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SECCIÓN ABIERTA MULTIDISCIPLINARIA

# Ciencia para el Desarrollo Science for Development

Vol. 37, N° 1 (2025)

ISSN 0257 - 1749

e - ISSN 1390 - 3659

DOI 10.37815/rte





Guayaquil, Ecuador  
Vol. 37, Núm. 1 (2025)  
Junio, 30

DOI: 10.37815/rte.v37n1



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## Editorial (Español)

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La **Revista Tecnológica ESPOL (RTE)** se complace en presentar a la comunidad académica y profesional el Volumen 37, Núm. 1, que incluye una **Sección Especial: Justicia Social en el Mundo Contemporáneo** y una **Sección Abierta Multidisciplinaria: Ciencia para el Desarrollo**. Este número refleja la diversidad temática, el enfoque aplicado y el compromiso con la generación de conocimiento al servicio de la sociedad, rasgos distintivos de nuestra publicación.

La **Sección Especial** constituye una contribución editorial exclusiva para este volumen, desarrollada en colaboración con *Global Migration Policy Associates (GMPA)*, con sede en Suiza. En ella se incluyen aportes de autores provenientes de diversas regiones del mundo, como Turquía, Reino Unido, Suiza, Australia, Ecuador, Estados Unidos, Canadá, Colombia, España y Marruecos, cuyas investigaciones abordan problemáticas actuales desde una perspectiva de justicia social global.

Por su parte, la **Sección Abierta**, publicada regularmente de forma semestral, se organiza en torno a tres ejes temáticos: innovación educativa, desarrollo tecnológico y gestión aplicada, así como producción agroindustrial y medio ambiente. Los artículos que la conforman ofrecen una visión integral de los desafíos contemporáneos en estas áreas del conocimiento.

**Innovación Educativa** agrupa tres artículos centrados en propuestas pedagógicas orientadas al aprendizaje activo y contextualizado. *Aprendizaje Basado en Proyectos: una práctica educativa innovadora en el Bachillerato Técnico* presenta una experiencia formativa que fortalece la autonomía estudiantil. A este le sigue *Gamificación en el aprendizaje de las matemáticas*, que analiza cómo el uso del juego puede mejorar la motivación y el rendimiento académico. La subsección se cierra con *Prácticas efectivas en la enseñanza de Lengua y Literatura para estudiantes de 9 a 12 años*, una revisión de metodologías con resultados prometedores para la educación básica.

**Tecnología y Gestión Aplicada** incluye investigaciones enfocadas en la innovación tecnológica y el uso del análisis de datos para la toma de decisiones. *Revisión sistemática de literatura sobre mecanismos de recolección de energía utilizados en dispositivos de monitorización de signos vitales* ofrece una panorámica útil sobre soluciones energéticas aplicadas a dispositivos biomédicos. A continuación, *Evaluación de un algoritmo de control para video adaptativo empleando enrutamiento tradicional y SDN* propone mejoras en la transmisión multimedia en redes. Finalmente, *Análisis predictivo y gestión optimizada de la cartera de clientes morosos en CNEL EP* aplica modelos de aprendizaje automático para anticipar comportamientos de pago, mejorando así la eficiencia en la gestión comercial del sector eléctrico.

**Agroindustria y Medio Ambiente** reúne estudios centrados en problemáticas del entorno agrícola, agroalimentario y ambiental. Inicia con *Virulencia de Phytophthora sp. en brotes de cacao*, que analiza enfermedades que afectan un cultivo estratégico para la región. Le sigue *Evaluación de la incidencia de insectos plaga en el cultivo de arroz en el cantón Nobol*, que proporciona datos clave para el manejo integrado de plagas. El artículo *Elaboración de helado de Morete con adición de suero lácteo* describe una alternativa innovadora de aprovechamiento alimentario. Finalmente, *Variación espacial de la contaminación por coliformes fecales en el río Portoviejo* aporta información relevante sobre la calidad del agua y la salud pública en la región.

En su conjunto, este volumen reafirma el compromiso de RTE con los enfoques interdisciplinarios de alcance internacional, y evidencia cómo la ciencia, la educación y la tecnología se articulan para dar respuesta a las necesidades sociales, ambientales y productivas, tanto a nivel local como global.

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## Editorial (English)

The **Revista Tecnológica ESPOL (RTE)** is pleased to present Volume 37, No. 1 to the academic and professional community, which includes a **Special Section: Social Justice in the Contemporary World** and an **Open Multidisciplinary Section: Science for Development**. This issue reflects the thematic diversity, applied approach, and commitment to generating knowledge in the service of society that are the hallmarks of our publication.

The **Special Section** is an exclusive editorial contribution to this volume, developed in collaboration with *Global Migration Policy Associates (GMPA)*, based in Switzerland. It includes contributions from authors from various world regions, such as Turkey, the United Kingdom, Switzerland, Australia, Ecuador, the United States, Canada, Colombia, Spain, and Morocco, whose research addresses current issues from a global social justice perspective.

The **Open Section**, published regularly every six months, is organized around three thematic areas: educational innovation, technological development and applied management, and agro-industrial production and the environment. The articles offer a comprehensive overview of contemporary challenges in these areas of knowledge.

**Innovation in Education** brings together three articles focused on pedagogical proposals for active and contextualized learning. *Project-Based Learning, an innovative educational practice in the Technical Baccalaureate*, presents a training experience that strengthens student autonomy. This is followed by *Gamification in Mathematics Learning*, which analyzes how the use of games can improve motivation and academic performance. This subsection concludes with *Effective Practices in the Teaching of Language and Literature for Students Aged 9 to 12*, a review of methodologies with promising results for basic education.

**Applied Technology and Management** includes research focused on technological Innovation and the use of data analytics for decision-making. *Systematic Literature Review on Energy Harvesting Mechanisms Used in Vital Signs Monitoring* offers a useful overview of energy solutions applied to biomedical devices. The following article, *Evaluation of an Adaptive Video Control Algorithm Using Traditional Routing and SDN*, proposes improvements in networked multimedia transmission. Finally, *Predictive Analysis and Optimized Management of the Delinquent Customer Portfolio at CNEL EP Bolívar Business Unit*, applies machine learning models to anticipate payment behaviors, thereby improving efficiency in commercial management in the electricity sector.

**Agroindustry and Environment** bring together studies focused on issues related to agriculture, agri-food, and the environment. It begins with *Virulence of Phytophthora sp in cocoa (Theobroma cacao L.) shoots at in vitro level* which analyzes diseases that affect a strategic crop for the region. This is followed by *Evaluation of the incidence of insect pests in rice (Oryza sativa L.) cultivation in Nobol canton, Guayas Province, Ecuador*, which provides key data for integrated pest management. The article *Production of Morete (Mauritia flexuosa L.f.) ice cream with whey addition* describes an innovative alternative for food utilization. Finally, *Spatial Variation of Fecal Coliform Contamination in the Portoviejo River, Manabí Province* provides relevant information on the region's water quality and public health.

As a whole, this volume reaffirms RTE's commitment to interdisciplinary approaches with an international reach. It demonstrates how science, education, and technology come together to address social, environmental, and productive needs, both locally and globally.

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**Special Section**  
**Sección Especial**

**Social Justice in the  
Contemporary World /  
Justicia Social en el  
Mundo Contemporáneo**



**RTE**

## Special Section Editorial (English)

The *Revista Tecnológica ESPOL (RTE)*, in collaboration with *Global Migration Policy Associates (GMPA)*, is pleased to present the *Special Section: Social Justice in the Contemporary World*. This section, fully published in English, delves into social justice as a subject of social-scientific and philosophical inquiry, public debate, and real-world social and political mobilization.

Social justice has re-emerged as a prominent theme, slogan, and organizing principle in contemporary political and social discourse, spanning local, national, and global arenas. The term is applied broadly and ambiguously across diverse domains such as politics, economics, social welfare, and environmental advocacy. Countless initiatives, campaigns, institutional frameworks, and governmental policies invoke the notion of social justice as a guiding rationale. Yet critical questions persist: Do these initiatives withstand rigorous, objective evaluation as effective mechanisms for advancing social justice? What normative, ethical, philosophical, or popular meanings are attributed to the term social justice? Which legal, policy, and practical strategies most effectively contribute to social justice realization? Despite its ubiquity in rhetoric and activism, “social justice” remains without a universally accepted definition, whether in academic discourse or international normative frameworks. The absence of conceptual clarity and scholarly convergence underscores the need for a more rigorous and structured exploration of the term and its applications.

Although a substantial body of literature addresses issues commonly framed as related to social justice, comprehensive academic treatments that examine the concept holistically remain scarce. The recent Global Coalition for Social Justice creation has further amplified the urgency of interrogating what “social justice” means and how it functions in practice. As a concept shaped by historical, cultural, scientific, and political contexts, social justice requires a multidisciplinary lens incorporating ethical inquiry, international legal standards, religious and philosophical traditions, and a critical understanding of social organizing, activism, and governance. In response to the gap in scholarly engagement, this Special Section brings together ten original articles that approach social justice from diverse theoretical and practical standpoints.

The opening article presents the findings of a broad literature survey, synthesizing seven key themes among forty topic areas in which the concept of social justice is frequently invoked. The second article engages theological and philosophical perspectives, focusing on dispossession as a paradigm of injustice. These are followed by three articles addressing fundamental social justice dimensions: gender equality, democratic and equitable international governance, and the sustainability of peasant family farming systems. Two additional contributions examine issues at the intersection of health and environmental justice. One focuses on rare diseases through a human rights lens, while the other analyzes the role of provision of adequate water, sanitation, and hygiene (WASH) in promoting social justice amid global warming. The final three contributions focus on community-level agency and institutional responses: two studies that examine the role of migrant associations and the labor experiences of female migrant workers in advancing social justice, and a country case study on Morocco with a representative analysis of the structural and political challenges confronting many nations in their pursuit of social justice.

Overall, the articles presented here are expected to stimulate critical reflection, foster ongoing academic research, and contribute meaningfully to the advancement of global discussions and knowledge production on social justice.

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## Editorial de la Sección Especial (Español)

La *Revista Tecnológica ESPOL (RTE)*, en colaboración con *Global Migration Policy Associates (GMPA)*, se complace en presentar la *Sección Especial: Justicia Social en el Mundo Contemporáneo*. Esta sección, publicada íntegramente en inglés, profundiza en la justicia social como tema de investigación sociológica y filosófica, debate público, movilización social y política en el mundo real.

La justicia social ha resurgido como tema, lema y principio organizador prominente en el discurso político y social contemporáneo, abarcando los ámbitos local, nacional y global. El término se aplica de forma amplia y ambigua en diversos ámbitos como la política, la economía, el bienestar social y la defensa del medio ambiente. Innumerables iniciativas, campañas, marcos institucionales y políticas gubernamentales invocan la noción de justicia social como fundamento rector. Sin embargo, persisten preguntas cruciales: ¿Resisten estas iniciativas una evaluación rigurosa y objetiva como mecanismos eficaces para promover la justicia social? ¿Qué significados normativos, éticos, filosóficos o populares se le atribuyen? ¿Qué estrategias legales, políticas y prácticas contribuyen con mayor eficacia a la consecución de la justicia social? A pesar de su ubicuidad en la retórica y el activismo, la “justicia social” sigue sin tener una definición universalmente aceptada, ni en el discurso académico ni en los marcos normativos internacionales. La falta de claridad conceptual y convergencia académica subraya la necesidad de una exploración más rigurosa y estructurada del término y sus aplicaciones.

Aunque existe una gran cantidad de bibliografía que aborda cuestiones comúnmente relacionadas con la justicia social, siguen siendo escasos los estudios académicos exhaustivos que examinan el concepto de manera integral. La reciente creación de la Coalición Global para la Justicia Social ha amplificado aún más la urgencia de cuestionar qué significa “justicia social” y cómo funciona en la práctica. Como concepto moldeado por contextos históricos, culturales, científicos y políticos, la justicia social requiere una perspectiva multidisciplinar que incorpore la investigación ética, las normas jurídicas internacionales, las tradiciones religiosas y filosóficas, y una comprensión crítica de la organización social, el activismo y la gobernanza. En respuesta a la brecha en el ámbito académico, esta sección especial reúne diez artículos originales que abordan la justicia social desde diversos puntos de vista teóricos y prácticos.

El artículo inicial presenta los resultados de una amplia revisión bibliográfica, sintetizando siete temas clave entre cuarenta áreas temáticas en las que se invoca con frecuencia el concepto de justicia social. El segundo artículo aborda perspectivas teológicas y filosóficas, centrándose en la desposesión como paradigma de injusticia. A estos les siguen tres artículos que abordan dimensiones fundamentales de la justicia social: la igualdad de género, la gobernanza internacional democrática y equitativa, y la sostenibilidad de los sistemas de agricultura familiar campesina. Otras dos contribuciones examinan cuestiones relacionadas con la intersección entre la salud y la justicia ambiental. Una se centra en las enfermedades raras desde la perspectiva de los derechos humanos, mientras que la otra analiza el papel de la provisión de agua, saneamiento e higiene (WASH) en la promoción de la justicia social en el contexto del calentamiento global. Las tres últimas contribuciones se centran en la acción a nivel comunitario y las respuestas institucionales: dos estudios que examinan el papel de las asociaciones de migrantes y las experiencias laborales de las trabajadoras migrantes en la promoción de la justicia social, y un estudio de caso sobre Marruecos con un análisis representativo de los retos estructurales y políticos a los que se enfrentan muchos países en su búsqueda de la justicia social.

En general, se espera que los artículos aquí presentados estimulen la reflexión, fomenten la investigación académica en curso y contribuyan de manera significativa al avance de los debates globales y de la producción del conocimiento sobre la justicia social.

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## Social Justice, Human Rights, Deliberate Action: An Analytical Review of the Literature in Seven Social Justice Thematic Areas

### Justicia Social, Derechos Humanos, Acción Deliberada: Una revisión analítica de la literatura en siete áreas temáticas de Justicia Social

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Sent: 2025/04/01  
Accepted: 2025/06/20  
Published: 2025/06/30

#### Abstract

This article presents an analytical review of contemporary social justice themes, drawing on an extensive literature survey. The review demonstrates that social justice is a central theme in many contemporary social struggles and demands for rights and justice. It further identifies key thematic issues, their normative foundations, and the principles of social justice, exploring how these are elaborated across different issue areas where social justice is a core concern. In several cases, social justice is also presented as a cross-cutting concern and conceptual approach. An overall literature survey identified 40 topical-thematic issue areas in which social justice is evoked and often thoroughly discussed. This article provides an overview of how social justice is addressed in seven of those 40 thematic topics. It presents summary analytical reviews of the literature on social justice considerations and dimensions in various arenas, including Human Rights, Decent Work, Health, Housing, the Digital Divide, Peacemaking/Small Arms Limitations, and Sustainable Development. These summaries review the connection between each topic and social justice and conclude with recommendations for how the social justice dimensions of each topic could be integrated into

**Summary:** Introduction, Methodology, Results: Analytical Review, Overall Conclusions.

**How to cite:** Düzgün, E., Sharma, H. & Taran, P. (2025). Social Justice, Human Rights, Deliberate Action: An Analytical Review of the Literature in Seven Social Justice Thematic Areas. *Revista Tecnológica - Espol*, 37(1), 17-43.  
<https://rte.espol.edu.ec/index.php/tecnologica/article/view/1302>

ongoing international policy processes, including the Global Coalition for Social Justice and the Second World Summit for Social Development, to be held in November 2025, and the implementation of their outcomes.

**Keywords:** Decent Work, Social Justice, Digital Divide, Disparities in Access to Technology, Peacebuilding, Sustainable Development.

### Resumen

Este artículo ofrece una revisión analítica de temas contemporáneos de justicia social, basada en un amplio estudio de la literatura. La revisión demuestra que la justicia social es un tema central en contenciones sociales y demandas de derechos y justicia contemporáneas. Esta revisión identificó, además, algunos de los temas clave y sus fundamentos normativos y principios de justicia social, y cómo estos se desarrollan en diferentes áreas temáticas que hacen referencia a la justicia social como un tema central. Algunos también muestran que es una preocupación común y un enfoque conceptual transversal. Un estudio general de la literatura identificó 40 áreas temáticas en cada una de las cuales se evoca la justicia social, a menudo ampliamente discutida. Esta revisión proporciona una visión general de cómo se identifica la justicia social en siete de los 40 temas cubiertos en el estudio amplio de la literatura. Aquí se presentan revisiones analíticas resumidas de la literatura sobre consideraciones de la justicia social en las áreas de Derechos Humanos, Trabajo Decente, Salud, Vivienda, Brecha Digital, Construcción de la Paz/limitación de armas pequeñas y Desarrollo Sostenible. En estos, se examinan las conexiones en el ámbito temático con la justicia social y se ofrecen como conclusiones de las respectivas revisiones algunas recomendaciones sobre cómo el tema en sus dimensiones de justicia social debería ser abordado por los procesos internacionales en curso, incluida la Coalición Mundial para la Justicia Social y la Segunda Cumbre Mundial sobre Desarrollo Social en 2025, y la posterior implementación de sus resultados.

**Palabras clave:** Trabajo decente, Justicia social, brecha digital, disparidades en el acceso a la tecnología, consolidación de la paz, desarrollo sostenible.

### Introduction

Our review of a vast body of literature indicates that social justice serves as an overarching conceptual and political framework for contemporary social struggles and demands for rights and justice. The literature identifies key thematic issues linked to social justice and highlights their foundations. Many works present social justice as a commonly associated—and even umbrella—concept and theme.

However, the literature also reveals that social justice is defined in various ways and used flexibly, if at all. Often it appears to be invoked to characterize and justify as good or beneficial whatever an institution, organization, government, or individual is doing, frequently without a clear and critical assessment of a policy's actual outcomes or whose interests it serves.

Following the invitation to compile, prepare and edit a special edition on social justice for *Revista Tecnológica Espol (RTE)*, the *Global Migration Policy Associates (GMPA)* team recognized the need for a concrete and thorough understanding of what is being addressed and what is meant when actors evoke the term and concept of social justice. This work was also developed in the context of ongoing global efforts led by the *Global Coalition for Social Justice (GCSJ)*, an international initiative that aims to promote coordinated action on social justice through research, policy, and advocacy. The Coalition convened its Second Forum in June 2025 in Geneva, and its recommendations are expected to shape the agenda of the Second

World Summit for Social Development, scheduled for November 2025 in Doha. In this context, the GMPA team conducted a comprehensive literature survey throughout 2024, supported by a team of graduate researchers completing 'research associate' internships at GMPA.

The team identified broad areas of exploration, including theoretical background and definitions. Additionally, 40 topics were identified in which the literature invoked or intersected with social justice. These included: Human Rights; Peacebuilding; Development; a Safe, Healthy and Sustainable Environment; Decent Work; Health and Universal Health Care; Water, Sanitation and Hygiene; Affordable Housing; Education and Schooling; Minimum Basic Income; Social Protection; Non-Discrimination and Equality of Treatment; Inclusion and Participation; Access to Technology/Digital Divide; and Human Security; among others.

As a key step in the process of building aggregate knowledge and understanding of social justice, team members undertook the next step: analyzing the literature summarized for each topical area, with each topical review covering 15 to 20 (or more) titles. The methodology for review and analysis is described below.

Given the variation in how the term is used across the literature, this study approaches social justice as a broad and multidimensional umbrella concept. It encompasses a range of interrelated concerns, including equitable access to resources and opportunities, the protection of marginalized communities, fair labor conditions, health equity, and inclusive development. These components may be referred to in the literature as "dimensions," "considerations," or "undergirding principles" of social justice, depending on context and emphasis. Despite this terminological variation, what unites these references is a normative orientation toward addressing systemic bias, discrimination, exclusion, and inequality, and promoting fairness and justice across diverse social contexts. Clarifying this conceptual framing at the outset allows for a more coherent analysis of how the term is evoked and applied across the thematic areas reviewed.

While acknowledging the varied and sometimes ambiguous usage of the term social justice across disciplines, this article argues that a thematic review of the literature can help illuminate shared normative orientations and practical implications. These insights may serve to inform ongoing global policy dialogues, such as those within the Global Coalition for Social Justice and the Second World Summit for Social Development.

What follows are summary analytical reviews of the literature evoking social justice concerns in the thematic areas of Human Rights, Decent Work, Health, Housing, Digital Divide, Peacemaking/Small Arms Limitations, and Sustainable Development.

### **Methodology**

The methodological approach comprised two main steps. The first was compiling an annotated literature review organized by topical-thematic categories related to social justice as evoked in the literature, discourse, and practice. Brief one- to two-paragraph summaries were prepared for each item of literature, noting the main content, ideas, and the mention of or links to social justice. These were compiled into a survey report covering more than 800 articles, book chapters, policy briefs, institutional statements, profiles, and other documents across 40 topical categories, totaling 240 pages at the time of writing.

The literature survey was conducted over the past year with the assistance of a graduate-level research team, which contributed to the production of annotated summaries for the

approximately 800 works selectively identified in the initial round. The team employed a schematic *prisma* approach to select relevant documents and publications, using paired keywords (social justice and the name of each thematic topic) as search terms. An initial overview reading of the identified items allowed for the selection of those that substantively discuss the triad of the thematic topic, social justice, and the inter-relationships between them. This initial round focused on literature in the English language. Reviews of works in French, Spanish, Russian, Arabic, Chinese, and other languages remain pending, dependent on resource availability, to gain a fuller global view and assessment.

The second and ongoing stage comprised a structured, significantly more detailed review and analysis of the literature found in each of the seven social justice topical-thematic areas reviewed in this article. This analytical review examined the content of the literature according to the following research and analysis questions:

- I. What are they talking about?
  - General characteristics of the topical content as noted in the articles: academic studies, case studies, campaigns, actions, organizational descriptions, etc.
  - Definitions of the topic area, as stated or defined in international instruments and/or by international organizations or academics, including variants that arise in the literature.
- II. How is it linked to, based on, or supportive of social justice (or not)?
  - Usage of the term: elaborated or only mentioned.
  - Explicit linking of the topic/concern/action to social justice and to what extent.
- III. What specific concept and definition of social justice are articulated?
  - Concept/conceptualization of social justice evoked or referred to.
  - Definition of social justice explicitly raised or outlined.
  - Normative bases referred to.
- IV. What explanation is given for the links between the topic and social justice?
  - Explanation of how the entity, agenda, activity, etc., advances social justice.
  - References to other topics, issues, and actions on social justice.
- V. What recommendations are made on *what to do?* (With current global processes as reference points)
  - How a global coalition on social justice should address the issues discussed in the literature.
  - How this social justice topic area should be taken up in the Second World Summit on Social Development process.

The structured literature analysis focused on seven thematic areas selected based on the depth and relevance of their connection to social justice, as previously outlined.

## **Results: Analytical Review**

### **Social Justice and Human Rights**

#### ***General Characteristics of Topical Content***

This topical review found a considerable number of articles, academic studies, policy reports, and advocacy statements that explicitly elaborate on the intersection between human rights and social justice, both in titles and content. These works generally refer to the normative frameworks of human rights in relation to social justice, highlighting how these frameworks promote equality and inclusion while also addressing systemic injustice. Several sources referred to definitions of human rights in international standards, most notably the Universal

Declaration of Human Rights (1948) and the ILO Declaration of Fundamental Principles and Rights at Work (1998), as well as their relationship to social justice. The literature also addressed how different arenas, such as labor rights and public health, incorporate human rights to promote social justice.

Across the reviewed texts, social justice is commonly framed as the equitable distribution of resources and opportunities, with a particular focus on eliminating systemic disadvantages. Many studies identify human rights as a normative framework through which social justice can be understood and implemented.

### ***The Link Between Human Rights and Social Justice***

Some of the literature reviewed elaborates on links between human rights and social justice. For example, Cotula (2020) highlights how international human rights law can address challenges brought by economic globalization, advocating for an empowered approach that centers on marginalized groups. Amnesty International (2015) critiques traditional human rights frameworks for failing to fully address systemic inequalities and calls for a more inclusive approach that integrates social justice ideals. Braveman (2010) explores the integration of human rights into policy and its role in addressing systemic inequality. A statement by the High Commissioner for Human Rights, Ms. Bachelet (2019), explicitly discussed social justice.

Ms. Bachelet's 2019 statement, Rashid Bhat and colleagues' empirical analysis of the correlation between human rights and social justice indicators (Bhat et al., 2022), and Tim De Meyer's (2022) discussion on labor rights demonstrate how the integration of human rights principles and norms across various sectors promotes social justice.

In Braveman's (2010) work, social justice is linked to addressing the social determinants of health—factors such as income, education, and housing—and argues for integrating human rights with public health policies to reduce inequities. The Amnesty International report (2015) defines social justice as the equitable treatment and protection of marginalized communities within human rights frameworks.

Tim De Meyer's (2022) work on labor rights emphasizes how fair wages, maternity protection, and safe working conditions contribute to social justice by promoting decent work for all. Similarly, Kenyon et al. (2018) emphasize how addressing social determinants of health through a rights-based approach can promote both human rights and social justice, particularly within marginalized communities.

Several works referenced global efforts to integrate human rights protections with broader social justice agendas. For example, Cotula (2020) discusses the need to address economic globalization within the human rights framework to empower marginalized communities and create a fairer international system.

### ***Recommendations***

This literature generally emphasizes the need for a multidimensional approach to addressing the intersection of human rights and social justice. Cotula (2020) recommends rethinking international human rights law to better address the challenges posed by economic globalization. Rashid Bhat et al. (2022) stress the importance of policymakers prioritizing the reduction of economic inequality through enhanced human rights protections, particularly in the labor and public health sectors.

Based on these findings, the authors of this review recommend that both the Global Coalition for Social Justice (CSJ) and the World Summit on Sustainable Development (WSSD) emphasize the integration of human rights frameworks with social justice agendas. Key areas of focus should include labor rights, universal health coverage equity, and addressing systemic discrimination, exclusion, and inequalities exacerbated by globalization.

To enhance relevance to these platforms, it is further recommended that the GCSJ prioritize aligning human rights-based protections—such as employment and health—with broader justice-driven development strategies. Similarly, the WSSD could focus on applying the insights from the literature to promote policy measures that safeguard rights and reduce discrimination, exclusion, and inequity. Strengthening the connection between human rights and social justice in these global efforts may help ensure inclusive legal frameworks and multilateral cooperation that actively protect marginalized communities – indeed, all communities – and ensure equitable access to resources and opportunities.

## **Health and Social Justice**

### ***General Characteristics of Topical Content***

The reviewed literature presents a comprehensive exploration of how health disparities intersect with broader social justice concerns. Core themes include public health strategies, social determinants, healthcare equity, ethical principles, intersectionality, and structural factors such as climate change and migration.

Corey H. Basch (2014) advocates for population-level public health interventions that address the root causes of poverty as a means to mitigate health disparities. Braveman and Gottlieb (2014) similarly emphasize tackling the "causes of the causes" of inequities. These authors emphasize the importance of considering social, economic, and environmental contexts—rather than focusing solely on individual behaviors or clinical access—when aiming to improve health outcomes.

Cummiskey (2008) advocates for a social insurance approach to healthcare, arguing that it should be treated as a social good rather than a market commodity. Prah Ruger (2004) and Daniels (2008) echo this normative framing by positioning health as a fundamental aspect of social justice that demands institutional and governmental focus.

The literature also includes global and regional reports. The WHO (2008) emphasizes social determinants of health, while the OHCHR (2016) connects climate change, health, and inequality. Whitehead and Dahlgren (2021) advocate a multisectoral strategy to reduce health inequities in Europe.

Several region- and population-specific studies further contextualize these themes: Garneau and Bélisle (2021) call for equity-based transformation in Canadian health education; Griffiths et al. (2016) and Gooshki et al. (2016) focus on Indigenous and migrant health, respectively; and Pande et al. (2017) propose a multidimensional framework for assessing health justice in Egypt.

Intersectionality is introduced by Crenshaw (1989) and developed by Metzl and Hansen (2014), highlighting how overlapping identities shape health outcomes. Rogers and Kelly (2011) employ a feminist intersectional lens to connect research ethics with structural justice, while Dagrón (2019) examines the intersection of legal barriers with health and migration. Environmental dimensions of health justice are emphasized in Rouf and Wainwright's (2020) analysis of climate change.

Normative foundations include the Universal Declaration of Human Rights (Article 25) and the WHO Constitution, both of which affirm the right to health. Additional global frameworks, such as Universal Health Coverage (UHC) and SDG 3, reinforce the right to equitable, quality healthcare without financial burden.

### ***The Link Between Health and Social Justice***

Many of the reviewed studies directly connect health systems to social justice, while others approach the relationship more implicitly. Basch (2014) and Farmer (2004) both argue that addressing structural causes of ill health is essential to achieving social justice. Gostin and Powers (2006) examine this connection in public health policy, while Buettner-Schmidt and Lobo (2012) focus on nursing.

Dilworth-Anderson et al. (2012) and Griffiths et al. (2016) explore disparities affecting minority elders and Indigenous communities, respectively. Maja et al. (2023) provide a comprehensive global overview of health inequality, while Owen (2009) critiques consumer-driven healthcare from a justice perspective.

A significant portion of the literature engages normative political theory. Ruger (2010) proposes a theory of health justice grounded in the capability approach, which integrates both ethical reasoning and procedural fairness. Peter (2001) and Pande et al. (2017) draw on Rawlsian principles, particularly "justice as fairness" (Rawls, 1971), to argue that unequal health outcomes reflect broader societal injustices.

Dukhanin et al. (2018) introduce distributive justice frameworks—such as prioritarianism, egalitarianism, and sufficientarianism—into healthcare economics. Persad (2018) reviews metrics of justice, including welfarism, resourcism, and capabilities, emphasizing their role in evaluating public health interventions.

Powers and Faden's (2006) six-dimensional theory of justice (health, personal security, reasoning, respect, attachment, self-determination) is applied in Gooshki et al. (2016) to analyze migrant health in Iran. Merz et al. (2023) build on Collins' definition of intersectionality as both a research and justice framework, proposing a paradigm shift in public health scholarship.

Ethical critiques are also prominent: Rogers and Kelly (2011) emphasize the importance of redistributive fairness in research design, while Ruger (2010) provides operational frameworks for evaluating health equity and allocating resources efficiently.

Economic evaluation literature (Dukhanin et al., 2018; Drummond et al., 2005) outlines both direct (equity weighting, stratified cost-effectiveness) and indirect (multicriteria decision analysis) strategies for incorporating justice. Merz et al. (2023) stress the importance of epistemological reflexivity in intersectional public health research.

### ***Recommendations***

The reviewed literature emphasizes that advancing social justice in health requires both ethical frameworks and concrete institutional reforms. Ruger (2010) proposes a model of shared health governance, which distributes responsibility among governments, institutions, civil society, and individuals. This model is grounded in ethical commitments and aims to achieve equity through the redistribution of resources, public regulation, and the creation of public goods. By including both personal and collective obligations, Ruger's theory links health equity to a broader vision of participatory justice.

Complementing this theoretical foundation, Pande et al. (2017) provide a practical roadmap for improving health systems through 14 targeted, evidence-based reforms. These include national action plans, integrated service delivery, monitoring high-risk groups, provider payment reforms, grievance mechanisms, and citizen participation. Their model emphasizes that achieving social justice in healthcare requires systemic and institutional transformation backed by policy instruments.

Building on these contributions, this review recommends that the Global Coalition for Social Justice (GCSJ) integrate shared health governance principles into its agenda. Given its multi-actor composition, GCSJ is well-positioned to support cross-sector coordination in areas such as equitable healthcare access, financing, and quality assurance. Ruger's emphasis on co-responsibility offers a compelling ethical basis for guiding coalition initiatives.

The World Summit on Sustainable Development (WSSD) should align Sustainable Development Goal 3—"Ensure healthy lives and promote well-being for all at all ages"—with actionable social justice frameworks. Pande et al.'s reform package provides a concrete entry point for operationalizing health equity in summit-level commitments.

Both platforms should prioritize Universal Health Coverage (UHC) as a global justice imperative. Framing UHC not only as a health goal but as a human right can help shift the focus from access alone to structural transformation. Drawing on justice frameworks from Ruger, Powers and Faden, and Pande et al., these efforts can embed fairness, accountability, and participation at the core of global health governance.

## **Decent Work and Social Justice**

### ***General Characteristics of Topical Content***

The concept of decent work has long been recognized as a cornerstone of social justice. As work constitutes an integral part of human life, ensuring decent work is fundamental to improving the quality of life and promoting equity. The International Labour Organization (ILO) has played a pivotal role in defining and advancing the decent work agenda, which centers on fair income, job security, social protection, and the safeguarding of workers' rights. This definition underpins both international labor standards and Sustainable Development Goal 8, which promotes inclusive economic growth and decent work for all.

The literature reviewed spans multiple disciplines, including labor studies, psychology, economics, and political science, and reflects a shared understanding of decent work as essential to achieving social justice. Numerous studies highlight the normative basis of decent work, emphasizing how it can reduce structural inequalities and empower marginalized groups.

Devitt (2016) highlights the contribution of decent work to social cohesion, poverty reduction, and dignity, especially for marginalized populations such as women, migrants, and people with disabilities. Balin and Kang (2018) advocate for incorporating the ILO's decent work framework into counseling practices, viewing it as a tool for advancing human welfare and peace. Budwiski, Jany, and Schief (2020) revisit the concept in light of digitalization and care work, arguing for an expanded understanding that addresses gender inequality and informality in labor markets.

From a psychological perspective, Blustein et al. (2016) link decent work to individual well-being and life satisfaction, presenting it as both a personal and societal good. Their work draws from the Psychology of Working Theory, underscoring the role of meaningful employment in fostering justice and human development.



Other studies take a more policy-oriented view. Wickham (2016) positions decent work as central to combating workplace inequality, emphasizing the need for inclusive environments that support both fair treatment and full participation. Koenig (2023) examines the significance of decent work in Nigeria's development agenda, advocating for its role in combating poverty and inequality through gender-sensitive and inclusive policies.

The literature also engages with the role of governments, unions, employer organizations, civil society, and international bodies in operationalizing decent work. Madina (2024) emphasizes that decent work principles must be integrated into national strategies, particularly for vulnerable populations such as youth, women, and migrant workers. Across these texts, decent work is consistently framed as a tool for empowerment, redistribution, and sustainable development.

### ***The Link Between Decent Work and Social Justice***

In the literature reviewed, decent work is consistently presented as a fundamental human right and a key mechanism for achieving social justice. Vosko (2002) highlights the ILO's evolving role in promoting decent work amid globalization and technological change, framing it as a central strategy for addressing global inequalities.

Ryder (2017) positions decent work policies as the engine of inclusive growth and social cohesion. He argues that labor protections, combined with targeted social investment, can counteract inequality and strengthen societal resilience. Similarly, Blustein et al. (2016) and Devitt (2016) articulate social justice in terms of equitable access to meaningful work, particularly for marginalized groups.

Koenig (2023) connects decent work to poverty reduction and sustainable development, calling for targeted labor policies that dismantle structural barriers. Trebilcock (2005) expands the discourse to the informal economy, arguing that social justice cannot be achieved without extending decent work protections to informal workers.

The literature also explores intersections between decent work and other dimensions of justice. Budwiski et al. (2020) address gender inequality in care work and informal labor, while Madina (2024) links decent work with environmental sustainability through green jobs and socially responsible industry practices.

Collectively, these studies define social justice as the protection of rights and the fair distribution of resources and opportunities within the world of work. They underscore the importance of regulatory labor standards, safe working environments, and inclusive economic systems in advancing both workplace justice and broader societal equity.

### ***Recommendations***

The literature emphasizes the importance of integrating decent work principles into development frameworks at both national and international levels. Ryder (2017) advocates for global cooperation to implement inclusive growth strategies grounded in labor rights, particularly through investments in education, skills development, and social protection.

Koenig (2023) claims that national development strategies—especially in low- and middle-income countries—must prioritize decent work to reduce inequality and promote inclusive economic participation. She calls for targeted interventions for at-risk groups, including women, youth, and migrant workers.

Based on these insights, this review supports the Global Coalition for Social Justice's (GCSJ) decision to uphold decent work as a central organizing principle in its multistakeholder initiatives. The literature supports the GCSJ in providing space for knowledge exchange, aligning with ILO standards, and coordinating labor-focused reforms that directly address inequality in the world of work.

Similarly, the World Summit on Sustainable Development should ensure that commitments to SDG 8 are grounded in concrete measures to expand labor protections, reduce informality, and guarantee the rights of vulnerable workers. Decent work should be integrated into all levels of sustainable development planning, not as a peripheral concern but as a driver of equitable growth.

Both platforms should support coordinated policy action, mobilize technical assistance, and facilitate cross-border cooperation to implement decent work agendas. In doing so, they can help transform decent work from a normative ideal into a practical instrument for achieving social justice on a global scale.

### **Decent-Affordable Housing and Social Justice** *General Characteristics of Topical Content*

The reviewed literature underscores housing as a fundamental global issue of social justice. According to the UN-Habitat Annual Report (2023), 318 million people are currently homeless, while 1.1 billion live in slums or informal settlements. Since 2020, an additional 200 million people have been pushed into slums (UN-Habitat, 2023). These statistics reflect the urgent, multidimensional nature of housing injustice, encompassing the right to housing, affordability, urban inequality, homelessness, and the failures of neoliberal housing policies.

Numerous studies focus on the rights-based and structural dimensions of housing. Adams (2008) examines the philosophical foundations of housing as a human right, while Aribigbola (2011) emphasizes the importance of housing affordability in Nigeria to sustainable development. Anierobi, Nwalusi, et al. (2023) examine social exclusion between formal and informal settlements in Enugu, highlighting how housing inequality impacts spatial justice. Similarly, Bone and O'Reilly (2010) critique the commodification of housing in the UK, linking it to social fragmentation and instability.

Global frameworks, such as those developed by Busch-Geertsema et al. (2016), emphasize the need for systematic tracking of homelessness, noting its global neglect in comparison to other basic needs. The joint report by Habitat for Humanity, UN-Habitat, and UNICEF (2022) addresses the specific housing vulnerabilities of children, drawing attention to key rights frameworks, including the Universal Declaration of Human Rights and the UN Convention on the Rights of the Child.

Studies from various national contexts provide comparative insights. Hearne and Murphy (2017) critique Ireland's over-reliance on private rental markets, while Jacobs (2019) explores neoliberal housing policy across the U.S., UK, and Australia, arguing that global financial forces deepen housing inequality. Kimhur (2024) proposes a capabilities-based approach to housing justice, suggesting that housing policies should be evaluated based on individual security and opportunity rather than distributive formulas.

Recent research has expanded the housing justice framework to encompass intersections with health, education, and environmental sustainability. Mallach (2020), Soederberg (2017), and Swope and Hernández (2019) demonstrate how housing conditions

directly affect well-being, health equity, and access to opportunity. Springer (2000) and Vissing (2022) link homelessness to children's developmental outcomes and educational inequality.

International and regional studies by Weaver (2018), Dawkins (2021), and Mueller and Rosie (2013) examine the responsibilities of local governments, the role of homeownership policies, and the implications of racial and economic segregation. The literature also includes practical tools, such as the Housing Barometer (UN-Habitat, 2020c), and case studies from New York (Bloom & Lasner, 2019), the UK (Burton, 2003), China (Huang, 2013; Shi et al., 2016), and Singapore (UN-Habitat, 2020a).

The role of housing movements is also well-documented. Irazábal (2018) explores Brazil's MTST movement as a form of "restorative land grab," while Lima (2021) and Chatterjee et al. (2024) highlight activist strategies that link housing justice to wider struggles against neoliberalism and social exclusion. These studies demonstrate how grassroots activism complements institutional policy efforts by redefining housing as a right, rather than a commodity.

### ***The Link Between Decent-Affordable Housing and Social Justice***

Many works explicitly define housing as a key dimension of social justice. Vissing (2022) emphasizes that secure, sustainable housing is central to dignity, safety, and health, especially for children. Her work also highlights the connection between housing, education, employment, and community stability. Swope and Hernández (2019) argue that housing inequality contributes to addressing health disparities through affordability, stability, housing quality, and neighborhood opportunity.

The literature also critiques dominant justice frameworks. Watson and Cuervo (2017) challenge resource-based approaches to youth homelessness, drawing on Iris Marion Young's theory to stress subjecthood, self-determination, and the politics of recognition. Similarly, Weaver (2018), building on T.H. Marshall's concept of urban social citizenship, critiques liberal theories of justice for tolerating structural inequality in urban contexts. He proposes a model that focuses on tangible needs and public responsibility in housing provision.

International human rights instruments further institutionalize the right to housing justice. Vissing (2022) lists key treaties that reference housing rights, including the ICESCR (Article 11.1), the CRC (Article 16), and various ILO conventions on workers' housing conditions. Housing rights are also protected under refugee law, humanitarian law, and criminal law instruments such as the Rome Statute. These frameworks affirm housing as a basic component of human dignity and legal protection.

The intersection of housing and justice is also reflected in global initiatives such as the UNECE Geneva Charter (2015), #Housing2030 (2021), and the New Urban Agenda (2016), all of which emphasize inclusive urban development, affordability, and sustainability. These initiatives further underscore the multifaceted role of housing in promoting global justice.

### ***Recommendations***

The literature review presents both theoretical frameworks and practical policy guidance for promoting housing justice. Adams (2008) proposes a rights-based model that balances dignity with practical implementation challenges. Kimhur (2024) calls for a shift from distributive approaches to capability-based assessments that emphasize housing opportunity, security, and functionality.

Global initiatives provide further direction. UNECE's #Housing2030 (2021) outlines tools across governance, finance, land policy, and climate-neutrality. The UN-Habitat handbook on land (2020) and expert group reports (2020b) propose comprehensive strategies to combat homelessness through affordable housing and social protection systems. These efforts align with the 2030 Agenda for Sustainable Development and SDG 11.

Based on these findings, this review supports recommending that the Global Coalition for Social Justice (GCSJ), the World Summit on Sustainable Development (WSSD) and other global policy processes elevate housing within their broader agendas by promoting the implementation of international frameworks such as the Geneva Charter, the New Urban Agenda, and SDG 11. These and other global processes could facilitate cross-regional collaboration on rights-based housing reforms, support the use of UN-Habitat's evaluation tools (e.g., Housing Barometer), and promote capability-based housing assessments in partnership with governments, social partners, and civil society actors. Member states should be encouraged to adopt integrated urban planning policies that prioritize affordability, equity, and environmental sustainability, and focus on populations at risk, including children, refugees, informal settlers, and low-income urban residents. Housing should be emphasized not only as a development goal but as a human right grounded in international law. In fostering multilevel policy dialogue, technical assistance, and rights-based innovation, contemporary international policy processes can help transform housing justice into a central pillar of social justice worldwide.

### **Digital Divide/Access to Technology and Social Justice**

The literature surrounding the digital divide highlights its significant connection to social justice. As access to technology becomes an essential component of daily life, disparities in digital access and literacy create barriers to education, employment, healthcare, and civic participation. These inequities disproportionately impact marginalized communities, including low-income, rural, and racial minority populations, further entrenching broader social inequalities. Common themes across the literature include calls to action for equitable access to technology through policy interventions, infrastructure development, and community-driven solutions, promoting digital inclusion.

### ***General Characteristics of Topical Content***

The literature encompasses various studies, case analyses, and institutional reports that examine the intersection of digital exclusion with social justice. Cooper (2021) explores the digital divide in San Francisco, highlighting how limited access to technology deepens socio-economic disparities. Stephens and Marc (n.d.) expand this discussion by linking the digital divide to broader issues such as education and access to essential services. Hardy (2023) emphasizes systemic barriers that hinder marginalized communities from benefiting from digital technologies, while the Internet Society Foundation (2023) underscores the role of digital literacy and affordability in ensuring meaningful access.

Global perspectives also emerge. Iberdrola (2024) examines how socio-economic status and geography impact access to digital resources globally. Singh and Singh (2021) address these challenges in the Indian context, highlighting how unequal digital access hinders social mobility and perpetuates social exclusion.

International organizations, such as the International Telecommunication Union (ITU) and the United Nations, integrate digital access into their broader development agendas. The ITU defines the digital divide as the gap between those with and without access to ICTs, highlighting its implications for economic development and inclusion. SDG 9 calls for

inclusive and sustainable infrastructure, including expanded digital access, as a means to reduce inequalities and foster innovation.

### ***The Link Between Digital Divide/Access to Technology and Social Justice***

Social justice is a recurring theme in digital divide literature. Many scholars explicitly frame digital equity as a fundamental right in the digital era. Cooper (2021) and Hardy (2023) argue that limited digital access perpetuates inequalities in education, employment, and health, highlighting the importance of digital inclusion in advancing social justice. Stephens and Marc (n.d.) highlight digital literacy and infrastructure as foundational to equitable societal participation.

The IEEE Future Network Program (2024) links the digital divide to educational and economic disparities, while the World Science Forum Declaration (2022) emphasizes the necessity of inclusive digital policies to bridge technological gaps in underserved regions.

Across the literature, social justice is conceptualized through shared themes of equity, fairness, and inclusivity. Cooper (2021) frames digital equity as a right, asserting that everyone should have access to the tools and knowledge needed to participate in the digital economy. Stephens and Marc (n.d.) associate social justice with fair resource distribution, directly connecting it to digital access. Krings (2021) positions internet access as a human rights issue, reinforcing its importance in addressing broader societal inequalities.

The Internet Society Foundation (2023) advocates for a multidimensional approach to digital equity, considering affordability, usability, and digital literacy. This comprehensive perspective underscores the need for policies that address both material and structural barriers to digital inclusion.

Singh and Singh (2021) exemplify how rural areas, particularly in India, face compounded exclusion due to limited infrastructure. Hardy (2023) similarly emphasizes how digital barriers hinder marginalized populations from achieving educational and economic advancement, thereby perpetuating social injustice.

### ***Recommendations***

Addressing the digital divide is essential for fostering inclusive and equitable societies. Bridging this divide contributes to broader social justice aims, including economic empowerment and universal access to education and healthcare.

The literature strongly supports a multilevel strategy. Cooper (2021) recommends expanding broadband infrastructure and ensuring affordability. Stephens and Marc (n.d.) emphasize the importance of digital literacy programs specifically designed for marginalized communities. Hardy (2023) advocates for public-private partnerships and systemic policy reforms to address infrastructure gaps and provide digital skills training.

At the international level, the IEEE Future Network Program (2024) advocates for coordinated policy efforts that prioritize digital inclusion as part of global development. Singh and Singh (2021) stress the role of community-led initiatives in bridging technological gaps in rural areas. The World Science Forum Declaration (2022) emphasizes ethical governance of technology to ensure that digital innovation aligns with principles of equity and justice.

Together, these findings support the recommendation that the Global Coalition for Social Justice and the World Summit on Social Development prioritize the promotion of digital

inclusion. This would include investment in digital infrastructure, digital literacy initiatives, and equity-focused policy design to ensure that technological progress contributes meaningfully to social justice.

### **Peacebuilding/ Small Arms and Light Weapons (SALW) and Social Justice**

The relationship between small arms control, peacebuilding, and social justice is a well-explored area in international relations and development studies. Numerous international organizations, particularly the United Nations, emphasize the critical importance of controlling Small Arms and Light Weapons (SALW) to foster peace, security, and sustainable development. The United Nations Development Programme (UNDP, n.d.) emphasizes that SALW significantly contribute to violence and instability, particularly in regions affected by conflict. The widespread availability of these weapons hampers socio-economic progress and, consequently, undermines global peacebuilding efforts. Moreover, SALW control is seen as integral to advancing social justice by addressing the systemic inequalities that often fuel conflict and instability. In addition to SALW control, foreign aid plays a crucial role in peacebuilding efforts, particularly when focused on promoting social justice and inclusive development. This literature review examines key definitions and examples to explore the intersection of small arms control, peacebuilding, and social justice.

#### ***General Characteristics of Topical Content***

The literature on small arms control and peacebuilding is extensive, encompassing academic analyses, case studies, policy reports, and empirical research. According to UNDP, the proliferation of SALW is a major obstacle to peace, security, and sustainable development. The UN Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons (PoA), adopted in 2001, focuses on curbing the illicit trade in these weapons and stresses the importance of coordinated national, regional, and global strategies.

Foreign aid is another major component discussed in the literature. The 2030 Agenda for Sustainable Development, particularly SDG 16, emphasizes the promotion of peaceful and inclusive societies, access to justice, and the development of effective institutions. Several studies underline that foreign aid in post-conflict contexts must strike a balance between promoting inclusive development and avoiding aid dependency.

#### ***The Link Between Peacebuilding / SALW and Social Justice***

The literature consistently links SALW control and peacebuilding with social justice, particularly through the lenses of equity, human rights, and the rule of law in post-conflict societies. Social justice is framed as achievable only through inclusive peacebuilding processes that address the root structural inequalities that drive conflict.

Pherali (2021) explores how foreign aid can either promote or undermine social justice depending on its design and implementation. Maber (2019) highlights the role of education in peacebuilding and its link to ethnic and social equity. Connolly and ACCORD (2012) emphasize the importance of post-conflict gender analysis for inclusive governance.

SALW proliferation disproportionately affects already-marginalized communities, intensifying violence, displacement, and insecurity. A ReliefWeb (2014) article advocates for embedding human rights and democratic governance within peacebuilding to secure justice. Tiekou et al. (2021) call for addressing historical injustices to achieve reconciliation and long-term peace.

Transitional justice mechanisms, as described by ECDPM (2014), play a key role in advancing social justice. These mechanisms emphasize accountability and reconciliation to repair societal divisions after conflict. The literature suggests that integrating small arms control with participatory governance, economic equity, and transitional justice is crucial for establishing sustainable peace.

### ***Recommendations***

The literature recommends an integrated approach to social justice, peacebuilding, and small arms control. Key strategies include:

- Strengthening international regulatory frameworks,
- Enhancing technical and financial support to SALW-affected regions,
- Promoting participatory governance and transitional justice mechanisms,
- Ensuring that post-conflict reconstruction includes the voices of marginalized communities.

These approaches aim to reduce systemic violence and foster accountability, equity, and reconciliation.

In light of these insights, the literature supports recommending that the Global Coalition for Social Justice (GCSJ) and the World Summit on Sustainable Development (WSSD) include peacebuilding and arms control as core agenda items. These efforts should be framed within the broader pursuit of social justice and aligned with interconnected themes such as human rights, decent work, affordable housing, and sustainable development. Addressing structural injustices and promoting social cohesion in post-conflict situations is essential to realizing a peaceful society.

### **Social Justice and Sustainable Development**

The intersection of sustainable development and social justice is a growing focus in academic literature, policy reports, and case studies. Although still limited in number, the reviewed sources reflect a wide range of subthemes, including the role of governance, Indigenous knowledge systems, and inclusive economic development. These studies underscore the need for sustainability and social justice to be addressed in tandem to achieve fair and lasting outcomes.

### ***General Characteristics of Topical Content***

Here we cite a few examples from the 15 items reviewed, as shown in the bibliographical listing below and as will be seen in the full literature survey available online. First, Langhelle (2000) examines sustainable development in the Arctic, where resource exploitation poses a threat to both the environment and Indigenous communities. This article advocates for governance mechanisms that strike a balance between economic goals and Indigenous rights, emphasizing the importance of social justice in regional environmental policy.

Bălăceanu et al. (2012) argue that poverty, inequality, and exclusion must be addressed through fair governance and equitable resource distribution in order to realize sustainability. Similarly, Munasinghe (2019) stresses that the post-COVID world has made the integration of social justice into development strategies even more critical.

Pirini et al. (2023) focus on Indigenous-led economic initiatives as sustainable and socially equitable models. These initiatives emphasize environmental stewardship, community resilience, and intergenerational justice.

Sampson and Fischhoff (2024) examine just climate transitions in Africa, showing that communities least responsible for climate change often suffer its worst consequences. They argue for climate policies that correct such injustices. Finally, Bhuyan (2017) highlights the role of governance in aligning sustainability with equity, contending that sustainable development can only be achieved if its benefits are fairly distributed.

### ***The Link Between Sustainable Development and Social Justice***

Most literature agrees that sustainable development is not viable without integrating social justice. Langhelle (2000) ties Indigenous self-determination and participation in governance to environmental sustainability, asserting that social exclusion undermines ecological goals.

Bălăceanu et al. (2012) call for strategies that target inequality and poverty, positioning justice as both a means and an end in sustainability. Pirini et al. (2023) argue that Indigenous approaches to economic development inherently incorporate sustainability principles, underscoring the importance of community-centered solutions. Sampson and Fischhoff (2024) present climate justice as central to sustainable transitions, especially in vulnerable regions.

Across the sources, social justice is framed through values of equity, fairness, participation, and recognition. For example, Langhelle (2000) focuses on Indigenous rights and inclusion in Arctic governance, Bălăceanu et al. (2012) emphasize addressing systemic poverty and exclusion, and Pirini et al. (2023) advocate for empowering marginalized groups through Indigenous economic leadership.

The literature demonstrates that social justice is both a prerequisite and a goal of sustainable development. Langhelle (2000) shows how excluding Indigenous voices in Arctic governance undermines environmental policy. Sampson and Fischhoff (2024) argue that unless Africa's climate transitions prioritize equity, sustainability itself will remain out of reach.

### ***Recommendations***

The literature states that sustainability efforts must embed social justice principles to be effective. Inclusive governance, Indigenous rights, and participatory development are key strategic arenas for further research, policy development, and practical action to ensure that sustainability serves all communities, particularly those at risk of exclusion or harm.

Langhelle (2000) recommends multilateral mechanisms that prioritize Indigenous participation. Bălăceanu et al. (2012) emphasize the importance of community-based decision-making and equity-focused resource allocation policies. Munasinghe (2019) calls for recovery policies that reduce inequality and improve access to environmental and economic resources. Pirini et al. (2023) advocate for the recognition of Indigenous rights in economic planning as a path to both justice and sustainability. Sampson and Fischhoff (2024) underscore the importance of international funding and solidarity in achieving climate justice in Africa.

In light of this literature, the Global Coalition for Social Justice (GCSJ) and the World Summit on Sustainable Development (WSSD) should frame sustainable development not only as an ecological issue but also as a justice imperative. Social justice must guide climate transitions, economic planning, and development cooperation. This includes equitable policy



frameworks, the protection of Indigenous and marginalized communities, and shared governance models that align with global sustainability goals.

### **Overall Conclusions**

The seven thematic areas examined in this analytical literature review—drawn from a broader mapping of 40 topical social justice domains—illustrate both the specificity and interrelatedness of the challenges to realizing social justice globally. A unifying insight across these diverse areas is the central role of international normative frameworks, particularly human rights conventions and International Labour Standards—specifically the Conventions of the International Labour Organization (ILO). These instruments provide not only guiding ethical principles but also serve as operational benchmarks for evaluating progress related to justice across sectors.

A key finding from this review is that social justice must be understood and approached as a multidimensional and integrative concept. In health, work, housing, technology, peacebuilding, and sustainability, the literature repeatedly highlights overlapping systems of exclusion and structural inequality. Across these domains, social justice is consistently articulated not only as a normative ideal but as a practical agenda requiring institutional, legal, and policy transformation.

In the realm of human rights, the reviewed literature advocates for a more inclusive and empowered application of rights frameworks—ones that explicitly confront economic inequality and systemic discrimination. Human rights are positioned as tools to implement social justice, particularly when integrated into labor, health, and development strategies.

In health, justice is grounded in ethical reasoning, the social determinants of health, and intersectional frameworks. The literature supports models of shared health governance, linking personal and collective responsibility to structural reforms that address entrenched disparities and promote equitable access to care.

Regarding decent work, the literature frames labor rights as foundational to social justice. It highlights the urgent need to embed decent work principles in national and global development agendas to ensure fair treatment, income security, and workplace dignity, particularly for marginalized populations, including migrants, women, and young people.

The analysis of housing reveals it as both a fundamental right and a structural condition shaping life opportunities. Secure, affordable, and dignified housing is portrayed as a prerequisite for realizing other rights, including education, health, and employment, with calls for a rights-based, capability-oriented, and participatory housing policy approach.

In the area of the digital divide, the literature emphasizes that equitable access to digital infrastructure and skills is no longer optional but a prerequisite for social inclusion, education, employment, and democratic participation. Digital equity is increasingly viewed as a contemporary expression of the right to participation and opportunity in society.

The review of peacebuilding and small arms control (SALW) literature highlights that addressing root causes of conflict—including inequality, exclusion, and historical injustice—is vital for sustainable peace. The literature emphasizes the importance of embedding justice and accountability into disarmament and post-conflict reconstruction processes, positioning these as central to achieving equitable and lasting peace.

Ultimately, in the context of sustainable development, the literature demonstrates that environmental and economic objectives must be inextricably linked to social justice principles.

Inclusive governance, recognition of Indigenous rights, and equitable distribution of benefits are repeatedly emphasized as essential to ensuring sustainability outcomes are both just and effective.

Taken together, these findings underscore the importance of integrating these thematic areas in agendas of the Global Coalition for Social Justice and the Second World Summit for Social Development. Such integration would contribute to building coherent and action-oriented strategies for advancing social justice globally, drawing on robust normative foundations and responding to lived realities across diverse social, economic, and geopolitical contexts.

### Acknowledgements

The authors wish to express their gratitude to Elisa Allegra Ferrante and Emma Rimonteil for their work as part of the GMPA literature review team on researching and preparing the Global Literature Survey on Social Justice, and to Olga Kadysheva for her assistance in finalizing the article.

The authors declare equal contribution and sharing of authorship roles for this publication.

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# The Dynamics of Dispossession

## La dinámica del despojo

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Sent: 2024/05/21  
Accepted: 2025/05/07  
Published: 2025/06/30

### Abstract

This article takes established findings of economic research as its starting point to discuss social justice principles and the dynamics of dispossession that deny many people, as well as entire communities, realization and enjoyment of social justice. Several key themes are identified and analyzed in three sections. The first section presents fundamental principles of social justice, particularly those relevant to economic ethics, and shows that sustainable development embodies these principles. It then distinguishes between individualism, society and community, arguing that community provides the most effective framework within which to apply the identified principles. The second section examines the dynamics of dispossession that underpin virtually any form of economy. The third section describes countermeasures that have been recommended throughout history. The conclusions emphasize the dynamic of most economies that wealth or power, left to their own devices, attract yet more wealth or power at the expense of the poor and powerless. The essential remedy is to defuse the dynamics of dispossession. Conscious collective countermeasures are indispensable in order to restore to the deprived the freedom and prosperity of which these processes deprive them. However, these countermeasures require further elaboration and political action to be put into practice.

**Keywords:** social justice, sustainable development, cumulative causation, periphery, the poor, poverty, Prebisch-Singer Thesis.

**Summary:** Introduction, Fundamental Principles of Social Justice, The Inexorable Dynamics of Dispossession, Countermeasures, Conclusions.

**How to cite:** Dommen, E. (2025). The Dynamics of Dispossession. *Revista Tecnológica - Espol*, 37(1), 44-55. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1169>

## Resumen

Este artículo se origina de los hallazgos de la investigación económica con el fin de analizar los principios de justicia social y las dinámicas de desposesión que niegan a muchas personas, así como a comunidades enteras, la realización y el disfrute de la justicia social. Para este objetivo, se identifican varios temas clave que fueron analizados en tres secciones. En la primera sección se presentan los principios fundamentales de justicia social, relevantes para la ética económica; se evidencia que el desarrollo sostenible los resume. Luego, se diferencia entre individualismo, sociedad y comunidad; esta última proporciona el marco más eficaz para aplicar los principios identificados. En la segunda sección se describen las dinámicas de desposesión que impulsan cualquier forma de economía. Finalmente, en la tercera sección se explican las contramedidas recomendadas a lo largo de la historia. Posterior al análisis, las conclusiones enfatizan la dinámica de la riqueza o el poder de la mayoría de las economías, que por sí mismas, atraen aún más riqueza y poder a expensas de los pobres e indefensos. El remedio esencial es desactivar las dinámicas de desposesión. Por ello, las contramedidas colectivas conscientes son indispensables para restaurar la libertad y la prosperidad que estos procesos privan a los desposeídos. Sin embargo, estas requieren mayor elaboración y acción política para su implementación.

**Palabras clave:** justicia social, desarrollo sostenible, causalidad acumulativa, periferia, los pobres, pobreza, Tesis de Prebisch-Singer.

## Introduction

You are reading a review of technology. Technology is the application of scientific knowledge for practical purposes.<sup>1</sup> In that spirit, this article takes established findings of economic research as its starting point. It does not describe new scientific research. Part 2 describes the practical issues to which we want to apply these findings. Part 3 describes the policy measures which need to be taken in the light of Part 2 to achieve the objectives presented in Part 1.

## Fundamental Principles of Social Justice

To meet one's own needs without compromising the ability of others to meet theirs is a principle deeply rooted in many of the world's major ethical traditions. It is often traced back to the Hippocratic oath of the third century AD, but even earlier, it is reflected in a Biblical commandment often mistranslated into English as "Thou shalt not steal" (Exodus 20:15). The original term more accurately refers to the unjust appropriation of what rightfully belongs to others, specifically actions that compromise others' ability to meet their own needs. As the eighteenth-century North American social thinker and activist John Woolman (1763) observed: "If we trace an unrighteous claim ... proved by sufficient seals and witnesses, this gives not the claimant a right, for that which is opposite to righteousness is wrong".

This essential principle is restated in one of the foundational documents of the French Revolution, *The Declaration of the Rights of Man and the Citizen* (1789), which affirms: "Liberty consists in being able to do anything that does not harm others" (Article 4).

The World Commission on Environment and Development (1987), in its report "Our Common Future"<sup>2</sup> essentially established the concept of sustainable development. Its definition reflects the principle in its opening sentence, though it oddly restricts it to relations between

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<sup>1</sup> <https://www.google.com/search?q=technology+definition+english>

<sup>2</sup> The Report is commonly known as "the Brundtland Report"; that is how we shall refer to it henceforth.

present and future generations. However, the report corrects this in the very next sentence, which highlights "the essential needs of the world's poor<sup>3</sup>, to which overriding priority should be given". This is indisputably a matter of relations within the present generation, the primary concern of this article.

## Society

Some thinkers view society as a mere aggregate of individuals (Rousseau, 1762, chap. 6). This author argued: "The most ancient of all societies, and the only one that is natural, is the family: and even so the children remain attached to the father only so long as they need him for their preservation. As soon as this need ceases, the natural bond is dissolved. The children, released from the obedience they owed to the father, and the father, released from the care he owed his children, returned equally to independence. If they remain united, they continue so no longer naturally, but voluntarily" (Rousseau, 1762, chap. 2).

Margaret Thatcher, Prime Minister of the United Kingdom from 1979 to 1990, was even blunter: "There is no such thing as society", continuing "There are individual men and women and there are families" (Thatcher, 1987). Her statement echoes the ideas of Jeremy Bentham, who asserted (1780, chap.1): "The interest of the community then is, what? — the sum of the interests of the several members who compose it". Bentham, founder of the utilitarian school of economics, championed the slogan "The greatest happiness of the greatest number" (Bentham, 1776, Preface), which implies "Tough luck for the rest." Individualism is still at the base of economics as taught in universities today.

In the Bible, the invitation to "love your neighbour as yourself" appears three times (Leviticus 19.18, Matthew 22.39, Mark 12.31). The word 'as' can be read in two ways. Firstly, it may be understood as "Love your neighbour as much as yourself" or "... in the same way that you love yourself" This interpretation aligns with the individualist perspective described previously.

## Community

Alternatively, *as* can be interpreted to mean "Love your neighbour because he is a part of yourself". This is the position of the poet John Donne (1624):

*No man is an island, entire of itself; every man is a piece of the continent, a part of the main... and therefore never send to know for whom the bell tolls; it tolls for thee.*

The Bantu concept of 'ubuntu'<sup>4</sup>, "I am because you are", or "I am because we are", encapsulates that notion. "The origins of ubuntu are rooted in a holistic vision, for which human existence only makes sense within the totality of all that is" (Murove, 2011). In this perspective, each of us is shaped by others.

'I am because you are' is another phrase which can be read in two ways:

1. You are the cause of what I am
2. My purpose is to attend to your needs

In the first sense, we all share the same ecosphere; regardless of who you may be, your actions help shape the conditions that shape me. In countless ways, others contribute to the person I have become.

<sup>3</sup> We shall return later to the word 'poor'.

<sup>4</sup> The name varies between languages.

In the second sense, the phrase becomes a call to action. Our vocation, our calling, indeed our very reason for being on earth at all, is to respond to the needs of our neighbour, particularly those who cannot cope without us. That is what the Brundtland definition of sustainable development alludes to when it refers to the overriding priority that must be given to the essential needs of the world's poor. The French version of the definition emphasises the point: instead of using the nondescript word 'poor', it uses 'démuni', i.e. deprived or defenceless.

John Calvin (1509-1564) was a Protestant reformer who paid significant attention to social and economic justice. He stated: "Since God has joined the whole human race into one unit, the aim is that the welfare and conservation of all must be a concern of each one of us. In short, any violence, harm, or trouble that wounds our neighbour is forbidden to us. If we can do something to preserve the life of our neighbour, we must faithfully work at it, either by providing the things which are needed or by avoiding whatever does the opposite. Likewise, if they are in any danger or perplexity, we must help and support<sup>5</sup> them." (Calvin, *Institutes*, 2.8.39).

In Sermon 53 on 1Tim 6.17-19, Calvin further speaks of *mon prochain qui a faute de moi*- roughly, I must lend my neighbour a hand inasmuch as I am missing from their toolkit. The essential point is that we are called to help our neighbours meet the needs they themselves consider they have, not, like the International Monetary Fund or the World Bank, to provide for the needs we think they ought to have.

The word 'community' has a vast range of meanings. One key aspect of the concept is the idea of boundaries. Every community draws a line between 'we' and 'they'. 'We', the insiders, are considered right and superior. 'They' are inferior and often morally reprehensible. This pattern recurs throughout history. For example, in the 20<sup>th</sup> century, right-thinking people considered the unemployed to be idle slackers (Pickard, 1919). Colonialism was built upon the belief that the colonised were savages who needed managing —colonisers, often believing themselves well-meaning, saw it as their duty to "civilise" them. In recent times, Israel has described its Palestinian neighbours as animals.

History is an unending succession of tribal, civil and international wars, including religious persecutions. The Brundtland definition of sustainable development seeks to transcend this mindset. Its emphasis on giving overriding priority to the essential needs of the world's poor carries a profound implication: that the whole of humanity forms a single community. This idea follows in the footsteps of Calvin, who declared, "We must share with each other to uphold the community of the whole human race" (Calvin, 1564, Exodus 22.25).

The call to transcend boundaries is reflected in several incidents recounted in the New Testament. One of its most powerful illustrations is the parable of the Good Samaritan (Luke 10.25-37).

Similarly, the Devonshire Declaration, a British document of 1923 signed by the Duke of Devonshire as Colonial Secretary, stated: "His Majesty's Government think it necessary definitely to record their considered opinion that the interests of the African natives must be paramount ..." Although originally intended for a narrow context—namely, to suppress the political claims of Indian and Arab communities in Kenya and preserve colonial dominance—the phrase took on new life. By the mid-20<sup>th</sup> century, as decolonisation became inevitable,

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<sup>5</sup> Calvin uses the word 'subvenir' which is associated with the classical notion of 'subsidiū' - troops held in reserve until called upon. The concept is embodied politically in the subsidiarity principle.

young colonial officers were taught to treat it as a broad, principled directive: "The interests of the natives are paramount".

Helping the defenceless and the poor must be given priority over everything. By definition, they have no reserves or alternatives to fall back on. Those who are not poor can afford to wait; the poor cannot.

Liberation theology, a movement within Latin American Catholicism, developed in the 1960s driven by this concern. The Catholic institution, however, absorbed the notion into its social teaching in a moderate form, adopting the phrase "preferential option for the poor".<sup>6</sup>

### **The Inexorable Dynamics of Dispossession**

A popular dictum of the time appears several times in the Bible pithily and accurately describing the dynamics of most economic systems (there are exceptions, like the "subsistence affluence"<sup>7</sup> of traditional South Pacific island economies). The verse reads: "To those who have, more will be given, and they will have more than enough; but from those who have nothing, even what they have will be taken away" (Matthew 13.12).

### **The Jubilee**

The biblical concept of the Jubilee, described in Leviticus 25.8-13 and likely written in the middle of the 5<sup>th</sup> century BC, illustrates this mechanism. It involves three elements:

1. Cancellation of debts
2. Return of the land to its original owners
3. Freedom for the slaves

These measures address a recurring economic cycle in which the poor are stripped of even the little they possess. The Jubilee scenario assumes that a peasant household, which is under normal conditions, can only meet its basic needs. However, disruption such as illness in the family, drought or bad weather can throw this balance into crisis. In order to survive, the family must borrow. However, in good times, the land could produce only enough for subsistence. Now, on top of current needs, the family has to face the extra burden of repaying the debt, so it falls inexorably further into debt. Unable to repay, it must sell some of its land. With even less land now, it no longer has any prospect of breaking even. When the family has consequently lost all its land, its only remaining recourse in the culture of the time was to sell themselves into slavery.

Of course, once the Jubilee has reset the counters to 0, the mechanism starts off again, and sooner or later, the operation will have to be repeated - every 50 years, Leviticus theatrically proclaims.<sup>8 9</sup>

### **The mechanism**

<sup>6</sup> "The phrase 'preferential option for the poor' was first used in 1968 by the superior general of the Jesuits, Father Pedro Arrupe, in a letter to his order. The term was later picked up by the Catholic bishops of Latin America." (Dault, 2015)

<sup>7</sup> The phrase was coined by E.K. Fisk (1962)

<sup>8</sup> In fact, the Jubilee is a brilliant piece of specious communication. The Jewish elites had been deported to Babylon at the end of the 6<sup>th</sup> century. Their land had been taken over by the peasants who cultivated and looked after it. When the elites were allowed to return over half a century later, they wanted their land back. They invented this convincing tale to legitimate their claim.

<sup>9</sup> This section is drawn from Dommen (2003), chap.2.



The divergence between the rich and poor is causally linked. The wealth of the rich increases at the expense of the poor. To illustrate this, consider an area in which everyone is equally prosperous. Due to some catalyst, one place becomes more prosperous than the others. This new wealth attracts various factors of production: capital is drawn to invest, entrepreneurs migrate to exploit new opportunities, and labour follows, attracted by higher wages and better prospects. All this increases income and opportunities that strengthen the appeal of the place. Meanwhile, the brighter, more adventurous people are leaving the periphery to seek their fortune in the new growing hub. People in the periphery with capital to spare see the advantage of investing it in the centre, where the prospects of profit are more promising, so the periphery is starved of new investment. In many economic activities, there are economies of scale, making it increasingly cheaper to expand them. All in all, the centre sucks life out of the periphery.

That illustration is geographical. The same argument can be applied to class or social situations. The children of the rich have access to greater formal and informal educational opportunities; their playmates, classmates and neighbours are similarly advantaged. Thus, they have access to a better network of people who can advise them, offer them jobs or point them toward opportunities. They will not suffer the humiliations of being regarded as inferior, which, in itself, leads them to see themselves as inferior and behave accordingly. Better educated in what makes for good health and better able to afford it, they are likely to be more effective in their work and to live longer.<sup>10</sup>

Wheels within wheels: since there is more profit to be made in selling cures for the illnesses of the rich than for those of the poor, pharmaceutical research concentrates on the former. As a result, the health and life expectancy of the rich continue to improve relative to that of the poor since the medicines to treat the latter's illnesses are simply not being developed.

The backwash effects we have just described are mitigated by spread effects that function in an opposite direction. Insofar as people, enterprises, and public authorities spend where they are, a range of activities develops to meet their on-the-spot needs. Prosperity spreads outwards, but more thinly the further it gets from its source. At a certain distance, the spread effects are outweighed by the backwash effects.<sup>11</sup>

Gunnar Myrdal (1957) sums up how the mechanism works:

*My starting point is the assertion that the notion of stable equilibrium is normally a false analogy to choose when constructing the theory to explain the changes in the social system... Behind this idea is another and still more basic assumption, namely that a change will regularly call for a reaction in the system in the form of changes which on the whole go in the opposite direction to the first change.*

*The idea I want to expound ... is that, on the contrary, in the normal case, there is no such tendency towards automatic self-stabilisation in the social system. The system is by itself not moving towards any sort of balance between forces but is constantly on the move away from such a situation. In the normal case, a change does not call forth countervailing changes but, instead, supporting changes which move the system in the same direction as the first change, but much further. Because of circular causation, a social process tends to become cumulative and often to gather speed at an accelerating rate.<sup>12</sup>*

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<sup>10</sup> These examples can be found in Myrdal (1944) and Myrdal (1968).

<sup>11</sup> The previous paragraphs are drawn from Dommen (2014).

<sup>12</sup> Gunnar Myrdal was awarded the Nobel Prize in Economics 1975.

Myrdal generalised a conception of the economy that had been applied to relations between rich and poor countries described as the centre and the periphery of the world economy, and known as dependency theory.

In 1964, the United Nations Conference on Trade and Development (UNCTAD) was created to focus specifically on North-South Trade from this perspective. Raúl Prebisch, an Argentinian economist, was a leading figure in analysing and explaining this kind of economic dynamic. The name "Prebisch-Singer Thesis" was given to an analysis of the particular macro-economic dynamics of trade between a commodity-exporting periphery and a centre importing those commodities since each of them had published a study of the question in 1949, coming to similar conclusions. Hans Singer was working at the time in the United Nations Department of Economic Affairs in New York; his study, therefore, appeared without the author's name, as was UN practice (UN DESA, 1949). In the same year, Raúl Prebisch published his corresponding paper as Executive Director of the freshly founded UN Economic Commission for Latin America (ECLA) (Prebisch, 1949).<sup>13</sup>

Prebisch was logically appointed the first secretary-general of UNCTAD. Its secretariat was located in Geneva so that it could dialogue constructively with GATT, the General Agreement on Tariffs and Trade, which had successfully nurtured the prosperity of developed economies by fostering spread effects through trade among them. The accession of several peripheral countries to independence in the early 1960s made the developed countries (to use the terminology of the time) aware of the issue and, uniquely, willing to explore solutions to it. In the 1960s, dialectics were recognised as a fruitful means of exploring an issue (regrettably for the progress of the social sciences, they went out of fashion after the fall of the Berlin Wall in 1989).

In 1976, Prebisch published a paper, "*A Critique of Peripheral Capitalism*", summing up his work over the years. We shall draw on it to outline his thesis. It gives a detailed account of the process of creation of surplus and its primary appropriation by the upper strata through the power derived from their ownership of the means of production and its secondary appropriation by the middle strata (Prebisch, 1976, p.4).

*The penetration of the production technology of the centres plays a dominant role in peripheral development. The rise in productivity that accompanies it brings changes in the structure of society [in both the centre and the periphery], in the course of which the upper income strata increase their power by concentrating most of the means of production in their own hands, with the result that they have institutional capacity for primary appropriation of the fruits of technological progress. The middle income strata [in both the centre and the periphery] also strengthen their position as they expand with the development of industry and other related activities, but the lower strata remained largely excluded... The so-called free play of economic forces is in fact subordinated to these power relations and the interests and stimuli which govern them (Ibid, p.12) ...The essential requirement [of vigorous capital formation] is not being met in peripheral capitalism. It would appear to be incompatible with the widespread growth of the consumer society ..., which could not exist without the considerable economic and political power of the upper strata, which insures their primary appropriation of the fruits (Ibid, p.14).*

Justine Masika Bihamba, an internationally known human rights activist based in the Eastern Congo, describes the brutal way the process is working in that region: "Eastern Congo has been ravaged by war for three decades. One main reason is that this region, and in particular

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<sup>13</sup> Incidentally, the Wikipedia article 'Latin American liberation theology' describes ECLA, albeit one of the official regional commissions of the United Nations, as a "leftist think tank"!

the province of North Kivu, is rich in raw materials. In particular, there are immense reserves of coltan, an essential mineral for the batteries used in cell phones and electric cars. For our people, this wealth is a curse. More than a hundred armed groups wage war against each other to control these resources, which are then sold to multinationals via neighbouring countries. Western governments turn a blind eye to the origin of these minerals, which are indispensable to their industries. This probably explains why this war remains largely ignored by the international community".<sup>14</sup>

Brutality is a widespread feature of the process we are describing. According to local folk memory, the forced labourers who built Oaxaca's Dominican church in the late 16th century were required to bring two eggs to work every day- not to feed themselves but to strengthen the mortar of the building against earthquakes. In the same vein, the interior of the Franciscan church in Quito is richly decorated with gold. In its entryway, there is a painted panel which reads, "But you have made it a den of thieves"<sup>15</sup>, showing incidentally that one can joke even about brutal deprivation.

"The ownership of the means of production enables the upper strata to be the first to lay hands on a large part of the fruits... A smaller share then passes to the middle strata." (Prebisch, 1976, p.10). Prebisch stresses the role of power in the appropriation of resources. Myrdal's genteel presentation of the same processes refers to primary and secondary appropriation neutrally as 'backwash' and 'spread effects', avoiding the need to explain that the spread effects keep the fruits of appropriation within the circle of winners.

John Woolman (1720-1772) was born and lived in the British colonies of North America, i.e. the periphery of the world economy of his day. His *Plea for the Poor* foreshadows the arguments Prebisch developed a couple of centuries later (Woolman, 1763). Indeed, its opening paragraph sums them up, including due attention to secondary appropriation: "Wealth desired for its own sake obstructs the increase of virtue, and large possessions in the hands of selfish men have a bad tendency, for by their means too small a number of people are employed in things useful; and therefore they, or some of them, are necessitated to labour too hard, while others would want business to earn their bread were not employments invented which, having no real use, serve only to please the vain mind."

"Oppression in the extreme appears terrible, but oppression in more refined appearances remains to be oppression, and where the smallest degree of it is cherished, it grows stronger and more extensive" (Woolman, 1763, Chap.13). With this, Woolman comments succinctly on the dynamics of cumulative causation<sup>16</sup> described in this paper.

"Three phenomena are typical of the periphery and help to explain the inadequate rate of capital formation. Power relations appear in them all: in the excessive consumption indulged in by the upper strata, which would be inexplicable without the inequitable distribution deriving from those relationships; in the spurious absorption of labour, influenced above all by the power of the middle strata; and in the disproportionate incomes the centres extract through the play of power relations at the international level." (Prebisch, 1976, p.14)

John Woolman stresses the role of power in shaping economic relations: "Wealth is attended with power, by which bargains and proceedings contrary to universal righteousness

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<sup>14</sup> Quoted in the Geneva newspaper *Le Courrier*, 8 March 2024.

<sup>15</sup> Luke 19.46

<sup>16</sup> The term is Gunnar Myrdal's.

are supported; and here oppression, carried on with worldly policy and order, clothes itself with the name of justice ..." (Woolman, 1763, Chap.10)

Prebisch follows in Woolman's footsteps when he stresses the role of consumerist aspirations in driving the cumulative process of appropriation at the expense of the dispossessed: "which have their root in self-pleasing, this spirit, thus separating from universal love, seeks help from that power which stands in the separation; and whatever name it hath, it still desires to defend the treasures thus gotten. This is like a chain where the end of one link encloses the end of another. The rising up of a desire to attain wealth is the beginning. This desire being cherished moves to action, and riches thus gotten please self, and while self hath a life in them it desires to have them defended." (Woolman, 1763, Chap.10).

### Countermeasures

We have seen that consumption, if not outright consumerism, is a major factor driving the mechanism. Moderating the urge to consume can at least mitigate it. "Were all superfluities and the desire of outward greatness laid aside and the right use of things universally attended to, such a number of people might be employed in things useful that moderate labour with the blessing of heaven would answer all good purposes relating to people and their animals, and a sufficient number have leisure to attend on proper affairs of civil society" (Woolman, 1763, Chap.2). Furthermore, "their example in avoiding superfluities tends to incite others to moderation" (Woolman, 1763, Chap.1).

The Jubilee myth is rooted in the biblical notion of the Sabbath, which involves rest and letting go. On the weekly Sabbath, people do not work. The sabbatical year extends its principle to the marginalised, and not only the human ones: "Six years thou shalt sow thy land, and shalt gather in the fruits thereof: but the seventh year thou shalt let it rest and lie still; that the poor of thy people may eat: and what they leave the beasts of the field shall eat" (Exodus 23.10-11).

The urge for economic growth fuels the mechanism, as does consumerism. One response has been the growth of the *décroissance* movement in Europe. The word is often rendered in English as de-growth, but this translation captures only part of its meaning. *Décroissance* is not simply the opposite of growth but rather something different from it (Dommen, B. & Dommen, E., 2016). Policy-makers tend to take the Gross Domestic Product (GDP) as the primary measure of growth, but it includes only a subset of activities, ignoring several which are invaluable to human welfare (UNDAT, 1974).

When Western Samoa became independent in 1962, it refused to calculate its GDP on the grounds that doing so would distract attention - and human resources - from its own democratically determined priorities. However, it did not stop experts from international organisations from estimating it themselves for their own purposes.

There have been some clumsy efforts to address the shortcomings of GDP, such as UNDP's Human Development Index.<sup>17</sup>

We have seen that prioritising the essential needs of the world's most deprived is a key feature of sustainable development. This calls not only for restraint but for redistribution. "Men who have large possessions and live in the spirit of charity, who carefully inspect the circumstance of those who occupy their estates, and regardless of the customs of the times

<sup>17</sup> <https://hdr.undp.org/data-center/human-development-index>

regulate their demands agreeable to universal love, these, by being righteous on principle, do good to the poor without placing it as an act of bounty. While industrious, frugal people are borne down with poverty and oppressed with too much labour in useful things, the way to apply money without promoting pride and vanity remains open to such who truly sympathise with them in their various difficulties" (Woolman, 1763, Chap.1).

Calvin insisted that the rich were ministers to the poor. "All rich people, when they have the means to do good, are clearly there as God's deputies, and they must do their job, which is to help their neighbours to live." (Calvin, Sermon 141 on Deuteronomy 24.19-22.)

Ambrose (339-397), one of the four fathers of the Roman Catholic Church, places his idea in the perspective of the dynamics described in this paper when he says, "If you have two pairs of sandals and your neighbour is barefoot, you should not give him one but return one to him."

In 1996, UNCTAD launched a BioTrade Initiative in line with its founding ideals. Its objectives include the sustainable use of resources, the fair and equitable sharing of benefits, and community empowerment. The initiative is alive and well. (UNCTAD, 2024)

### **Migration<sup>18</sup>**

Migration is a natural consequence of the processes of appropriation and dispossession inherent in the functioning of the world economy. When people are deprived of their means of livelihood, it is normal for them to follow them to where they were taken. If countries receiving migration flows do not want them, they could refrain from stripping the source countries of their resources or, failing that, return their means of livelihood to them. Those who migrate could then make good use of their resources at home without leaving their kith and kin in search of them. "Inhabitants of rich and happy countries don't emigrate." (d'Épinay, 1831) Furthermore, migrants tend to be more adventurous and more resilient than their stay-at-home neighbours. Those who arrive at their destination are also likely to be in better health than the average: good health helps to survive the journey. These are precisely the kind of people who stimulate the dynamism of the place where they are. The place from which they emigrate loses that asset; the country of destination acquires it. Thus, migration feeds the dynamic of dispossession. On the other hand, in so far as migrants send remittances home they mitigate the process.

### **Conclusion**

The natural dynamic of most economies is that wealth or power left to their own devices attract yet more at the expense of the poor and powerless. The essential remedy is to defuse the dynamics of dispossession.

The process is systemic. Individual actions may change their style or temper its intensity but not the essence of its operation. Conscious collective countermeasures are indispensable in order to restore to the deprived the freedom and prosperity of which these processes deprive them.

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<sup>18</sup> This section may seem lapidary, but migration is but one among the manifestations of the centre-periphery dynamic explained throughout this paper. The essential remedy to them all is to defuse the dynamics of dispossession.

This brief and necessarily schematic summary overview of the dynamics of dispossession identifies several key themes for responses and countermeasures. They of course require further elaboration and and political action if they are to be put into practice.

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## Gender Equality as Integral to Social Justice – and vice versa

### La igualdad de género como elemento integral a la Justicia Social – y viceversa

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Sent: 2024/07/22  
Accepted: 2025/04/24  
Published: 2025/06/30

#### Abstract

The pursuit of social justice fundamentally requires gender equality, just as meaningful gender equality necessitates social justice. This means that each is integral to achieving the other. While commonly characterised as "two sides of the same coin," this paper aims to demonstrate they are, in fact, the very coin itself: a unified entity forged into an indissoluble foundation. As perceptions and definitions of social justice in different contexts demonstrate, the term "social justice" remains deceptively simple in everyday usage. Similarly, the term "gender equality" has emerged to bring together a large number of basic precepts crucial to removing sex-based discrimination in all spheres of human endeavour. While social justice arises from binding and non-binding instruments, and workplace social justice stems from the 1919 ILO Constitution and international labour standards, gender equality springs from a plethora of international treaties negotiated by States to end discrimination based on sex. This article examines the content and overlay of these concepts using a comparative law methodology, citing examples where social justice and gender equality combine. It reviews texts that give context to social justice, texts that define gender equality, and the main hard law treaties giving substance to gender equality, providing applied illustrations of implementation of gender equality. The article concludes that without these principles and rights, social justice remains illusory. If decision-makers strive to produce the composite coin itself, the two concepts melded together as a whole will lead to genuine improvements in the quality of all human life, as this paper demonstrates.

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**Summary:** Introduction and Objectives, Methodology, The texts that give context to social justice, The texts that give context to gender equality, The main (hard law) treaties giving substance to gender equality, Applied illustrations of implementation of the gender equality texts, Conclusion..

**How to cite:** Aeberhard-Hodges, J.(2025). Gender Equality as Integral to Social Justice – and vice versa. *Revista Tecnológica - Espol*, 37(1), 56-67. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1221>



**Keywords:** Non-discrimination, gender equality, CEDAW, international labour standards, fairness, pay, gender-based violence, ILO conventions and recommendations, social justice.

### Resumen

La justicia social requiere la igualdad de género, del mismo modo que una igualdad de género no puede lograrse sin justicia social. Aunque suelen describirse como dos caras de la misma moneda, este artículo sostiene que, en realidad, constituyen una sola: una entidad unificada forjada sobre una base indisoluble. Tal como lo evidencian sus definiciones y percepciones en distintos contextos, el término ‘justicia social’ resulta simple en el uso cotidiano. Por su parte, ‘igualdad de género’ ha emergido como un concepto que engloba principios orientados a eliminar la discriminación por razón de sexo en todos los ámbitos de la vida humana. Si bien la justicia social tiene su origen tanto en instrumentos vinculantes y no vinculantes, y su aplicación en el ámbito laboral se fundamenta en la Constitución de la OIT y las normas internacionales del trabajo, la igualdad de género se deriva de tratados internacionales orientados a eliminar la discriminación por razón de sexo. Este artículo examina el contenido y la interrelación de estos conceptos mediante una metodología de derecho comparado, e ilustra su análisis citando ejemplos en los que ambos términos convergen. Se analizan textos que contextualizan la justicia social, definen la igualdad de género y abordan su concreción jurídica, ofreciendo ejercicios prácticos para su implementación. Finalmente, sin estos principios y derechos, la justicia social permanece como una aspiración ilusoria. Si se trabaja por forjar una ‘moneda compuesta’, es decir, la fusión efectiva de estos conceptos, puede mejorar la calidad de vida de toda la humanidad.

**Palabras clave:** No discriminación, mujeres y hombres, CEDAW, normas internacionales del trabajo, equidad, remuneración, violencia de género, convenios y recomendaciones de la OIT, justicia social.

### Introduction and Objectives

Social justice and gender equality are fundamentally interdependent—neither can be fully realised without the other. While activists and commentators often describe them as two sides of the same coin, this metaphor understates their profound interconnection. Like metals fused into a single alloy, these concepts combine to form something stronger and more enduring than either could achieve alone. In other words, neither can be achieved without upholding both principles.

This paper examines, against the backdrop of social justice frameworks, how contemporary gender equality instruments are integral to social justice, with the aim of broadening understanding of how these two fundamental issues shape improvements in human existence. Examples, particularly from the world of work, are used to demonstrate the interrelatedness of the two concepts. While none of the hard law treaties contains the words "social justice," the background to their adoption (in-house and academic research, *travaux préparatoires*, among others) clearly shows the alloy blend. Moreover, State Parties' reporting on their implementation at a national level – the coinage, to continue the metallurgy allegory – describes legislation and practice examples that clearly mesh with social justice.

The world stands at a crucial juncture for social justice, as it also faces a crossroads for gender equality. Despite decades of recognition that sex discrimination is both wasteful and unjust, women and men are not treated equally in political, civil, economic, health, education, cultural, and work domains. The ILO Director-General's 2018 report (para. 43) noted that

gender equality is a means to achieve social justice and went further, at para. 84, to point out how catastrophic gender injustice is for social justice: "The undeniable reality is that the disadvantages that women continue to face at work, notwithstanding the real progress that has been recorded, including through the ILO, constitute perhaps the most flagrant and the greatest offence to social justice."

Six years on, that "greatest offence" lives on. According to UN data, globally, 10.3 % of women live in extreme poverty today<sup>2</sup>, with women disproportionately affected compared to men. This systemic marginalisation of women exacerbates intersectional inequalities. The ILO's Committee of Experts on the Application of Conventions and Recommendations (CEACR), commenting on its 2023 General Survey on achieving gender equality at work, stated:

Full equality between women and men at work cannot be achieved in a broader context of inequality. Gender equality is a fundamental component of decent work and social justice, anchored in both a rights-based and an economic efficiency approach to sustainable and inclusive development. As illustrated in the General Survey, the COVID-19 crisis exacerbated pre-existing gender inequalities and reversed previous gains, as many girls and women were forced to leave education, training, and the labour market in order to shoulder most of the burden of unpaid care and domestic work. Women continue to be disproportionately represented in the hardest-hit service sectors, including the informal paid care economy and domestic work.<sup>3</sup>

The United Nations (UN) Commission on the Status of Women (CSW), in its 2024 annual session, acknowledged that women and girls in poverty experience multiple and compounding deprivations that are intensified by other dimensions of inequality, including race, ethnicity, disability, location, marital and migrant status, among others, and their experiences of poverty are shaped by gender norms and stereotypes. CSW's Agreed Conclusions linked our two terms just once, at the beginning of its 57-paragraph-long text without elaborating on the link:

13. The Commission expresses concern that eradicating poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and that the feminisation of poverty persists. It notes that eradicating poverty in all its forms and dimensions is an indispensable requirement for sustainable development, social justice, gender equality, and the empowerment of all women and girls and their human rights...<sup>4</sup>

Thus, reinvigorating the global framework for both concepts is essential, starting with this paper's overview of the main soft and hard law texts already existing and rekindling interest in sharing information on measures that have proven successful in implementing them, as exemplified by the cases of progress noted in the ILO supervisory machinery in the last part of this paper.

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<sup>2</sup> UN Commission on the Status of Women, *Accelerating the achievement of gender equality and the empowerment of all women and girls by addressing poverty and strengthening institutions and financing with a gender perspective: Report of the Secretary-General*, E/CN.6/2024/3, 12 January 2024.

<sup>3</sup> ILC, 111<sup>th</sup> Session, *Report of the Committee of Experts on the Application of Conventions and Recommendations*, Report III (Part A), para.51 (ILO, Geneva, 2023).

<sup>4</sup> UN Commission on the Status of Women, 68<sup>th</sup> Session, *Agreed Conclusions*, E/CN.6/2024/L.3, 25 March 2024 at <https://docs.un.org/en/E/CN.6/2024/L.3>.

## Methodology

Moving beyond the common slogan of "two sides of the same coin," this paper employs a coin-minting analogy—the fusion of metals into a standardised, universally valuable unit—to underscore the inseparability of gender equality and social justice.

Through comparative legal analysis of key texts (non-binding yet persuasive soft law instruments and binding hard law treaties), the paper examines the interrelationship against 21st-century challenges. Standard-setting texts were chosen for their universal applicability, enduring relevance, and role as benchmarks for progress despite growing public narratives dismissing legal obligations.

In the analysis, general global texts that give context to the concepts and then delve more deeply into the substantive content of international instruments are examined to demonstrate the interdependence of gender equality and social dialogue. This qualitative exploration highlights the prevalence of such linkages, demonstrating that the 'one coin' metaphor permeates even implicit policy thinking. Finally, the world of work examples – the cases of satisfaction regarding improved implementation of the main ILO gender equality treaties reported by the ILO's Committee of Experts on the Application of Conventions and Recommendations (CEACR) – are used to validate the 'one coin' thesis. The literature review draws on UN reports, academic publications, and the Global Migration Policy Associates' survey of 700+ social justice texts (featured elsewhere in this issue).

## The Texts that Give Context to Social Justice

The ILO's constitutional mandate anchors social justice in the pursuit of lasting peace: "Whereas universal and lasting peace can be established if it is based upon social justice."<sup>5</sup> This special issue commemorates the 80th anniversary of the 1944 Declaration of Philadelphia, which advanced social justice in labour systems.

Today, social justice is a cornerstone of UN and ILO discourse on human well-being. For example, post-2019 centenary research focused on persistent workplace inequalities. This culminated in the June 2021 International Labour Conference (ILC) general discussion and subsequent resolution on inequalities in the world of work. The resolution stresses that effective action to reduce inequalities, promote inclusive growth, and build forward better requires addressing root causes to achieve both social justice and the Sustainable Development Goals (SDGs). It specifically calls on the International Labour Office, among other measures, to strengthen its social justice mandate and place a strong emphasis on gender equality strategies grounded in international labour standards.<sup>6</sup> At the June 2023 ILC Session, the Director-General presented the *Advancing Social Justice* report, focusing on the global need for greater social justice and concrete pathways to achieve it. During the accompanying World of Work

<sup>5</sup> ILO, *Constitution*, First Preamble, 1919, followed by the reference in Part II of ILO's *Declaration of Philadelphia* of 1944, subsequently annexed to the original Constitution, repeating "the (demonstrated) truth ... that "lasting peace can be established only if it is based on social justice"." ILO has made the attainment of social justice the central aim of all national and international policies, as witnessed by the reference to "the universal aspiration for social justice" in the Preamble to the *Declaration on Social Justice for a Fair Globalization*, 2008, as well as the characterisation of social justice as a "fundamental value" along with freedom, human dignity, security and non-discrimination. See [https://normlex.ilo.org/dyn/nrmlx\\_en/f?p=1000%3A62%3A0%3A%3ANO%3A62%3AP62\\_LIST\\_ENTRIE\\_ID%3A2453907%3ANO](https://normlex.ilo.org/dyn/nrmlx_en/f?p=1000%3A62%3A0%3A%3ANO%3A62%3AP62_LIST_ENTRIE_ID%3A2453907%3ANO).

<sup>6</sup> ILC, 109<sup>th</sup> Session, *Resolution concerning inequalities and the world of work*, ILC.109/Resolution XVI. (International Labour Office, Geneva, 2021) at paras 12 and 24(a) at [https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40ed\\_norm/%40relconf/documents/meetingdocument/wcms\\_832096.pdf](https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40ed_norm/%40relconf/documents/meetingdocument/wcms_832096.pdf)

Summit, he advocated for a Global Coalition for Social Justice. The ILO Governing Body (GB) endorsed this initiative in November 2023 as a multi-stakeholder platform to encourage cooperation and prioritise social justice on multilateral agendas ahead of key UN events - the 2024 Summit of the Future and the November 2025 World Social Summit.<sup>7</sup> The Coalition includes Global Migration Policy Associates (GMPA), an ECOSOC-accredited NGO advocating for migrant rights. GMPA participated in the Coalition's Geneva launch on 13 June 2024, where it highlighted specific social justice measures.

The UN incorporates economic equity into its conceptualisation of social justice. Its 2006 definition emphasises "the fair and compassionate distribution of the fruits of economic growth..." and this process must ensure that "growth is sustainable, that the integrity of the natural environment is respected, that the use of non-renewable resources is rationalised, and that future generations are able to enjoy a beautiful and hospitable earth."<sup>8</sup> While the *2030 Agenda for Sustainable Development* does not explicitly use the term "social justice," its foundational principles (including human dignity, equality, justice, non-discrimination and leaving no one behind), embody this concept. Moreover, the SDGs explicitly address key dimensions of social justice through commitments to eradicate poverty, end hunger, ensure health and well-being, provide quality education, achieve gender equality, reduce inequalities, promote decent work, and combat climate change. This institutional commitment was further solidified when the UN General Assembly declared 20 February as *World Day of Social Justice* in 2007 (Resolution A/RES/62/10), explicitly linking social justice to gender equality, among other priorities.<sup>9</sup> The 2009 observance message defined social justice as encompassing fairness, equality, respect for diversity, access to social protection, and the application of human rights across all societal domains, including workplaces.

Academic writers and researchers describe social justice as encompassing both economic and human rights dimensions. Measurement frameworks typically employ multidimensional indicators across life domains—including health, education, employment, income security, and criminal justice—with gender equality consistently recognised as a core component. The *European Union Social Justice Index* exemplifies this approach through its six measurement dimensions: poverty prevention, access to equitable education, labour market inclusion, social inclusion and non-discrimination/gender equality, intergenerational justice, and healthcare provision. The 2019 Bertelsmann Stiftung *Social Justice Index* expanded its coverage to include Member States of the Organisation for Economic Cooperation and Development (OECD). It recognises (page 129) that

<sup>7</sup> ILC, 111<sup>th</sup> Session, *Advancing social justice*, ILC.111/Report 1A. (International Labour Office, Geneva, 2023). Para.5 states "Social justice is reflected in the aspiration that "all human beings, irrespective of race, creed or sex, have the right to pursue both their material well-being and their spiritual development in conditions of freedom and dignity, of economic security and equal opportunity". See also the Governing Body's Oct.-Nov.2023 decision welcoming the Global Coalition for Social Justice in GB.349/INS/4, para. 52.

<sup>8</sup> UN, Department of Economic and Social Affairs (DESA), *Social Justice in an Open World: the Role of the United Nations*, 2006, ST/ESA/305, p. 7. DESA's report, at pp. 17-19, identified six inequalities that can severely impair the pursuit of social justice being inequalities in: the distribution of income; access to assets; access to work and remunerated employment; gaining knowledge; health services, social security provision and safe environments; and opportunities for civic and political engagement and participation. With time, other UN entities have been more precise in linking gender equality and social justice, e.g. in 2014, Member States of the Economic and Social Commission for Western Asia (ESCWA) reached regional consensus on a definition of social justice, which includes equal rights and access to resources and opportunities to all men and women with social justice centred on the principles of equality, equity, rights and participation. E/ESCWA/28/8, 5 May 2014 at <https://documents.un.org/doc/undoc/ld/i14/001/29/img/i1400129.pdf?token=iZsAEHCggiLC2jIiw6&fe=true>.

<sup>9</sup> UN General Assembly, 62nd Session, *Resolution 62/10 World Day of Social Justice*, A/RES/62/10 of 18 December 2007, para.4.

defining what social justice means and how best to achieve it is often subject to considerable controversy. The conceptual boundaries of social justice are continually in flux because the idea is a result of culturally and historically dependent value systems. Nevertheless, a modern concept of social justice that refers to the aim of realising equal opportunities and life chances provides us with a conceptual ideal able to garner the consensus needed for a sustainable social market economy.

Berik et al. analyse social justice through an economic fairness approach, arguing that neoliberal policy reforms produce gendered disparities in well-being, with macroeconomic measures systematically disadvantaging women. They adopt a feminist economic approach that evaluates policies based on their capacity to enhance social justice and improve living conditions for both women and men. Their conception of social justice integrates multiple dimensions: distributive fairness, equity in provision, universal access to basic needs, the elimination of poverty and discrimination, social cohesion, and capability strengthening. However, their case-study research demonstrates that fiscal austerity measures directly undermine these objectives by weakening labour market protections and eroding previous gains in gender equality. Ultimately, their findings establish gender-equitable well-being as an essential component of substantive social justice (Berik et al., 2008, p. 5).

The COVID-19 pandemic disproportionately impacted women, who comprise the majority of caregivers both in formal and informal economies, while simultaneously facing risks of gender-based violence during lockdowns. Turquet (2021) emphasises that during the COVID-19 pandemic, gender-responsive approaches were essential for both crisis response and recovery efforts to achieve meaningful social justice. In the same vein, the UN Women's *Feminist Plan for Sustainability and Social Justice* (Turquet, 2021, p. 8) states: "But going back [to before COVID] is not the answer. Instead, a visionary agenda that places sustainability, social justice, and gender equality at the centre of economic recovery and transformation is urgently needed to pave the way towards a new social contract." This framework clearly establishes the connection between post-crisis social justice and gender equality through economic transformation, structural rethinking, and reinforced democratic processes that guarantee women's active participation.

Other authors link social justice and gender equality to specific themes such as migration (Truong, 2014), health (Hawkes et al., 2022), and political emancipation (Donert, 2024). According to Truong's research, migrant workers (both women and men) face significant challenges in claiming social justice protections despite being entitled to a range of national, regional, and international norms. As Truong states (p.21): "Realising social justice and migrant rights claims requires much more than a purely legalistic approach and must be intertwined with other, more grounded and migrant-centred strategies." Hawkes et al. (p.1) note that calls for social justice and the right to health are often met with resistance. They argue that "Taking a social justice approach encourages us to think beyond the gendered inequalities apparent among people who use health services and act on the unequal and gendered distribution of power and privilege that drives health inequities more broadly." They identify the solution in social justice's participation and engagement approach, combined with properly funded, fully functioning, and accountable public healthcare institutions. Donert (2024) employs Central European case studies to examine the challenges of achieving gender equality amid 20th-century conflicts between fascist, state-socialist, and liberal-democratic conceptions of social justice. She argues that dismantling embedded gender inequalities, which have remained a defining element of Europe's modern history, is needed to fully incorporate women into narratives of social justice.

The same recommendations (to name but a few raised by the above authors: more grounded strategies, the collective power of citizens, strong state institutions, actively removing gendered power structures) apply to claims for gender equality, thus demonstrating again how intertwined these notions remain in today's world.

### **The Texts that Give Context to Gender Equality**

For gender equality, the *Beijing Declaration and Platform for Action* (BPfA, 1995) stands as the key soft law instrument specifically advocating equality between women and men. It pioneered the mainstreaming of a gender perspective across all policies and programmes.<sup>10</sup> The Declaration was a precursor to blending social justice with gender equality, referencing social justice in multiple provisions, beginning in paragraph 16:

Eradication of poverty based on sustained economic growth, social development, environmental protection, and *social justice* requires the involvement of women in economic and social development, equal opportunities, and the full and equal participation of women and men as agents and beneficiaries of people-centred sustainable development (emphasis added).

The accompanying Beijing Platform for Action, Chapter 1, paragraph. 41 also supports this paper's one-coin approach, stating, "Equality between women and men is a matter of human rights and a condition for social justice and is also a necessary and fundamental prerequisite for equality, development, and peace." Emphasising the social dimension of development, the Platform states (paragraph. 14) that "...all members of society (must) benefit from economic growth based on a holistic approach to all aspects of development: growth, equality between women and men, social justice, conservation and protection of the environment, sustainability, solidarity, participation, peace and respect for human rights."

Researchers also support the integrality of the two concepts. Miller argues that social justice includes not only distributive justice (concerned with fair resource allocation) but also relational justice (focusing on the quality of societal relationships). In exploring social justice, gender equality, and health outcomes, Miller discusses how inequities in access to resources, power dynamics, and gender discrimination contribute to health disparities. Overcoming these inequalities requires understanding social justice principles: recognition, distribution, and participation. Miller concludes that promoting gender equality and addressing social injustices can significantly improve health outcomes, particularly for marginalised groups (2001, pp 19-20).

### **The Main (Hard Law) Treaties Giving Substance to Gender Equality**

The UN Convention on the Elimination of All Forms of Discrimination Against Women, 1979 (CEDAW)<sup>11</sup> advocates substantive equality both in law and in practice. First, it requires States Parties to incorporate the principle of equality between women and men in their legal and judicial systems and to abolish all discriminatory laws. Furthermore, it obligates States to take all necessary measures to ensure that women actually experience equality in their lives. CEDAW defines discrimination against women and establishes, through its 16 substantive Articles, protections for women's full enjoyment of rights across social, cultural, economic, civil, and political spheres. While the treaty does not explicitly use the terms "gender equality" or "social justice," it extensively addresses the social dimension of women's lives,

<sup>10</sup> UN, *Beijing Platform for Action* (UN, NY, 1995) paras 164, 187 and 189 at <https://www.unwomen.org/en/digital-library/publications/2015/01/beijing-declaration>

<sup>11</sup> <https://www.ohchr.org/sites/default/files/Documents/ProfessionalInterest/cedaw.pdf>. As at April 2025 CEDAW has been ratified by 189 of the 193 UN Member States.

recognising that societal expectations about gender roles constitute a fundamental element of sex discrimination. Article 1 defines "discrimination against women" as

any distinction, exclusion, or restriction made on the basis of sex which has the effect or purpose of impairing or nullifying the recognition, enjoyment, or exercise by women, irrespective of their marital status, on the basis of equality of men and women, of human rights and fundamental freedoms in, among other domains, the social field.

Other UN human rights treaties,<sup>12</sup> for example, on eliminating race discrimination, ending disability discrimination, abolishing torture, protecting children's rights, and promoting the rights of migrant workers, frequently use the term "social" without including "social justice" but contain provisions that directly or indirectly support gender equality. For instance, the International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families<sup>13</sup> provides the global legal framework and comprehensive measures for migration rights based on gender equality and women's empowerment. Article 1 states, "1. The present Convention is applicable, except as otherwise provided hereafter, to all migrant workers and members of their families without distinction of any kind such as sex ..." while Article 7 requires that

States Parties undertake, in accordance with the international instruments concerning human rights, to respect and to ensure to all migrant workers and members of their families within their territory or subject to their jurisdiction the rights provided for in the present Convention without distinction of any kind, such as to sex, ...

Beyond the UN framework, there are specific ILO Conventions (binding upon State ratification) and Recommendations (soft law, not open to ratification, often accompanying the same-subject Convention) on gender equality in the world of work. Moreover, most international labour standards – even on very technical subjects– can be read as indirectly supporting gender equality since they apply to all workers without sex-based distinction or unfair differential treatment. The two main instruments, both highly ratified by the ILO Member States,<sup>14</sup> are the Discrimination (Employment and Occupation) Convention, 1958 (No. 111, Convention 111 here) and the Equal Remuneration Convention, 1951 (No. 100, Convention 100 here). These fundamental ILO treaties are accompanied by non-binding recommendations. The following treaty descriptions draw from this author's work for the *ASEAN Guideline on Gender Mainstreaming into Labour and Employment Policies* (2021), where this author served as Regional Consultant (p. xiv).

Convention 111 prohibits discrimination in employment and occupation on seven grounds, one of which is "sex." It permits ratifying States to add other grounds (like family responsibilities or social benefit recipient status) that often affect workers differently based on sex. The convention defines "discrimination" as any distinction, exclusion, or preference that has the effect of nullifying or impairing equality of opportunity or treatment in employment or occupation (covering both direct and indirect discrimination). The terms "employment and occupation" include access to vocational training, access to jobs and specific occupations, and terms and conditions of employment. Recommendation 111 specifies that these cover vocational guidance and placement services, training, career advancement, job security, wages, working hours and rest periods, occupational health and safety, and social security. Neither

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<sup>12</sup> Texts available at

<https://www.ohchr.org/en/core-international-human-rights-instruments-and-their-monitoring-bodies>.

<sup>13</sup> As at April 2025, this Convention has been ratified or acceded to by 60 States.

<sup>14</sup> As at April 2025, ratifications of Convention 111 totalled 175 of ILO's 187 Member States; for Convention 100, ratifications totalled 174.

inherent job requirements nor temporary special measures to remedy past discrimination violate the Convention.

Convention 100 requires ratifying States to apply the equal remuneration principle for work of equal value between women and men. It broadly defines "remuneration" to include basic or minimum wages/ salaries, all additional payments (direct/indirect, cash/kind), and any employment-related benefits from employers. States may implement this through national laws or regulations, wage-setting mechanisms, or collective agreements. The Convention also advises objective job evaluation methods to determine work value comparability.

In addition to these two fundamental treaties, there are four topic-specific standards encouraging women's and men's equality at work:

1) Workers with Family Responsibilities Convention, 1981 (No. 156) and its accompanying Recommendation 165 establish the principle of equal opportunity and treatment between men and women workers with family responsibilities and between such workers and other workers. The Convention defines "workers with family responsibilities" as men and women workers with care obligations for dependent children or other immediate family members requiring support, where these responsibilities limit their ability to participate or advance in economic activity. Ratifying States are required to implement community planning measures and services, including childcare and family support services. The Convention expressly prohibits termination of employment on the grounds of family responsibilities. These instruments contain a clear gender dimension, acknowledging women's unpaid care work and the need to reduce, redistribute, and remunerate such work.

2) Maternity Protection Convention, 2000 (No. 183) and Recommendation 191 stipulate that all employed women, including those in atypical forms of dependent work, are entitled to a minimum of 14 weeks paid maternity leave (with six weeks compulsory postnatal leave), medical benefits covering: prenatal, childbirth and postnatal care, as well as hospitalisation when necessary, cash benefits to ensure proper living conditions for mother and child, calculated at two-thirds of previous earnings or equivalent, funded through social insurance or public funds. Convention 183 specifically prohibits dismissal during pregnancy, maternity leave, or breastfeeding periods unless for reasons unrelated to pregnancy or nursing (with the burden of proof on the employer, and pregnancy testing during recruitment. It guarantees the right to return to the same or an equivalent position at equal pay and paid daily breaks or reduced working hours for breastfeeding.

3) The Domestic Workers Convention, 2011 (No. 189) and Recommendation 201 provide that women and men domestic workers globally who care for families and households must have the same basic labour rights as other workers, including specifically reasonable hours, weekly rest of at least 24 consecutive hours, limits on in-kind payments, clear written terms and conditions of employment, and protection of fundamental work principles (those referenced earlier). While data on domestic workers is difficult to obtain, ILO estimates that women represent the majority of such workers.

4) The Violence and Harassment Convention, 2019 (No. 190) and Recommendation 206 define "violence and harassment" as encompassing unacceptable behaviours or threats - whether single or repeated incidents - that cause or may cause physical, psychological, sexual or economic harm. They specifically define "gender-based violence and harassment" as such conduct targeting individuals because of their sex or gender or disproportionately affecting a particular sex or gender, including sexual harassment. The Convention establishes that workplace violence and harassment can constitute a human rights violation and contradict



decent work principles. Its broad scope covers conduct occurring during work, in work-related contexts (sanitary facilities, work trips, training, or social activities), through work communications (including ICT), and during commutes. The protections apply to all workers regardless of contractual status. Both instruments recognise the effects of domestic violence and require measures to mitigate its impact. Ratifying States must implement inclusive, integrated, and gender-responsive prevention strategies, including against third-party perpetrators. Recommendation 206 lists high-risk sectors (isolated work, healthcare, hospitality, domestic work, transport, and education) where women workers predominate. The Convention requires enforcement mechanisms, effective remedies, training, and awareness campaigns. Recommendation 206 further advises educational initiatives to address root causes, including power imbalances and gender, cultural, and social norms that enable violence and harassment.

Beyond explicit gender equality instruments, numerous technical labour standards on employment promotion, working conditions, social protection, and international labour migration indirectly advance gender equality. While some older texts may use masculine pronouns (e.g., "...the worker, he shall have the following rights..."), the International Labour Conference has ensured that all ILO instruments must be interpreted as inclusive of both women and men.<sup>15</sup> Examples of the technical standards that are gender mainstreamed include: Employment Policy Convention, 1964 (No. 122), Human Resources Development Convention, 1975 (No. 142), Social Security (Minimum Standards) Convention, 1952 (No. 102), and Termination of Employment Convention, 1982 (No. 158). Notably, Convention No. 158 explicitly prohibits termination based on sex, marital status, family responsibilities, pregnancy, or maternity leave absence.

Together, these texts show how dignity and fairness shape global understandings of equality between women and men. They draw States towards making social justice a reality in practice.

### **Applied Illustrations of Implementation of the Gender Equality Texts**

The above overview of UN and ILO standards demonstrates how gender equality and social justice can blend both explicitly and implicitly. But can States Parties accept and apply this "minted coin" concept in law and practice? And how is this being done?

A positive answer emerges when examining real-world applications in the labour sector. Since 1964, the ILO's CEACR has recorded progress in applying ratified gender equality standards.<sup>16</sup> Its 2024 report notes "satisfaction" (the CEACR term for States demonstrating measurable improvements in gender equality implementation) regarding Convention 111 in El Salvador (where Labour Law now guarantees immediate reinstatement for women dismissed during pregnancy or postpartum), and Lesotho (where the 2022 Harmonisation of the Rights of Customary Widows with the Legal Capacity of Married Persons Act grants customary widows property rights over marital estates).

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<sup>15</sup> *ILC resolution concerning gender equality and the use of language in legal texts of the ILO* (which is accompanied by an Editor's Note to be attached to the Organization's 1919 Constitution in order to avoid sexist language), 100<sup>th</sup> Session, ILO, Geneva, 2011.

<sup>16</sup> In some States ratified international instruments enter directly into the panoply of national legal texts and can be relied on by courts; in others, government must take the additional step of domesticating the ILS principles into the national legal framework. For more detail on the ILO's supervisory system, see *Rules of the Game*, Centenary Edition, ILO, Geneva, 2019 available at [www.ilo.org/normes](http://www.ilo.org/normes).

The 2024 cases demonstrating the satisfactory application of Convention 100 include three significant implementations. In Bolivia, Supreme Decree No. 4401 (2020) mandates that "the State shall promote the entry of women into employment and also the same remuneration for women and men for work of equal value" and "it shall be prohibited to consider differences or justify the existence of a wage gap through aspects directly or indirectly linked to the fact of being a woman, on the grounds of pregnancy, maternity, paternity, breastfeeding or family responsibilities." Canada's Federal Pay Equity Act (effective 31 August 2021) requires federally regulated private and public sector employers with at least 10 employees to develop and maintain pay equity plans, with additional provisions for unionised workplaces and companies with 100 or more employees to establish joint pay equity committees. The Act also created a Pay Equity Commissioner empowered to order compliance audits, impose monetary penalties, and investigate complaints. Japan amended the Women's Advancement Promotion Act (July 2022, MHLW Ordinance No. 104) to require private employers with over 300 regular employees to disclose "differences in wages between men and women."<sup>17</sup>

The above examples of gender equality progress equally demonstrate social justice advancement. Implementing practical measures to uncover pay disparities based on sex or guaranteeing women's equal inheritance rights alongside men's lies at the core of fairness and human dignity.

### Conclusions

As previously noted, a large number of soft law instruments highlight social justice as essential for addressing contemporary challenges, reflecting a 21st-century need to pursue deeper fundamental justice, as the post-Second World War instruments like the ILO Philadelphia Declaration sought more than peace. An equally significant number of legally binding instruments (and soft law, non-binding texts as well) establish sex-based non-discrimination, more broadly framed as gender equality, as foundational for human well-being. This legal evolution spans from ILO Convention 111 and UN CEDAW to the most recent ILO Convention 190, which specifically targets violence and harassment, particularly gender-based violence, in the world of work. The social justice instruments consistently refer to equality and, more recently, gender equality, both as a core component of the concept and as a key metric for assessing the success of social justice measures. While gender equality texts may not explicitly reference social justice, their practical implementation by state parties frequently advances social justice objectives. For instance, legislative reforms guaranteeing widows equal property rights with men demonstrate this dual gender equality/social justice approach in action. Likewise, making equal pay a reality through publishing wage differences, requiring pay audits, and enforcing penalties for violations demonstrates how gender equality and social justice work together.

The two concepts are more than two sides of the same coin. They are fundamentally fused, comprising the very substance of the coin itself. This integrated approach carries substantial weight in policymaking circles. In good and bad times (such as the COVID-19 pandemic), social justice remains unattainable while gender inequalities endure, just as gender equality cannot be achieved without social justice. Together, they form a powerful foundation for human well-being, sustainable development, and peace. For policymakers and international actors, this means any single-concept approach, whether ideologically or pragmatically motivated, will not work, producing inadequate outcomes for all genders.

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<sup>17</sup> ILC, 112<sup>th</sup> Session, *Report of the Committee of Experts on the Application of Conventions and Recommendations*, Report III (Part A), para. 117 (ILO, Geneva, 2024).

A deeper understanding of this fundamental interdependence remains crucial in our contemporary world. Initiatives like the Global Coalition for Social Justice may foster awareness by reinvigorating multilateral efforts to advance both social justice and gender equality. Readers will be well-advised to follow the Coalition's developments, helping ensure "the one coin" enters regular use rather than becoming just a commemorative collector's item.

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# Social Justice for a Democratic and Equitable International Order

## Justicia Social para una orden internacional democrática y equitativa

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Sent: 2025/03/18  
Accepted: 2025/05/14  
Published: 2025/06/30

### Abstract

This article reviews key substantive issues addressed by main ongoing global policy processes with a particular focus on the Second World Summit for Social Development (WSSD2) and the Global Coalition on Social Justice. These issues include the Right to Development as a core principle underlying social development and the realization of social justice and development in terms of international law standards. The article identifies and assesses relevant international law, policy formulations, expertise, and political processes to demonstrate their bearing on the WSSD2 and global discussion of social justice. This approach is intended to bridge academic exercise with briefing guidance for Social Justice and development actors. Core building blocks are identified: human rights codification and social responsibility; transforming the Rule of Law into the Rule of Justice; and imperatives for enforcement of United Nations Treaties, judgments and resolutions. Also, UN texts on the Right to Development and the Right to International Solidarity; the Summit of the Future and the BRICS Summit 2024; and norms and expectations of international cooperation are analysed herein. Conclusions posit that the Right to Development must be seen as juridical, *justiciable* and enforceable. Finally, the article recommends that the content and outcome of the WSSD2 and other global processes need to *redress the paradigm* by reaffirming international legal obligations and casting social justice development in terms of international law, the existing human rights treaty system, formal UN Declarations, disarmament for development.

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**Summary:** Introduction, Methodology: A note on approach, Results, Conclusions and Recommendations: WSSD2 must change the paradigm.

**How to cite:** de Zayas, A.(2025). Social Justice for a Democratic and Equitable International Order. *Revista Tecnológica - Espol*, 37(1), 68-88. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1294>

**Keywords:** Social Development, Right to Development, International Solidarity, Rule of Law, Rule of Justice, International cooperation.

### Resumen

Este artículo examina aspectos sustantivos abordados por los principales procesos de políticas globales en curso, con atención a la Segunda Cumbre Mundial sobre Desarrollo Social (CMDS2) y la Coalición Mundial sobre Justicia Social. Estos temas incluyen el derecho al desarrollo como fundamento para el desarrollo, y la concepción de la justicia social en términos de los estándares del derecho internacional. Se identifica y evalúa el derecho internacional, las formulaciones de políticas, la experiencia y los procesos políticos para demostrar su incidencia en la CMDS2 y el debate mundial sobre justicia social. Este enfoque tiene como fin conectar la práctica académica y la orientación para la justicia social y los actores de desarrollo. Se identifica como pilares la codificación de los derechos humanos y la responsabilidad social, la transformación del Estado de Derecho al Estado de Justicia, y los imperativos para la aplicación de los tratados, declaraciones y resoluciones de las Naciones Unidas. Además, se analiza textos sobre el derecho al desarrollo y el derecho a la solidaridad internacional, la Cumbre del Futuro, la Cumbre BRICS 2024, y las normas y expectativas de la cooperación internacional. Como conclusión, se reafirma que el derecho al desarrollo debe ser jurídico, *justiciero* y exigible. Se recomienda que los resultados de la CMDS2 y otros procesos globales deben reafirmar las obligaciones jurídicas internacionales fundamentando el desarrollo y la justicia social en términos del derecho internacional, el sistema de tratados de derechos humanos existente, las declaraciones de las Naciones Unidas, y el desarmamiento para el desarrollo.

**Palabras clave:** Desarrollo social, Derecho al desarrollo, Solidaridad internacional, Estado de derecho, Estado de justicia, Cooperación internacional.

*Pursuant to General Assembly Resolution 78/261 of 26 February 2024, a "Second World Summit for Social Development" (WSSD2) is to be held in Doha, Qatar on 4 to 6 November 2025<sup>2</sup>.*

### Introduction

The Right to Development must be seen as juridical, justiciable and enforceable. The Second World Summit for Social Development (WSSD2, 2025) provides a unique opportunity to reaffirm the Right to Development as a core principle underlying social development. In tandem, WSSD2 has the responsibility to reaffirm the fundamental relevance of binding international legal commitments to advancing development, and to cast the realization of social justice and development in terms of international legal standards. WSSD2 should link social development *inter alia* to: the existing Human Rights Treaty system, the UN Declaration on the Right to Development (1986), and pertinent international labour standards/ILO Conventions. Preparatory discussion for the Summit and drafting of the outcome should build on the work of the United Nations Department of Economic and Social Affairs, the UN Reports on the Sustainable Development Goals, the Reports of the Human Rights Council's Special Rapporteur on the Right to Development<sup>3</sup>, as well as the Reports of other independent experts whose mandates similarly give impulse to standard-setting and thus advance the cause of social development. UN expert work and reports of particular relevance include those of the Rapporteurs on the Right to Food, the Right to Health, the Right to Clean Water and Sanitation,

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<sup>2</sup> <https://social.desa.un.org/second-world-summit-for-social-development>

<sup>3</sup> <https://www.ohchr.org/en/special-procedures/sr-development>

the Right to Housing, the Right to International Solidarity, and the Promotion of a Democratic and Equitable International Order<sup>4</sup>.

Furthering development world-wide is one of the three pillars of the United Nations Charter, together with promoting peace and human rights. The United Nations Organization, however, finds itself in a grave crisis of identity, authority and credibility, largely because several permanent members of the Security Council want to instrumentalize the Organization to advance their own geopolitical agendas and not the interests of humanity at large. Worse than that, the permanent members of the Security Council still enjoy institutionalized impunity. Draft Decisions and Resolutions of the Security Council are systematically frustrated by the abuse of the obsolete veto power contained in Article 27(3) of the Charter. Judgments and Advisory Opinions of the International Court of Justice are being flouted with impunity. We are facing not only an implementation gap, but a serious loss of trust in the institutions created to uphold our rights.

The UN Charter and civilization itself are under mortal attack by what may be called an open *rebellion* against international law and morals. Provocations, aggressions, escalations, wars culminating in crimes against humanity and genocide as defined in the Convention on the Prevention and Punishment of the Crime of Genocide (1948) are destroying the fabric of the domestic and international legal order that humanity has woven and interwoven over the centuries. WSSD2 cannot afford to ignore these facts. It must address them and see how good faith – that fundamental general principle of law – is vindicated.

This article provides an overview of *what's at stake* during the 2<sup>nd</sup> World Summit on Social Development and identifies key concerns and approaches to shape the outcome. A primary purpose of the exercise encapsulated in this journal article is to promote dialogue and mutual enrichment between the worlds of operational practitioners, academia, and political actors addressing inter-related fields of social development and social justice.

### **Methodology: A note on approach**

This article draws together key elements of international law, policy, expertise, and political processes to demonstrate their bearing on the 2<sup>nd</sup> World Summit on Social Development as well as on advancing the social justice agenda. It articulates a summary review of key factors and issues at stake in social development and social justice. It is intended to serve as a practical briefing guide accessible to member representatives at the Global Coalition on Social Justice and delegates to preparatory meetings and the 2<sup>nd</sup> World Summit on Social Development. In doing so, it may benefit a wider audience concerned by these issues and events.

The article derives from knowledge and experience accumulated by the author over a half century of practical operational dedication as well as research and academic teaching on issues of international law, global justice and human rights. Its methodological approach is to elaborate on an annotated inventory identifying the key thematic and political topics that should be core elements on the agendas of the main global law and policy processes in 2025. The study comprised a process of identifying, compiling, analyzing, and cross-referencing documentation on relevant international law, United Nations declarations and policy articulations, and expert observations and writings. The presentation builds the case with a critique of the failures in realizing the first World Summit on Social Development vision and program, a summary of prospects for the 2<sup>nd</sup> WSSD, a discussion of fundamental understandings of human rights in law, an identification of international legal and declarative principles especially pertinent for

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<sup>4</sup> <https://www.ohchr.org/en/special-procedures/ie-international-order>

the WSSD process and result, and discusses several key constraints to advancing social development and social justice prospects at WSSD2 in the current world context.

The author draws on his extensive written work in published articles, reports and books –several of which cited herein-- reflecting five decades of international experience including as senior legal advisor at the Office of the UN High Commissioner for Human Rights (OHCHR) and two terms as the first *UN Independent Expert on the Promotion of a Democratic and Equitable International Order*. This article's approach naturally presumes ongoing academic exploration of each of the topical concerns identified in this inventory.

## Results

### **Realization of the first WSSD outcome thwarted by militarization**

The hopes and expectations associated with the Copenhagen Declaration and Programme of Action (1995) adopted at the first World Summit for Social Development were not realized. There are multiple reasons for this failure, notably the increasing militarization of the world and the decreased level of multilateralism that followed the dissolution of the Soviet Union. For a brief moment, the world stood before the possibility of advancing sustainable peace and development for all. The dissolution of the Warsaw Pact in 1991 should have been followed by the dissolution of NATO and a recommitment to the pledge of “we the peoples of the United Nations” to save succeeding generations from the scourge of war.

It would have been entirely feasible to gradually convert military-first economies into human security economies and to redirect the resources hitherto devoted to the production of weapons of mass destruction, conventional armaments, maintaining military bases and conducting wars worldwide (Report of the Independent Expert on the promotion of a democratic and equitable international order, 2014). Disarmament for development would have helped to eradicate extreme poverty worldwide, eliminate famine, prevent pandemics, advance social justice, and create jobs worldwide. However, to the contrary, the increasingly militaristic trend in policy and action of Western countries in the 1990s was impregnated by the fantasies of Francis Fukuyama (1992) *The End of History*, Zbigniew Brezinski (2016) *The Grand Chessboard* and the illusion that “winner takes all”.

Instead of resolving the Kuwait crisis by peaceful means, with patience and perseverance, the United States persuaded the United Nations to approve the use of devastating force against the people of Iraq in what became known as “Operation Desert Storm”, which resulted in enormous losses among the hapless civilian population of Iraq in a needless war that was primarily a war /ver oil (de Zayas, 2021; de Zayas, 2023). A mantle of legality was thrown over the massacre of civilians and the subsequent murderous UN sanctions that devastated the economy of Iraq and killed over one million Iraqis, causing Assistant Secretary General Denis Halliday, the UN humanitarian coordinator in Iraq, to tender his resignation in protest and calling the UN sanctions regime a form of genocide (ibid). Halliday was followed in the job by Assistant Secretary-General Hans von Sponeck, who similarly resigned in protest and wrote a book “ *different kind of war*”, deploring the destruction of UN values by the UN itself (d'Aymery, 2007).

Through an enormous level of public relations and propaganda, it became possible to confuse the peace-keeping functions of the United Nations with the geopolitics of NATO, which essentially usurped the mandate of the Security Council (Naidu, 2000). Instead of working for peace and development, the United Nations morphed into a force to advance United States hegemony over the entire world.

NATO itself morphed from a legitimate alliance for defence into a war coalition to impose US interests and capitalism on the rest of the world. Objectively seen, NATO had ceased to be a legitimate regional organization under Article 52 of the UN Charter, and did not consider itself subordinate to the Purposes and Principles of the UN Charter, nor bound to act in a manner that would serve the object and purpose of the United Nations Organization (de Zayas, 2023b). This augured badly for the achievement of social justice that is essential for advancing social development.

Cognitive dissonance played a role in this epistemological confusion. While politicians and neo-liberal think tanks continued giving lip service to peace and development, the US and the “coalition of the willing” rushed into every possible war and pretended to impose peace – and capitalism – by force.

Instead of this scenario, a totally different situation could have emerged after the dissolution of the Soviet Union and the Warsaw Pact. This would have entailed the dissolution of NATO. Instead, President Bill Clinton decided in 1997 to expand NATO eastwards, a decision which George F. Kennan decried in a New York Times opinion article as “A fateful error” (Kennan, 1997; Switzer, 2024). The focus on military force accompanied by fear-mongering and the propagandistic selling of NATO as a legitimate defence alliance upended the priorities of the United Nations, effectively sidelining its social and development mandate and marginalizing the treaty commitments under the International Covenant on Economic Social and Cultural Rights.

### **Prospects of the Second World Summit for Social Development**

WSSD2 must build on what already exists, and there is an enormous body of international law and jurisprudence that must be reaffirmed and built upon.

The motto of the International Labour Organization “*si vis pacem, cole justitiam*” should guide the deliberations of the Second World Summit for Social Development, in which the countries of the Global South, BRICS members and others will doubtless play a more important role than during the 1995 Copenhagen summit.

In direct contradiction to advancing social justice for all, in the year 2024 the wealth of the billionaires grew three times as fast as in 2023, while at the same time extreme poverty and famine plagued the world. The contemporary systems of financial governance, taxation, odious foreign debt, World Bank projects, IMF loan conditionalities, and the capitalist approach in general are manifestly not advancing social justice nor pursuing social justice. The World Economic Forum in Davos will not reverse this trend, on the contrary.

It is for the United Nations and the World Social Forum to make the necessary decisions and for the countries of the Global South to press for their implementation. We should turn away from what Professor Jean Ziegler of the University of Geneva calls the cannibalistic world order. (Ziegler, 2024, p. 9.)

There has been considerable progress in comprehensive standard setting and the establishment of monitoring mechanisms. Enforcement, however, has been a disappointment. Over the past 50 years most monitoring mechanisms and judicial and quasi-judicial organs have been hijacked to serve the interests of Washington and Brussels. This may sound shocking to many, but it is the sad reality which is substantiated in detail in the book *The Human Rights Industry* (de Zayas, 2023c).



What is progress? The abolition of capital punishment and the gradual improvement of the condition of women are highlights over the previous several decades. However, even these are under attack and facing push-back in challenges to international law, in global policy processes, and in national law and practice in many countries.

But there are many other major problems. Of course, what some persons consider “progressive”, other persons may consider a threat to well-established religious beliefs, customs and traditions that also deserve protection. We owe it to ourselves and to future generations to remove those systemic obstacles that make the realization of the human rights to peace, life, food, water, family, justice, and development ever more difficult.

In order to have added value, the Second World Summit for Social Development must go beyond other United Nations summits, such as the World Summit of 2005 and the Summit of the Future of 2024. It should not just end with a vague list of desiderata, but formulate concrete proposals how to achieve the Sustainable Development Goals and craft mechanisms to enforce relevant United Nations resolutions.

WSSD2 should reaffirm that the United Nations Charter constitutes our only “norms based international order”, akin to a world constitution. All peoples should observe this world constitution and all States must enforce it. Civilization means the Rule of Law, due process, transparency, accountability, justice, reparation, reconciliation, inclusion, international solidarity. The survival of mankind depends on good faith implementation of treaties and agreements (*pacta sunt servanda*) (Vienna Convention on the Law of Treaties (1969), Article 26), on pro-active cooperation, based on a conviction that we all share the same human dignity, the same needs and aspirations, that we must somehow coexist on this one planet Earth. With good will conflicts can be prevented and grievances can be addressed in a timely fashion and resolved.

### **Human Rights codification and social responsibility**

All human rights necessarily derive from human dignity. Codification of human rights is never definitive and never exhaustive, but constitutes an evolutionary *mode d'emploi* for the exercise of civil, cultural, economic, political and social rights. However, the interpretation and application of human rights is hindered by positivism, wrong priorities and inflexible legalisms. In this author's observation, many rights advocates show little or no interest in the social responsibilities that accompany thesis exercise of rights, and fail to see the necessary symbiosis of rights and obligations, notwithstanding the letter and spirit of Article 29 of the Universal Declaration of Human Rights (1948) which stipulates: “Everyone has duties to the community in which alone the free and full development of his personality is possible.” The time has come to change the human rights paradigm away from narrow positivism towards a broader understanding of human rights norms in the context of an emerging customary international law of human rights.

Law is neither physics nor mathematics, but a dynamic human institution that day by day addresses the needs and aspirations of society, adjusting here, filling lacunae there. Every human rights lawyer knows that the spirit of the law (Montesquieu) transcends the limitations of the letter of the law, and hence codified norms should always be interpreted in the light of those general principles of law that inform all legal systems, such as good faith, proportionality and *ex injuria non oritur jus*.

The obsolete and artificial division of human rights into those of the falsely called first generation (civil and political), second (economic, social and cultural) and third generation

(environment, peace, development) rights—with its obvious predisposition to favour civil and political rights—should be discarded. This generational divide is part of a mental structure that perpetuates a world order that much too often appears to allow injustice. It should be replaced by a functional paradigm that would consider rights in the light of their function within a coherent system—not of competing rights and aspirations, but of interrelated, mutually reinforcing rights which should be applied in their interdependence and understood in the context of a coordinated strategy to serve the ultimate goal of achieving human dignity in all of its manifestations.

Four categories would replace the skewed narrative of three generations of rights:

1. Enabling rights: the rights to food, water, shelter, development homeland and the right to peace, since one cannot enjoy human rights unless there is an environment conducive to the exercise of those rights. Article 28 of the Universal Declaration of Human Rights postulates the right of every human being “to a social and international order in which the rights and freedoms set forth in this Declaration can be fully realized.” This entails the basic necessities of life and the right to access the tools for individual and collective development.
2. Inherent or immanent rights: the rights to life, integrity, liberty and security of person, in the light of which other rights must be interpreted and applied. Every such right must necessarily contain within itself the element of equality, the self-evident requirement that it be applied equally and equitably, that there be uniformity and predictability. There are also inherent limitations to the exercise of rights. The general principle of law prohibiting abuse of rights, *sic utere tuo ut alienum non laedas*—the use of a right without harming others, a principle advocated by Sir Hersch Lauterpacht<sup>5</sup> as an overarching norm prohibiting the egoistic exercise of rights to achieve anti-social results or unjust enrichment. This principle means that every right, including all human rights, must be exercised in the context of other rights and not instrumentalized to destroy other rights or to harm others. There is no right to intransigence in law—as we know from the sad character of Shylock in Shakespeare’s *Merchant of Venice*. The letter of the law must never be used to subvert the spirit of the law.
3. Instrumental or procedural rights: the rights to due process, access to information, the right to truth, freedom of expression and peaceful assembly, association, work, education, social security, leisure—rights that we need to achieve our potential, to complete our personalities, to engage in the pursuit of happiness.
4. Outcome rights: the concrete exercise of human dignity, that condition of life that allows each human being to be himself or herself. This ultimate right is the right to our individual identity, to our privacy, the right to be ourselves, to think for ourselves and express our humanity without indoctrination, without intimidation, without pressures of political correctness, without having to sell ourselves, without having to engage in self-censorship. The absence of this outcome right to identity and self-respect is reflected in much of the strife we see in the world today. It is through the consciousness and exercise of the right to our identity and the respect of the identity of others that we will enjoy the individual and collective right to peace.

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<sup>5</sup> <https://books.openedition.org/iheid/1551>

## The Rule of Law must evolve into the Rule of Justice<sup>6</sup>

WSSD2 has the opportunity to review the implications of the “Rule of Law” and discuss what must be done to make laws serve justice – and not just reflect power equations.

Many politicians, academics, media pundits are wont of invoking the “Rule of Law”, a “rules-based international order”, “values diplomacy” etc., but what do all these benevolent-sounding slogans actually mean in practice? Who makes the rules, who interprets them, who enforces them? What level of transparency and accountability accompanies these noble pledges?

In a very real sense, we already have a “rules based international order” in the form of the UN Charter and its “supremacy clause”, Article 103 of which grants it priority over all other treaties and agreements. The norms established in the Charter are rational, but effective enforcement mechanisms are yet to be created.

We also have humanistic “values” that should guide diplomacy and peace-making – including the principle “*pacta sunt servanda*” (treaties must be implemented). Nonetheless, both in domestic and international law there is a high level of bad faith and the tendency to apply double-standards. Major powers make agreements and then break them with impunity. Major powers undermine diplomacy by brazenly lying, by making promises and not keeping them. This subverts the credibility of the entire system of norms and mechanisms.

Politicians often forget that keeping one’s word is not only a matter of personal honour – it is an indispensable element of trust in the conduct of public affairs. Among other crucial values that we should promote are compassion, empathy, forgiveness, and solidarity common to religious faiths and teachings around the world.

It is axiomatic that the Rule of Law functions as a pillar of stability, predictability and the democratic ethos in modern society. Its object and purpose are to serve the human person and progressively achieve human dignity in the larger context of freedom.

Because law reflects power imbalances, we must ensure that the ideal of the Rule of Law is not instrumentalized simply to enforce the status quo, maintain privilege, and the exploitation of one group over another. The Rule of Law must be a rule that allows flexibility and welcomes continuous democratic dialogue to devise and implement those reforms required by an evolving society. It must be a rule of conscience, of listening.

Throughout history law has all too frequently been manipulated by political power, becoming a kind of dictatorship through law, where people are robbed of their individual and collective rights, while the law itself becomes the main instrument of their disenfranchisement. Experience has taught us that law is not coterminous with justice and that laws can be adopted and enforced to perpetuate abuse and cement injustice. Accordingly, any appeal to the Rule of Law should be contextualized within a human-rights-based framework.

Already in Sophocles’ drama *Antigone* we saw the clash between the arbitrary law of King Creon and the unwritten law of humanity. Enforcing Creon’s unjust law brought misery to all. In Roman times the maxim *dura lex sed lex* (the law is hard, but it is the law) was mellowed by Cicero’s wise reminder that *summum jus summa injuria* (extreme law is extreme injustice, *de Officiis* 1, 10, 33), i.e. the blind application of the law may cause great injustice.

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<sup>6</sup> This section drawn from: de Zayas (2021), pp. 50-51.

The contention that, irrespective of what it stipulates, “the law must be obeyed” has been challenged by human rights heroes for thousands of years. Spartacus fought against the Roman slave laws and paid with his life. Slavery remained constitutional and legal in the Western hemisphere until the mid-nineteenth century; colonialism was deemed constitutional and legal by the colonizers until the decolonization processes of the 1950s, 1960s and 1970s; Nazi Germany’s racist Nuremberg laws of 1935 were constitutional and legal, as were those of South Africa’s *Apartheid*, as those of Israel in Palestine; Stalin’s laws, the Holodomor in the Ukraine and the purges of the 1930’s were all based on Soviet laws and decrees; segregation in the US was constitutional and legal<sup>7</sup> until overturned in 1954.

Civil disobedience by Henry, David Thoreau, Zaghoul Pasha, Michael Collins, Dietrich Bonhoeffer, Mahatma Gandhi, Martin Luther King, Nelson Mandela, Ken Saro Wiwa, Mohamed Bouazizi was legitimate and necessary to give example and initiate reforms – but they all suffered the consequences of having opposed the fetishism of the “Rule of Law”.

Democracy in the twenty-first century requires that the Rule of Law cease being the rule of power, of might makes right, geopolitics and economics. The Rule of Law must incorporate human dignity into the equation and enable people power, self-determination and referenda. The Rule of Law must evolve into the rule of social justice and peace. The WSSD2 offers a great opportunity to explicitly promote the evolution of the Rule of Law into the Rule of Justice, all the more so with deliberate attention to advancing realization of the declarations and principles discussed in the following sections.

### **Enforcement of UN treaties, judgments and resolutions**

The authority and credibility of international law depends on its implementation. This applies also to decisions and recommendations of WSSD2.

The UN Charter, adopted on 24 October 1945, has not lost its relevance. In fact, the United Nations is needed more than ever. The General Assembly remains the most representative international body, the best forum for active diplomacy among nations and peoples, the logical venue to craft compromises, a peaceful *modus vivendi* that will advance social justice, facilitate development and prosperity for everyone on the planet. Civil society must play a stronger role in decision-making and strengthening a democratic and equitable international order.

Eighty years after the adoption of the UN Charter, new realities have emerged that are not properly reflected in the membership of the UN Security Council. Already in 2005 UN Secretary-General Kofi Annan proposed in his report “*In larger Freedom*” an expansion of the SC from 15 to 24 members:

“If the UN is to be a vehicle through which states can meet the challenges of today and tomorrow, it needs major reforms to strengthen its relevance, effectiveness, and accountability...No reform of the UN would be complete, however, without Security Council reform. The council’s present makeup reflects the world of 1945, not that of the twenty-first century. It must be reformed to include states that contribute most to the organization, financially, militarily, and diplomatically, and to represent broadly the current membership of the UN. Two models for expanding the council from 15 to 24 members are now on the table: one creates six new permanent seats and three new non-permanent ones; the other creates nine new non-permanent seats. Neither model expands the veto power currently enjoyed by the five permanent members. I believe the time has come to tackle this issue head on.” UN Secretary-General (2005).

<sup>7</sup> See, for instance, the US Supreme Court judgment *Plessy v. Ferguson*: <https://supreme.justia.com/cases/federal/us/163/537/>

This author endorsed Annan's proposal in his 2013 report to the General Assembly in his capacity as Independent Expert on International Order, formulated reform options, and laid out a plan of action how to gradually phase out the veto power in the Security Council, by amending Article 27 of the Charter. (Report of the Independent Expert on the promotion of a democratic and equitable international order, 2013; see also Schwartzberg, 2013).

There have been five amendments to the UN Charter, starting with the amendment adopted on 31 August of 1965 to increase the membership of the Security Council from 11 to 15 pursuant to Article 108 of the Charter. An expansion of the Security Council membership is urgent in order to make it genuinely representative and strengthen its authority and credibility. We no longer live in the world of 1945, although three members of the Security Council are still major powers: China, Russia and the US, but there is no justification to perpetuate the permanent seats of the United Kingdom and France, whose political and economic power has declined. A better reflection of today's world would be achieved through the permanent presence in the Security Council of Brazil, India, Indonesia, Japan, Mexico, Nigeria, South Africa and Turkey.<sup>8</sup>

If and when the UN Charter is amended, the States should also agree on the establishment of enforcement mechanisms beyond those foreseen in Chapter VII of the Charter, providing for the possibility of delegating or outsourcing certain functions to specialized agencies like the ILO, UNESCO, UNICEF and WHO with hands-on experience on the ground. Among the amendments that should be considered is the addition of a clause requiring countries to adopt enabling legislation granting domestic legal status to international judgments and decisions, so that local judges can actually order the implementation of international commitments.

In other words, international law and international jurisprudence should become part of the domestic legal order. For instance, citizens should be able to directly invoke the provisions of the International Covenant on Civil and Political Rights (ICCPR), the International Covenant on Economic, Social and Cultural Rights (ICESCR), the International Convention on the Elimination of all Forms of Racial Discrimination (ICERD), the Convention against Torture (CAT), the International Convention on the Prohibition and Punishment of the Crime of Apartheid<sup>9</sup>, the Convention on the Prevention and Punishment of the Crime of Genocide<sup>10</sup>, etc. Moreover, citizens should have standing in local courts to demand from their governments that they abide at least by the fundamental commitments undertaken in the United Nations Charter, e.g. not to deliver lethal weapons to countries committing war crimes, crimes against humanity and genocide. In a few States like the Netherlands, every citizen can invoke the ICCPR directly and start a case against the government for the delivery of weapons to a country committing war crimes and crimes against humanity<sup>11</sup>.

Law without enforcement loses its authority and credibility. Enforcement, however, presupposes a mental disposition to accept and implement judgments and advisory opinions of

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<sup>8</sup> See for example discussion of expanded UN Security Council membership in: *Transforming the United Nations System* by Joseph Schwartzberg (2013), also *Time to Bring the United Nations Security Council into the 21st Century*, by Nancy Soderberg in *Georgetown Journal of International Affairs* Vol. 16, No. 2 (2015).

<sup>9</sup> [https://www.un.org/en/genocideprevention/documents/atrocities-crimes/Doc.10\\_International%20Convention%20on%20the%20Suppression%20and%20Punishment%20of%20the%20Crime%20of%20Apartheid.pdf](https://www.un.org/en/genocideprevention/documents/atrocities-crimes/Doc.10_International%20Convention%20on%20the%20Suppression%20and%20Punishment%20of%20the%20Crime%20of%20Apartheid.pdf)

<sup>10</sup> <https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-prevention-and-punishment-crime-genocide>

<sup>11</sup> <https://apnews.com/article/netherlands-court-f35-israel-b33608b054a33fbacc518395b53b74e8>  
<https://www.ohchr.org/en/press-releases/2024/02/arms-exports-israel-must-stop-immediately-un-experts>

the ICJ (Sarraf, 2023) and other competent tribunals, whether or not the State agrees with the rulings or with their rationale. That is the essence of civilization: to accept that in every judicial dispute there are valid arguments on all sides and that the competent judicial instance has been given authority to decide. This entails an obligation to respect the decision in good faith. Selective enforcement of ICJ judgments and Orders, selective implementation of Resolutions of the General Assembly and Security Council, selective compliance with recommendations of UN bodies undermine the international order. On the other hand, enforcement does not mean only “sanctions” under Chapter VII of the UN Charter, and should not be primarily perceived as a form of punishment. Rather, it should be understood as a self-evident component of the social contract, of the Rule of Law, of civilization. Enforcement should be accompanied by incentives, advisory services and technical assistance in international solidarity<sup>12</sup>. Enforcement also requires the cooperation of non-state actors including transnational corporations, which have become subjects of international law.<sup>13</sup>

Indeed, civilization does not simply require society to have a set of laws, public education and incentives to abide by them, and powerful regulatory and policing agencies to enforce them. Civilization means ensuring the real welfare of people, creating the conditions necessary for their pursuit of happiness. The true indicators of civilization are not an expanding Gross Domestic Product, ever-growing consumption, and aggressive exploitation of natural resources – but rather respect for human and animal life, sustainable management of the environment, local, regional and international solidarity, social justice and a culture of peace.

Unfortunately, contemporary civilization does not measure up with its noble ideals. governments continue to sabotage the Rule of Law by instrumentalizing norms to destroy justice, e.g. by weaponizing extradition law to persecute whistle-blowers like Julian Assange and keep them bottled up for decades. Similarly, the extradition of Alex Saab from Cape Verde in 2021 to a kangaroo trial in the United States is a travesty of justice, as was the prosecution and imprisonment of the “Cuban 5”, victims of gross political injustice by a Miami tribunal. We have witnessed the increased use of “lawfare” to destroy political adversaries, e.g. the frame-up of Dilma Rousseff in Brazil, making the way free for “regime change”. Similarly, the subversion of election monitoring by the Organization of American States resulting in the *coup d'état* against Evo Morales of Bolivia in 2019. We have witnessed lawfare in Ecuador against former President Rafael Correa and former Vice-President Jorge Glas.

Considerable responsibility for the corruption of the Rule of Law is borne by the corporate media that systematically dis-informs the public about the facts and imposes a “managed narrative” that essentially cripples any chance for an objective debate. Over the past decades the corporate media has engaged in brazen propaganda to create a false “perception” of the law, including international law, that is very distant from any conception of justice. By suppressing information, dis-informing and whitewashing, the corporate media has become complicit in the war crimes and crimes against humanity perpetrated in Afghanistan, Iraq, Syria, Libya, Yemen etc. The media has even attempted to create an impression that the 2003 Invasion of Iraq was a “just war” (de Zayas, 2023a) in keeping with the UN Charter. Yet, the then UN Secretary General Kofi Annan repeatedly called an “illegal war” (BBC News, 2004).

Bottom line: in order to help the Rule of Law evolve into the Rule of Justice, we must demand our right to access to information, we must adopt a Charter of Rights of Whistleblowers, demand transparency and accountability from our governments, and ensure

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<sup>12</sup> See Revised draft declaration on human rights and international solidarity (2023)

<sup>13</sup> <https://www.oxfordbibliographies.com/display/document/obo-9780199796953/obo-9780199796953-0049.xml>

that Parliaments revisit obsolete laws that perpetuate injustice. We must remain vigilant to ensure that the Rule of Justice is built day by day and that our courts and tribunals apply the existing legislation in good faith and not in the service of corporations and special interests, who do not want rights – but only privileges. WSSD should join the struggle to re-establish the “Rule of Justice”.

### ***Business and Human Rights***

WSSD2 has an opportunity to discuss the UN Principles on Business and Human Rights (UN – OHCHR, 2011) and recommend that John Ruggie principles be made legally binding. A Treaty on the social responsibility of transnational corporations and other enterprises is long overdue. Social development will be difficult to achieve if transnational corporations and other enterprises are *legibus solutus* and immune from prosecution when they are responsible for serious human rights violations.

### ***The UN High Commissioner for Human Rights***

It is opportune to focus on the mandate of the UN High Commissioner for Human Rights. Following up on the recommendations of the Vienna World Conference on Human Rights, the General Assembly adopted on 20 December 1993 Resolution 48/141 creating the mandate of the High Commissioner for Human Rights. In its preambular paragraphs, the Resolution recalls “that one of the purposes of the United Nations enshrined in the Charter is to achieve international cooperation in promoting and encouraging respect for human rights”. In operative paragraph 4, the resolution enumerates the responsibilities of the High Commissioner, including “To enhance international cooperation for the promotion and protection of all human rights”<sup>14</sup>.

According to its terms of reference, the *raison d'être* of the Office of the High Commissioner for Human Rights is to advance human rights and the Right to Development by means of international cooperation, advisory services and technical assistance.

Among the many obstacles to peace and international cooperation is the on-going information war, the very high level of fake news, fake history and fake law disseminated by a complicit media that acts as an echo chamber for governments (de Zayas, 2023c, chapter 7, pp. 183-221). The growing “weaponization of human rights” means that human rights are being instrumentalized as weapons to attack and destabilize other countries. This corruption of a noble humanistic principle is tantamount to blasphemy and sacrilege.

It is crucial that the common effort to advance the enjoyment of human rights not be limited to rhetoric and lip-service to human dignity. The condemnation of abuses and crimes by governments cannot be the overarching object and purpose of the OHCHR and the Human Rights Council. “Naming and shaming” does not work. In fact, it is frequently counter-productive. Condemnation is always *ex post facto*. The emphasis must be on prevention of human rights violations through a coherent approach to identify and resolve the root causes of problems.

### **UN Declaration on the Right to Development and draft declaration on Right to International Solidarity**

The governments of the UN Member States adopted a UN Declaration on the Right to Development and have mandated drafting of a Declaration on the Right to International

<sup>14</sup><https://undocs.org/Home/Mobile?FinalSymbol=A%2FRES%2F48%2F141&Language=E&DeviceType=Desktop&LangRequested=False>

Solidarity. While the Declaration on the Right to Development and the anticipated Declaration on the Right to International Solidarity may not yet represent binding international legal standards, they should become so. Nonetheless, Declarations adopted by the UN General Assembly constitute in effect *soft law* with commensurately authoritative guiding principles. As such, they are foundational points for the WSSD2 discussion and for the outcome declaration and program of action. Core points in, respectively, the Declaration and draft declaration are thus reiterated below.

### ***Declaration on the Right to Development***

The UN Declaration on the Right to Development was adopted on 4 December 1986 pursuant to General Assembly Resolution 41/128 (UN, 1986). The Human Rights Council, in its resolution 33/13 of 29 September 2016, established the mandate of the Special Rapporteur on the Right to Development, who has produced many useful reports. WSSD2 should integrate the recommendations of these reports into its deliberations and conclusions.

Article 1 of the Declaration stipulates: “The Right to Development is an inalienable human right by virtue of which every human person and all peoples are entitled to participate in, contribute to, and enjoy economic, social, cultural and political development, in which all human rights and fundamental freedoms can be fully realized.

The human Right to Development also implies the full realization of the right of peoples to self-determination, which includes, subject to the relevant provisions of both International Covenants on Human Rights, the exercise of their inalienable right to full sovereignty over all their natural wealth and resources.”

Article 2 stipulates: “The human person is the central subject of development and should be the active participant and beneficiary of the Right to Development.

All human beings have a responsibility for development, individually and collectively, taking into account the need for full respect for their human rights and fundamental freedoms as well as their duties to the community, which alone can ensure the free and complete fulfillment of the human being, and they should therefore promote and protect an appropriate political, social and economic order for development.

States have the right and the duty to formulate appropriate national development policies that aim at the constant improvement of the well-being of the entire population and of all individuals, on the basis of their active, free and meaningful participation in development and in the fair distribution of the benefits resulting therefrom.”

WSSD2 should propose that the Declaration be further elaborated into a treaty that would be legally binding.

### ***Declaration on the Right to International Solidarity***

WSSD2 should endorse the revised draft Declaration on the Right to International Solidarity. The initial draft of the Declaration is contained in the Annex of report A/HRC/35/35 of the Independent Expert on human rights and international solidarity, Virginia Dandan (2017). The revised draft Declaration on Human Rights and International Solidarity is contained in Annex I to the report A/HRC/53/32 of the Independent Expert on Human Rights and International Solidarity, Obiora Chinedu Okafor (2023).



WSSD2 should pro-actively urge the General Assembly to adopt the revised version in the very near future and order its elaboration into a treaty. The Draft Declaration highlights in its preambular paragraphs the importance of sustainable development, in particular the promotion of social justice and social development:

“Inspired by the principle of international solidarity to enable the full realization of human rights through a democratic and equitable international order characterized by cooperation to overcome global challenges and promote sustainable development”.

Operative Article 3 stipulates in part:

“The general objectives of international solidarity are to create an enabling environment for: 1. Promoting the realization and enjoyment of all human rights and fundamental freedoms; 2. Engendering trust and mutual respect to foster peace and security, promote early response and prevention of conflict, provide humanitarian assistance and engage in peacebuilding; 3. Preventing and reducing asymmetries and inequities between and within States in realizing sustainable development, with particular attention paid to structural obstacles, such as systemic discrimination, that generate and perpetuate poverty and inequality worldwide and the concerns of the least developed countries and small island developing States...”

### **Summit of the Future and 16<sup>th</sup> BRICS Summit**

#### ***UN Summit of the Future***

In September 2024 Secretary General Antonio Guterres hosted the “Summit of the Future”, which adopted a “Pact for the Future”. More important than that would have been to hold a “Summit of the Present” to solve the enormous challenges pressing on us today. The Pact formulates 12 “Actions” to achieve sustainable development and sustainable financing. They are reiterated here as especially relevant to defining the content and outcome of the WSSD2:

“Action 1. We will take bold, ambitious, accelerated, just and trans formative actions to implement the 2030 Agenda, achieve the Sustainable Development Goals and leave no one behind.

Action 2. We will place the eradication of poverty at the centre of our efforts to achieve the 2030 Agenda

Action 3. We will end hunger and eliminate food insecurity and all forms of malnutrition

Action 4. We will close the Sustainable Development Goal financing gap in developing countries.

Action 5. We will ensure that the multilateral trading system continues to be an engine for sustainable development

Action 6. We will invest in people to end poverty and strengthen trust and social cohesion

Action 7. We will strengthen our efforts to build peaceful, just and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels and uphold human rights and fundamental freedoms

Action 8. We will achieve gender equality and the empowerment of all women and girls as a crucial contribution to progress across all the Sustainable Development Goals and targets

Action 9. We will strengthen our actions to address climate change

Action 10. We will accelerate our efforts to restore, protect, conserve and sustainably use the environment

Action 11. We will protect and promote culture and sport as integral components of sustainable development

Action 12. We will plan for the future and strengthen our collective efforts to turbocharge the full implementation of the 2030 Agenda for Sustainable Development by 2030 and beyond.” (UN, 2024)

Undoubtedly, the above actions are laudable. But will the international community take any concrete action to implement them? The WSSD2 provides a unique and immediate global opportunity to define and generate commitments to implementing these *actions* that are foundational to advancing social justice and realizing social development.

### ***Sixteenth BRICS Summit and the Kazan Declaration***

WSSD2 should study the proceedings of the 16<sup>th</sup> BRICS Summit and the Kazan Declaration of 23 October 2024. It would seem that the BRICS countries have more political will to do something about sustainable development than either the United States or the European Union.

The 16th BRICS Summit was hosted by the Russian Federation in the city of Kazan on the Volga River from 22 to 24 October and attended by 36 countries. There was hope in the air, a certain optimism that humanity can gradually change the paradigm, marshal the world disorder, move away from bloc-mentality, abandon confrontational politics, phase out dependence on the US-dollar, and craft a coherent policy to enhance trade, social and cultural exchange in tandem with the Purposes and Principles of the UN Charter and in the spirit of the UNESCO Constitution (de Zayas, 2024).

The Kazan Declaration (BRICS Summit, 2024) gives impulses for multilateralism and international cooperation with a view to achieve social development. Paragraph 6 of the declaration stipulates, *inter alia*, “We note the emergence of new centers of power, policy decision-making and economic growth, which can pave the way for a more equitable, just, democratic and balanced multipolar world order. Multipolarity can expand opportunities for [developing countries] to unlock their constructive potential and enjoy universally beneficial, inclusive and equitable economic globalization and cooperation. Bearing in mind the need to adapt the current architecture of international relations to better reflect the contemporary realities, we reaffirm our commitment to multilateralism and upholding international law, including the Purposes and Principles enshrined in the Charter of the United Nations as its indispensable cornerstone, and the central role of the UN in the international system, in which sovereign states cooperate to maintain international peace and security, advance sustainable development, ensure the promotion and protection of democracy, human rights and fundamental freedoms for all as well as cooperation based on solidarity, mutual respect, justice and equality.”

Paragraph 7 notes “... As a positive step in this direction, we acknowledge the G20 Call to Action on Global Governance Reform launched by Brazil during its G20 presidency. We also acknowledge dialogues and partnerships which strengthen cooperation with the African continent like Summit of the Forum on China-Africa Cooperation, India-Africa Forum Summit, Russia-Africa Summit and Ministerial Conference.”

Paragraph 8 recognizes the 2023 Johannesburg II Declaration and reaffirms "...support for a comprehensive reform of the United Nations, including its Security Council, with a view to making it more democratic, representative, effective and efficient, and to increase the representation of developing countries in the Council's memberships so that it can adequately respond to prevailing global challenges...."

### **International cooperation**

The WSSD should formulate concrete strategies to enhance the importance of international cooperation in order to achieve international peace, social justice, and social development.

The 1993 Vienna Declaration and Programme of Action reaffirms in its preamble "the commitment contained in Article 56 of the Charter of the United Nations to take joint and separate action, placing proper emphasis on developing effective international cooperation." Operative paragraph 4 further states: "The promotion and protection of all human rights and fundamental freedoms must be considered as a priority objective of the United Nations in accordance with its purposes and principles, in particular the purpose of international cooperation.

In the framework of these purposes and principles, the promotion and protection of all human rights is an *erga omnes* obligation of the international community. The organs and specialized agencies related to human rights should therefore further enhance the coordination of their activities based on the consistent and objective application of international human rights instruments." Operative paragraph 10 reaffirms the Right to Development and stipulates "States should cooperate with each other in ensuring development and eliminating obstacles to development. The international community should promote an effective international cooperation for the realization of the Right to Development and the elimination of obstacles to development."

Paragraphs 5 and 6 of the Outcome Document of the World Summit of 2005, Res. 60/1, emphasizes the importance of multilateralism and international cooperation.

"5. We are determined to establish a just and lasting peace all over the world in accordance with the purposes and principles of the Charter. We rededicate ourselves to support all efforts to uphold the sovereign equality of all States, respect their territorial integrity and political independence, to refrain in our international relations from the threat or use of force in any manner inconsistent with the purposes and principles of the United Nations, to uphold resolution of disputes by peaceful means and in conformity with the principles of justice and international law, the right to self-determination of peoples which remain under colonial domination and foreign occupation, non-interference in the internal affairs of States, respect for human rights and fundamental freedoms, respect for the equal rights of all without distinction as to race, sex, language or religion, international cooperation in solving international problems of an economic, social, cultural or humanitarian character and the fulfilment in good faith of the obligations assumed in accordance with the Charter.

6. We reaffirm the vital importance of an effective multilateral system, in accordance with international law, in order to better address the multifaceted and interconnected challenges and threats confronting our world..."

Paragraph 48 highlights the importance of the Right to Development. "We reaffirm our commitment to achieve the goal of sustainable development, including through the implementation of Agenda 21 and the Johannesburg Plan of Implementation. To this end, we

commit ourselves to undertaking concrete actions and measures at all levels and to enhancing international cooperation, taking into account the Rio principles.”<sup>15</sup>

Not to be forgotten in the context of international cooperation is the mutual respect that states owe to each other, and the commitment to recognize various approaches to achieve human dignity and democracy. Paragraph 135 of Resolution 60/1 stipulates:

“We reaffirm that democracy is a universal value based on the freely expressed will of people to determine their own political, economic, social and cultural systems and their full participation in all aspects of their lives. We also reaffirm that while democracies share common features, there is no single model of democracy, that it does not belong to any country or region, and reaffirm the necessity of due respect for sovereignty and the right of self-determination. We stress that democracy, development and respect for all human rights and fundamental freedoms are interdependent and mutually reinforcing.”<sup>16</sup>.

### **Conclusions and Recommendations: WSSD2 must change the paradigm**

For the world to achieve peace and development, every State must cultivate justice, domestically and internationally, in particular promote social justice (Sachs, 2011; Sachs, 2005; Rodrik, 2011), to ensure realization of human rights for all, a better distribution of wealth, universal social protection and health care, a reduction of the gulf between the super-rich and the abject poor, basic income, decent work and living wages for all, and other aspects.

What the world needs most is a fundamental rethinking of the paradigm, both with respect to international law and in particular with respect to human rights. WSSD2 owes the world a new functional paradigm of human Rights (de Zayas, 2021, pp. 451-54). The WSSD needs to revisit the spirituality of the Universal Declaration of Human Rights, recapture the enthusiasm and commitment of Eleanor Roosevelt, René Cassin, P. C. Chang and Charles Malik.

WSSD2 should address fundamental questions such as the prevalent international law paradigm, which while providing the framework for the rule of law, does not necessarily provide for the rule of justice. WSSD2 must also resolve the limitations of the human rights paradigm that focuses on individual rights and largely ignores collective rights.

The second World Summit on Social Development should formulate a program of action demanding that the governments of UN member states channel their energy into constructive cooperation paradigms to achieve measurable results in social development.

On the basis of the above considerations, it would be appropriate to propose to the Second World Summit for Social Development to consider adopting an outcome document that is concrete and result-oriented inclusive of the following elements:

1. Adopt an outcome document by virtue of which United Nations members recommit to the United Nations Charter as the only valid rules based international order. The United Nations should proactively invoke Article 103 of the Charter, the supremacy clause, and reaffirm the principle that the obligations under the UN Charter take precedence over all other international agreements, including agreements by regional and other international bodies including the OAS, EU, AU, NATO,

<sup>15</sup>[https://undocs.org/Home/Mobile?FinalSymbol=A%2FRES%2F2625\(XV\)&Language=E&DeviceType=Desktop&LangRequested=False](https://undocs.org/Home/Mobile?FinalSymbol=A%2FRES%2F2625(XV)&Language=E&DeviceType=Desktop&LangRequested=False)

<sup>16</sup> <https://documents.un.org/doc/undoc/gen/n05/487/60/pdf/n0548760.pdf>

- ASEAN. World Bank, IMF, BRICS. The priority of the UN Charter must be understood by all senior officials of the Organization and reaffirmed by the Secretary General and the General Assembly. Violations of the UN Charter must have consequences.
2. Endorse the UN Draft Declaration on International Solidarity, the UN Draft Treaty of the Social Responsibility of Transnational Corporations and other enterprises, the Declaration on the Rights of Peasants, and urge all WSSD2 participant countries to ratify relevant Treaties without delay.
  3. Promote disarmament for development. The WSSD should call for all UN member states to commit a larger percentage of the GDP to the achievement of the SDG's and reduce allocations to arms, military budgets and related expenditures. Bearing in mind that the world already has enough weapons to blow up the entire planet, it is a matter of survival of humanity as well as a matter of civilization.
  4. Demand non-engagement in military actions as well as the dismantlement of military alliances that endanger international peace and security. WSSD2 should establish criteria to evaluate and, as appropriate, call for censuring military actions and/or alliances that engage in threats of the use of force in contravention of Article 2(4) of the Charter, and/or use of force without approval by the Security Council, and/or documented gross violations of international humanitarian law.
  5. Launch a Global Compact on Education for Social Development. Such a Global Compact should advance the concept of social justice as a necessary element of ensuring stability, international peace and security.
  6. Condemn unilateral coercive measures, which are not legal sanctions under the UN Charter, do not qualify as "retortion" or "countermeasures" under the ILC's Draft Code on the Responsibility of States, and are contrary to fundamental principles of international law, including the principle of State sovereignty, the prohibition of interference in the internal affairs of states, and the rights of self-determination of peoples. So-called unilateral "sanctions" are incompatible with social development. Worse still – they kill (Weisbrot and Sachs, 2019).
  7. Urge participating States to invoke Article 96 of the UN Charter, whereby the General Assembly would request an Advisory Opinion from the International Court of Justice - ICJ concerning the obligations of States under the Charter to promote development and social justice.
  8. Recognize that the realization of the right of self-determination of peoples is a conflict-prevention strategy. Accordingly, WSSD2 should urge the United Nations to appoint a Special Advisor to the Secretary General on the Realization of the Right of Self-determination. The WSSD should call on the General Assembly to establish a special department within DESA with the task to organize, conduct and monitor self-determination referenda, where appropriate. Furthermore, the UN Human Rights Council should create the function of a Special Rapporteur on Self-determination.
  9. Support initiatives to reform the UN system, so as to make it more effective and eliminate overlaps. Among the necessary reforms is the democratization in the membership of the Security Council, an expansion of its membership from 15 to 25 members, and the phasing out of the veto power as recommended by Professor Joseph Schwartzberg (2013) in his book *Transforming the United Nations System*.
  10. Propose that the Human Rights Council thematic mandates be strengthened, that confrontational country mandates be phased out; and that the Universal Periodic Review procedures be revised in order to ensure constructive discussion and avoid duplication.

## Acknowledgements

The author wishes to express appreciation for the encouragement and supportive suggestions towards realizing this article provided by the journal special issue editor, Patrick Taran, and by the *blind* peer reviewers.

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# Social Justice and Sustainability of Peasant Family Farming

## Justicia social y sostenibilidad de la agricultura familiar campesina

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Sent: 2025/03/01  
Accepted: 2025/06/03  
Published: 2025/06/30

### Abstract

Peasant family farming in Ecuador is responsible for producing over two-thirds of the food required to sustain the country's nutrition and significantly contributes to agricultural exports. Despite this, rural areas in Ecuador experience the highest levels of poverty, leading to widespread undernutrition, particularly among pregnant women and infants. This stark disparity presents a social justice issue that demands urgent attention. Some analysts argue that the inefficiencies of peasant agriculture contributes these issues, labelling it as unsustainable due to its perceived low productivity and profitability. However, such assessments often overlook the sector's crucial role in food security, biodiversity preservation, and environmental balance. Family farming sustains local food supplies and promotes ecological stability through diverse, sustainable practices. Public policy orientation, particularly in support of small-scale farmers, is essential in determining these rural communities' sustainability and improved livelihoods, especially in the face of increasing pressures from modern corporate agriculture. Addressing these structural inequalities is key to ensuring that peasant family farming is economically viable, socially just, and environmentally sustainable.

**Summary:** Introduction, Method and Methodology, Analysis and Results, Discussion of the Results, Conclusions.

**How cite:** Espinel, R. & Solórzano, N. (2025). Social Justice and Sustainability of Peasant Family Farming. *Revista Tecnológica - Espol*, 37(1), 89-103. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1285>

**Keywords:** social problems, rural environment, rural emigration, sustainability, food supply, biodiversity, multi-cropping.

### Resumen

La agricultura familiar campesina en Ecuador es responsable de producir más de dos tercios de los alimentos necesarios para sostener la nutrición del país y contribuye significativamente a las exportaciones agrícolas. A pesar de ello, las zonas rurales en Ecuador experimentan los niveles más altos de pobreza, lo que conduce a una extendida desnutrición, especialmente entre mujeres embarazadas y niños. Esta marcada disparidad representa un problema de justicia social que exige atención urgente. Algunos analistas argumentan que las ineficiencias de la agricultura campesina contribuyen a estos problemas, calificándola como insostenible debido a su aparente baja productividad y rentabilidad. Sin embargo, tales evaluaciones a menudo pasan por alto el papel crucial del sector en la seguridad alimentaria, la preservación de la biodiversidad y el equilibrio ambiental. La agricultura familiar sostiene el suministro local de alimentos y promueve la estabilidad ecológica a través de prácticas diversas y sostenibles. La orientación de las políticas públicas, en particular el apoyo a los pequeños agricultores es esencial para determinar la sostenibilidad de estas comunidades rurales y la mejora de sus condiciones de vida, especialmente frente a las crecientes presiones de la agricultura corporativa moderna. Abordar estas desigualdades estructurales es clave para asegurar que la agricultura familiar campesina sea económicamente viable, socialmente justa y ambientalmente sostenible.

**Palabras clave:** problemas sociales, entorno rural, emigración rural, sostenibilidad, suministro de alimentos, biodiversidad y policultivo.

### Introduction

Family farming, a system of small-scale agricultural production, starkly contrasts with the modern "conventional" agriculture that dominates developed nations. While conventional agriculture emerged alongside the rise of industrial capitalism, characterized by capital-intensive practices and monoculture, family farming remains rooted in diverse, labor-intensive, and subsistence-oriented practices. This form of agriculture is crucial in food security, biodiversity conservation, and rural livelihoods globally and within Ecuador. Thus, this type of agriculture is not only a phenomenon of low-income nations; Central European countries and other developed countries, such as Japan, for decades have also favored this type of agriculture, which exists, to a greater or lesser extent, throughout the world (Mazoyer, 1997).

Historically, the shift from feudal systems to modern capitalism, particularly following the Industrial Revolution, significantly altered global agricultural practices. The enclosure movement in England, which privatized communal lands and displaced peasant labor to urban centers, marked the beginning of large-scale commercial agriculture. With innovations like the internal combustion engine and the steel plow in the 19th century, agriculture became increasingly mechanized and specialized in monocultures—large tracts of land dedicated to single crops, aiming to maximize profits and land rent (Marx [1867] 1990). This transformation entrenched capitalism as the dominant economic system, separating landowners and capitalists from the labor force, which increasingly migrated to cities.

In the 20th century, as colonial empires dissolved, a new global division emerged. The so-called developed countries began to differentiate themselves from the undeveloped countries, as described by Hobsbawm (1989) and as explained by Wallerstein (1980) in his work. This event has two marked consequences. Developed countries seeking to secure

agricultural production turned to plantation agriculture in former colonies. This form of agriculture, which closely mirrors the capital-intensive model seen in industrialized nations, primarily serves global commodity markets (Ferrer, 2000). However, within many developing countries, including Ecuador, a large segment of the rural population remains engaged in small-scale, subsistence-oriented family farming. This mode of production, marked by its reliance on the labor of peasant families, has persisted despite continuous economic and social challenges (Mañano Fernandes, 2014).

Family farming differs fundamentally from commercial monoculture in several key ways. First, it operates on small and medium-sized plots of land, where production is geared toward self-sufficiency rather than profit maximization. These farms are often characterized by polyculture, growing multiple crops to ensure food security and resilience. This multi-crop system starkly contrasts with the monoculture model of modern agriculture, which focuses on the large-scale production of a single commodity.

Family farming lacks financial capital and depends on multiple crop production. Without significant investments, these farms rely on the labor of peasant families and the surrounding community, creating a social system based on reciprocal labor rather than monetary exchange. This system supports the economic survival of these families and fosters strong community ties and mutual aid.

Additionally, it is important to highlight that these minority groups of family farming contribute significantly to biodiversity. Unlike monoculture, which often depletes the soil and reduces ecological diversity, family farming integrates natural ecosystems into its production processes. Peasant farmers maintain diverse crops and rely on the natural environment, such as wild plants and traditional irrigation methods, to support their agricultural activities. This biodiversity is crucial for the sustainability of family farming, as it provides resilience against environmental and economic shocks (Espinel, 2006).

However, family farming is often associated with poverty and social marginalization despite its sustainability and food security contributions. Peasant families, particularly in countries like Ecuador, frequently experience low incomes, limited access to basic services, and exclusion from broader economic opportunities (Espinel, 2010a; Milanovic, 2011). These issues raise important social justice concerns, as these communities are disproportionately affected by policies and economic systems that favor large-scale commercial agriculture.

This study investigates the significance of peasant family farming in Ecuador, exploring its contributions to sustainability, biodiversity, and rural livelihoods. It also seeks to understand the social justice issues that impact these farming communities, particularly regarding income inequality, access to resources, and the marginalization of peasant farmers. By examining these factors, this research will highlight the importance of preserving and supporting family farming as a key component of sustainable agricultural development in Ecuador.

## Literature Review

It is essential to understand any concept and previous research regarding social justice, food chain sustainability, and the role of peasant family farming and commercial agriculture in the context of the field discussed in the current study. Besides, looking into other investigations with similar objectives as confirmatory references helped the orientation of the current research.

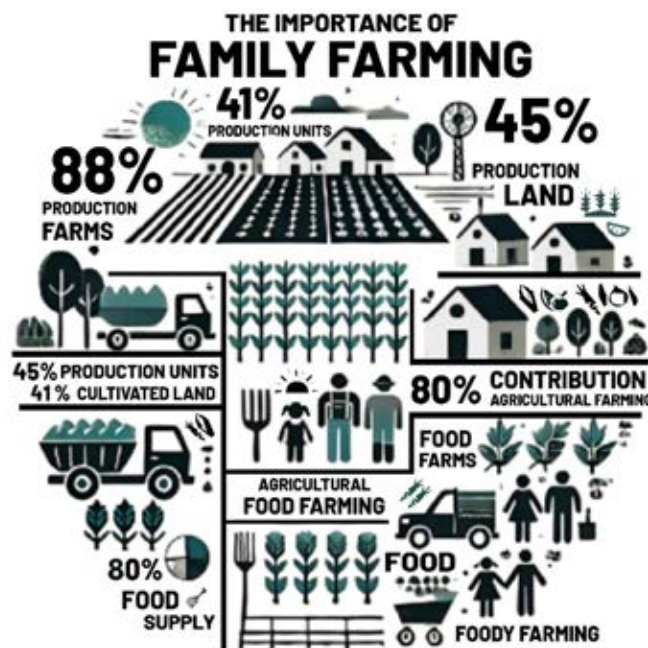
### *The role of family farming*

Family farming is essential to Ecuador's agricultural landscape, representing 88% of the country's production units and covering 41% of its cultivated land. According to the Agricultural Census of Ecuador in 2000, family farming contributes approximately 45% of the total agricultural production in the country, and it significantly supports Ecuador's food security and rural livelihoods. This sector not only plays a vital role in domestic consumption, accounting for 80% of the country's food supply but also supports 747,000 households, equating to 26% of Ecuador's total population. It represented 29.4% of the economically active population and generated 26.8% of employment, according to the National Statistics Institution data (INEC, 2021) [see Figure 1].

The family farming model contributes approximately 4.05% to Ecuador's GDP from the 9% of the agriculture contribution, and its importance extends beyond its economic contributions. Family farms are small to medium-sized, averaging 7 hectares, and employ different levels of labor depending on their classification. These farms provide subsistence for families and, in many cases, are essential for maintaining local economies. The model is characterized by its low reliance on hired labor, with subsistence farms relying entirely on family labor and other farms occasionally hiring external workers (Wong, 2009).

**Figure 1**

#### *Peasant Family Farming Production*



Despite its critical role, family farming is closely associated with rural poverty in Ecuador. The most recent statistics indicate that, in 2021, 42.96% of the rural population lived below the poverty line, with 20.3% in extreme poverty (INEC, 2021). Family farmers, particularly those operating on smaller plots of land, face significant economic challenges. They often rely heavily on off-farm income, with the smallest farms deriving up to 32% of their income from non-agricultural activities. This disparity highlights the vulnerability of small farmers, who struggle to sustain themselves in agriculture alone.

Adding to the social justice issue, the poverty rates in Ecuador's rural areas have worsened, particularly in provinces like Los Ríos, Manabí, and Esmeraldas, which are among

the country's most impoverished regions. The unequal distribution of land and resources, alongside the lack of a comprehensive rural development program, exacerbates these inequalities. Ecuador has one of the worst land distribution ratios in Latin America, with a Gini coefficient of 0.81, highlighting the stark contrast between wealthy landowners and impoverished rural communities (Espinel, 2010a). These systemic inequities between countries which affect large groups of producers, especially in the agricultural sector (Milanovic, 2013), reflect a larger issue of social justice, where the contributions of family farmers are undervalued, and they receive minimal support for sustainable development.

### ***Family farming and biodiversity in Ecuador***

Family farming plays a critical role in Ecuador, not only in food production but also in maintaining biodiversity. Peasant agriculture is characterized by crop diversity, which is essential for ecological sustainability. Even the smallest family farms, averaging around 0.5 hectares, cultivate various plant species—sometimes as many as a dozen. This biodiversity helps ensure the resilience of these farming systems and protects the environment from the impacts of monoculture (Espinel et al., 2006). Unlike large commercial farms, most family farming production is not marketed, with less than 30% of the produce sold, except in consolidated family farms. The remaining crops are consumed by the family or exchanged locally, forming part of a communal economy that operates largely outside of formal markets.

Family farming also relies on internal labor, as most farms lack the resources to hire external workers. Often based on mutual aid, labor exchanges strengthen community ties and ensure that farming operations continue even without monetary income. Bartering remains a vital component of rural economies, with labor being exchanged for goods and services, especially in subsistence farming. Local examples, such as farmers exchanging rice for seedlings in the Abras de Mantequilla sector, illustrate the importance of these reciprocal systems in rural Ecuador (Espinel et al., 2006).

This biodiversity-based agricultural model is an essential survival strategy for small farmers. The multi-cropping system that characterizes peasant agriculture<sup>1</sup> is mixed cropping, or the cultivation of different species within the same plot, which has allowed family farms to withstand market fluctuations and environmental challenges. By diversifying their crops, small-scale producers protect their families from food insecurity. This agricultural practice fosters biodiversity and helps preserve essential ecological systems, such as soil health, pollination, and water retention, which are crucial for sustainable farming (Wilkes, 1987). For example, the former author mentioned that Mexican peasant producers rely on nature's support to produce their plots due to the scarcity of capital. Thus, trees and shrubs are conserved to act as windbreaks, certain plants with a root system help retain moisture in the soil, birds and insects are preserved to promote the pollination of plants that are not nearby, and other species have medicinal properties for family use, some are decorative, and others allegedly ward off evil spirits<sup>2</sup>.

On the other hand, the monoculture model has evolved primarily through genetic selection and improvement. It gained significant productivity through the Green Revolution, where the development of plant varieties through hybridization methods allowed for the widespread use of chemical inputs and irrigation systems (Hesser, 2009). The remarkable achievements obtained in maize and wheat at CIMMYT in Mexico and in rice at the IRRI in the Philippines set the stage for the development of modern agriculture based on the

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<sup>1</sup> This topic has been addressed for decades in several studies one can review (Espinel, 1991), which was part of his doctoral dissertation at the University of California, Berkeley.

<sup>2</sup> For further reference to cases observed in Ecuadorian agriculture, see (Espinel, 2009).

combination of large land areas and capital under the monoculture system (Mann, 2018). The research and development of modern agriculture have evolved since the Green Revolution, based on input-intensive technology that allowed plants to tolerate large amounts of fertilizers, insecticides, herbicides, and even high volumes of irrigation water. However, the technology of the Green Revolution soon generated alarm among environmental and social activists, such as Carson (1962) and Shiva (2016), due to its environmental and social impacts. The breakthrough occurred with knowledge technology, which prevails in agriculture today. This technology relies on using mathematics, information technology, and genetics, requiring high-capacity and high-speed computers, which have enabled the sequencing of plant genomes upon which modern biotechnology is based. As a result, research processes today are referred to as "in silico," indicating that plant biology is now guided by applied mathematics, statistics, informatics, and robotics (Espinel, 2005).

Overall, despite the importance of the practices of multi-cropping systems from peasant agriculture versus monoculture agriculture, they have been poorly studied, especially in comparison to the modern commercial agriculture model, which often prioritizes monoculture and technological innovation over ecological sustainability (Bardel et al., 2008).

### ***Modern Commercial Agriculture and Peasant Agriculture Divergence***

In recent years, the conversation around agricultural development has largely focused on the tension between modern commercial agriculture and family peasant agriculture. Modern commercial farming, often supported by genetic engineering, large-scale monoculture, and capital-intensive production, prioritizes high productivity and market efficiency. Companies such as Plant Genetic Systems and Monsanto have invested significantly in technologies like the transgenic insertion of the bacterium *Bacillus thuringiensis* in cotton plants, known as "Bt Technology," to control the bollworm insect and "Roundup Ready" soybean seeds to elicit the use of herbicides in soy crops, which deliver short-term productivity gains but raise long-term concerns over environmental sustainability and social equity (Robin, 2008).

On the other hand, family peasant agriculture is built on principles of environmental harmony, using time-honored practices that prioritize biodiversity and ecological sustainability. These small-scale farms rely on traditional methods such as recycling waste, using natural fertilizers, and employing manual crop selection, making them an integral part of local ecosystems. As highlighted by Tisdell (2005), peasant agriculture plays a critical role in maintaining soil fertility and local biodiversity, which are often undermined by the mechanized processes of commercial monoculture.

The rise of organic agriculture has created a niche for family farming in the global market, where consumers are increasingly willing to pay premiums for food perceived as more natural, healthier, and closer to the environment (Roep & Wiskerke, 2007). This shift in consumer behavior has brought attention to the ecological and cultural benefits of smallholder farming, as opposed to the capital-driven, monoculture-based commercial agricultural model.

### ***Production and Productivity in Family Farming***

Family farming is often critiqued for its low productivity, especially compared to modern commercial agriculture. This view perpetuates that small farms are inefficient and struggle to compete in a market dominated by large-scale, high-output agricultural enterprises. Critics argue that family farmers' inability to produce at the scale of industrial farms leads to higher food prices, as farmers must charge more to cover their production costs. McMurtry (1998) explains that this economic disparity creates a vicious cycle in which small farmers are marginalized by a system that values efficiency and productivity at the expense of equity and sustainability.

Agricultural marketing and markets are other aspects considered issues related to the production volume rather than productivity itself, with the intention to promote bilateral agreements between economies. The trend in the relationship with developed countries has been towards establishing bilateral agreements to promote trade. Free trade agreements imposed by the North were presented as an alternative. However, as Munck (2005) explains in his work on globalization and social exclusion, it has become evident that the asymmetry between economies of unequal weight can have disastrous effects on less developed and vulnerable economies. In the case of Ecuador, Wong (2009) analyzes the impact of free trade agreements on family farming and sheds light on the issue.

In countries like Ecuador, it is found that a significant portion of the production from small rural producers is lost due to post-harvest handling. According to Dufumier (2004), these losses can average up to forty percent for perishable products and sixteen percent for grains. This matter is primarily due to the poor organization of agri-food chains, which affects peasant production.

On the other hand, agricultural policies in Latin America tend to reinforce these assumptions by favoring monoculture and large-scale farming. Hidalgo (2014) describes the dominant discourse in the region, where development is synonymous with capitalist enterprise, and peasant farming is seen as backward. This viewpoint leads to policies that disproportionately benefit large commercial farms, further widening the gap between industrial agriculture and family farming. However, as scholars like Espinel (2010b) point out, these narratives overlook the structural economic forces perpetuating poverty among small-scale farmers and undervalue the unique contributions of family farming.

### Method and Methodology

This section describes how the study employs a social constructivism paradigm, emphasizing the role of societal context in shaping the realities of family farmers. The methodology uses a mixed method, mostly a qualitative viewpoint, for analyzing systematic literature reviews (SLR). Some quantitative evaluations are taken from statistical bureaus such as the National Statistics Institution, Instituto Nacional de Estadísticas y Censos (INEC), and the Central Bank of Ecuador. Previous studies, the SLR, and statistical-related data were analyzed, aiming to confirm the arguments of the main researcher's field investigation that need to be expanded upon, linking it to previous works (e.g., Wilkes, 1987, on biodiversity and smallholder agriculture, and Espinel, 2018).

As part of the methodological strategy, the guiding Table 1, creates and identifies the topics involved in this research and the scope for each topic, facilitating the criteria to identify sources for the SLR and Statistics data, useful to accomplish the proposed described scopes and the outcomes that needed to be discussed to accomplish the aim of the current study.

**Table 1**

*Topics to identify sources for the SLR and Statistics data Analysis*

TOPIC	SCOPE	DESCRIPTION OF SCOPE	AIMED OUTCOME FOR DISCUSSION
Family Farming	Importance/role of Family Farming	Identify literature and statistical data regarding the contribution of family farming to Ecuador's agricultural output, population involvement, and impact on food security.	Economic Contributions and Challenges of Family Farming
Biodiversity	Family Farming and Biodiversity	Identify literature and statistical data to discuss how family farms contribute to biodiversity preservation and food sustainability through mixed cropping systems.	The Social and Environmental Impacts of Family Farming

TOPIC	SCOPE	DESCRIPTION OF SCOPE	AIMED OUTCOME FOR DISCUSSION
Agriculture	Modern Commercial Agriculture vs. Family Peasant Agriculture	Identify literature and statistical data to explain how large-scale commercial agriculture differs from family farming in production, environmental impacts, and societal outcomes.	Biodiversity, Innovation, and Social Justice in Family Farming
Production	Production and Productivity in Family Farming	Identify literature and statistical data to discuss the misconceptions about productivity in family farming, showing how efficiency is miscalculated when focusing on commercial methods.	The Complexity of Measuring Productivity in Family Farming
Social Justice	Social Justice in Peasant Family Farming	Identify literature to address the poverty and inequity experienced by peasant families, underlining the disparities in land ownership and the challenges posed by modern agricultural policies.	Implication of all the scopes in Social Justice for Peasant Family Farming

### Analysis and Results

The results of this study build on the extensive body of literature that highlights the critical role of family farming in promoting food security, biodiversity, and rural livelihoods, particularly in developing countries like Ecuador. Statistical data from national agricultural surveys and global reports underscore the economic and environmental contributions of family farming, which represents approximately 80% of all farms worldwide and produces over half of the world's food supply (FAO, 2014). Despite these contributions, family farmers often face structural disadvantages, including limited access to land, financial resources, markets, and socio-economic inequalities that hinder their ability to thrive.

This section examines the social justice issues affecting family farming in Ecuador, using empirical data to assess the sector's challenges about land inequality, poverty levels, and access to resources. The findings consider the aimed outcome for discussion proposed in Table 1 to provide a nuanced understanding of how the identified issues intersect with sustainability, offering insights into the need for targeted policies that support small farmers and promote equitable agricultural development.

#### *Economic Contributions and Challenges of Peasant Family Farming*

Family farming contributes to Ecuador's economy, impacting food security, employment, and rural development. It is responsible for a significant portion of the country's agricultural output, especially in key crops like rice, coffee, corn, and tomatoes. It employs 29.4% of the economically active population (INEC, 2021). However, in some cases, particularly for very small farms, much of the production—nearly 70%—is consumed locally, and only a third of it is sold in markets, limiting the ability of family farmers to generate significant income from their work (Espinel et al., 2006).

The reliance on local consumption underscores the undervaluation of family farming's output. While vital to food security, this production is often not accounted for in official market transactions, leading to a skewed perception of the sector's productivity and economic value. Additionally, the costs associated with family farming, including purchasing fertilizers and pesticides, further strain small farmers' already limited financial resources. These expenditures highlight the sector's struggle to access quality inputs, as many farmers resort to recycling seeds, which negatively impacts crop yields.

Despite these challenges, family farming remains crucial for Ecuador's economy, contributing around \$4.5 billion, about half of the agricultural GDP. However, the average productivity per hectare, while significant, varies widely due to inconsistencies in data collection and land tenure. Family farmers often operate on small plots of land, averaging just



0.47 hectares per unit, limiting their ability to scale up production and compete with large commercial farms (INEC, 2021).

One of the most pressing issues family farmers face is the lack of social justice in land distribution and agricultural policy. Ecuador's rural development policies have historically favored large-scale commercial agriculture, disadvantaging family farmers. The failure of the agrarian reform program in the 1970s, which aimed to redistribute land more equitably, has left small farmers without secure property rights or access to the resources needed to improve their livelihoods. As a result, rural poverty persists, and the benefits of Ecuador's agricultural growth are disproportionately concentrated among wealthy landowners (Espinel, 2010a).

### ***The Social and Environmental Impacts of Family Farming on Biodiversity***

Family farming's reliance on biodiversity creates several social and environmental benefits, which are often overlooked in traditional economic analyses. The smallholder farms that dominate rural Ecuador produce food in a manner that sustains the environment while also fostering social justice. The mixed cropping systems employed by peasant farmers ensure food security for individual families and preserve various living organisms, from plants to animals and microorganisms. This diversity is vital for maintaining the ecological balance of farming regions, as it reduces the need for external inputs, such as chemical fertilizers and pesticides, which can harm the environment (Martínez Allier, 2004).

Furthermore, preserving biodiversity on small farms is directly related to social justice. Family farmers, particularly those in rural Ecuador, are often marginalized by national policies that favor large-scale commercial agriculture. These farmers have limited access to financial resources, technological innovations, and markets, which forces them to rely on traditional farming methods. The resistance of peasant agriculture to accept some current agricultural techniques and modernization attempts, often dismissed by economists as risk aversion, is, in fact, a rational response to the needs of the local environment and the socio-economic realities of rural communities, that is more a decision to preserve an ancestral form of organization and efficiency within their farms (Schultz, 1964; Popkin, 1979)<sup>3</sup>.

While large-scale agriculture benefits from government subsidies and technological advancements, family farming is undervalued and under-supported. For decades, peasant farmers have been forced to rely on nature's services, such as birds for pollination and trees for windbreaks, due to a lack of capital for more modern farming technologies (Wilkes, 1987). Despite these constraints, family farming systems have proven to be remarkably resilient. Their reliance on biodiversity allows them to adapt to environmental changes and market fluctuations in ways that large monoculture farms cannot.

However, these traditional practices are under threat. As global agricultural policies continue to push for industrialized farming models, the ecological and social benefits of family farming are being eroded. Modernization efforts that encourage monoculture and heavy reliance on external inputs often fail to consider the long-term sustainability of these systems. Historically contributing to preserving biodiversity and protecting ecosystems, family farmers risk being displaced or marginalized by policies prioritizing short-term economic gains over ecological resilience.

### ***Biodiversity, Innovation, and Social Justice in Family Farming***

Family peasant agriculture fosters biodiversity in ways that large-scale commercial agriculture cannot. For instance, on small farms, production is not exclusively market-driven;

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<sup>3</sup> Extensive discussions on this topic can be found in McMurtry's (1998) and Bartra (2006) works.

much of the produce is used for local consumption, often exchanged through labor or goods bartering systems within communities (Espinel et al., 2006). These farming systems typically involve a combination of crops, animal husbandry, and aquaculture, contributing to a highly diverse environment that sustains the family and the ecosystem. Studies have shown that family farms rely on practices such as multi-cropping, which protect against environmental risks and market fluctuations, ensuring greater food security for small-scale producers (Martínez Allier, 2004).

The interaction between family farming and biodiversity is mutually reinforced. For example, using "bioles," or organic teas made from recycled farm waste, has been found to have hormonal effects that boost plant immunity, enhancing crop resilience against pests and diseases. The Biotechnological Research Center (CIBE) at ESPOL in Guayaquil has made significant progress in studying bioles in cocoa farms of Guayas; the use of bioles led to a dramatic increase in yields—from 300 pounds to over two metric tons per hectare—without resorting to harmful chemical pesticides. This innovation exemplifies how peasant farming practices can increase productivity while maintaining ecological balance.

Despite its advantages, family farming is marginalized in global agricultural policy, which often prioritizes large-scale commercial farms. The lack of support for family farmers exacerbates social justice issues, particularly regarding access to resources and property rights. As has been noted elsewhere (Espinel, 2018), the survival of family peasant agriculture depends on its biodiverse environment, and conversely, biodiversity in agricultural areas is sustained by family farms. Policies that favor monoculture and genetic engineering often overlook this symbiotic relationship, leading to market failures that result in the exploitation of rural communities and the erosion of biodiversity.

Moreover, there is a significant disparity in the treatment of intellectual property rights in agriculture. Large corporations that engage in genetic engineering often extract genetic material from biodiverse regions—many of which are cultivated by small-scale farmers—without proper recognition or compensation for the original custodians of that biodiversity (Van Huylenbroeck & Espinel, 2007). This practice raises critical concerns about the privatization of genetic resources and the exclusion of rural farmers from the benefits of technological advancements.

### ***The Complexity of Measuring Productivity in Family Farming***

Family farming differs fundamentally from the monoculture model that dominates conventional agriculture. As a result, productivity metrics that work for large farms are misleading when applied to small-scale farming. Conventional farms often comprise hundreds of hectares of a single crop, making measuring output in tons or kilograms per hectare easy. In contrast, family farms—typically less than 5 hectares—are polyculture, growing crops in small, mixed plots (Salcedo & Guzmán, 2014). Measuring productivity by crop output alone fails to capture the ecological, economic, and social benefits of family farming.

One critical factor in understanding family farm productivity is energy efficiency. Rather than relying on external inputs like chemical fertilizers and pesticides, peasant farmers often use local resources to maintain their farms. These practices include recycling organic waste, using natural fertilizers, and employing manual labor from the family or community, resulting in a more sustainable and efficient energy balance than in large-scale commercial farms (Espinel, 2018). Using local inputs reduces costs and fosters greater resilience in economic and environmental challenges.

Another important consideration is that family farming often produces for self-consumption or local markets. A significant portion of the output from small farms is used to feed the farmer's family or is exchanged within local economies through bartering systems. These aspects make family farms less reliant on external markets and buffer them against price fluctuations. However, it also means that much of their productivity goes unrecorded, as it does not go through formal market channels. This aspect of family farming is often overlooked by policymakers, who equate success with the ability to produce for global markets.

The misconception that family farming is unproductive is further perpetuated by agricultural policies shaped by the Green Revolution. These policies have historically promoted the adoption of technologies—such as chemical inputs and mechanization—developed for large-scale monoculture. However, these technologies are often inappropriate for small-scale polyculture farms and can undermine their sustainability by introducing chemicals that degrade soil health and reduce biodiversity. As de Janvry et al. (1995) argue, agricultural policies that ignore the unique needs of small farmers exacerbate rural poverty and fail to capitalize on the strengths of family farming systems.

Nevertheless, it is feasible to initiate rural development programs to enhance production conditions, productivity, and market dynamics in specific areas that could be considered pilot initiatives to adopt this approach. Implementing programs that favor the development of family peasant agriculture requires a first step to improve the livelihood of the people in rural areas in order to provide basic principles of justice as established by John Rawls in part two of his book “Justice as Fairness” (Rawls, 2001), also following suggestions enquiring the reasons why poorest countries are falling behind and what can be done about it (Collier, 2007).

### **Discussion of the Results**

Addressing social justice in Ecuador's family farming sector reveals the vital role of small-scale farmers in the agricultural landscape and their substantial challenges. Family farming is critical to Ecuador's food security, rural employment, and local economies. However, the sector is plagued by significant social justice issues, including poverty, land inequality, and restricted access to essential resources. These problems highlight the structural disadvantages that small farmers experience, with their contributions to food production and biodiversity often undervalued and excluded from broader economic development benefits.

To combat these social justice challenges, Ecuador must adopt policies prioritizing family farming as a cornerstone of sustainable development. Improved access to land, water, infrastructure, and targeted support for increasing productivity and income could alleviate some of the burdens small-scale farmers face. Equitable agricultural policies should also address the historical imbalances that have marginalized rural communities, particularly regarding land distribution and the absence of rural development programs. By fostering these changes, Ecuador can ensure that small farmers are included in and benefit from the nation's economic growth.

Family farming's importance extends beyond food production and is intrinsically tied to biodiversity preservation. Peasant farmers in Ecuador, typically excluded from the benefits of modern agricultural development, are at the forefront of maintaining ecological systems. Their reliance on biodiversity is an environmental strategy and a means of survival, supporting food security and sustainable practices within their communities. However, without adequate government support, biodiversity and these farmers' livelihoods are at risk.

Ecuador must reorient its agricultural policies to favor family farming to support biodiversity and promote social justice. These policies include providing financial resources, access to sustainable technologies, and recognizing the value of traditional farming methods prioritizing ecological balance. Ecuador can ensure environmental conservation and social equity by supporting small-scale farmers through biodiversity-friendly policies. Family farming should be viewed as a central pillar of a just and sustainable society, where protecting ecological diversity also safeguards the livelihoods of rural communities.

The gap between commercial agriculture and family farming also underscores deeper social justice issues. Peasant farmers face barriers limiting their access to markets, technologies, and fair compensation for their biodiversity and food security contributions. As modern agriculture becomes more advanced than peasant family farmers, agricultural policies must protect the rights of small farmers, ensuring they benefit from technological progress and market access.

Achieving socially just agricultural policies requires recognizing family farming's role in biodiversity conservation and rural livelihoods. Legislation must protect the intellectual property of small farmers, ensuring they benefit from genetic resources and technological advancements. Infrastructure investment is also needed to enable family farmers to compete in local and global markets. Ultimately, by addressing these structural inequalities and prioritizing sustainability and equity, agricultural policies can ensure that family farming remains a key part of Ecuador's economic and environmental future.

### **Conclusions**

In conclusion, family farming in Ecuador plays a crucial role in food security, biodiversity conservation, and rural livelihoods. Family farmers face significant social justice challenges despite these contributions, including poverty, land inequality, and exclusion from broader economic benefits. Addressing these issues requires policies that support family farming as both an economic pillar and a sustainable agricultural model. By improving access to land, resources, and infrastructure, Ecuador can empower small farmers to increase their productivity and income while preserving ecological systems.

Social justice in agriculture is an economic necessity and a matter of human rights. Recognizing the value of family farming and integrating traditional practices into agricultural development strategies will promote environmental sustainability and social equity. Future agricultural policies must prioritize the needs of family farmers, ensuring that they are included in technological advancements and market opportunities. This approach will reduce rural poverty and strengthen Ecuador's food security and biodiversity.

### **Future Research Directions**

Future research should focus on enhancing social justice within peasant agriculture to improve food security and reduce poverty. This continued study should explore policy frameworks that increase market access, sustainable technologies, and financial resources for family farmers. Further studies could also examine the role of biodiversity in family farming systems, identifying how traditional practices can be integrated into national agricultural strategies to foster resilience against climate change. By deepening the understanding of these issues, future research can help create more inclusive and sustainable agricultural policies that benefit rural communities and the environment.

## Acknowledgments

Our special thanks to the Escuela Superior Politécnica del Litoral (ESPOL University), which sponsors the presentation of this work. We also want to acknowledge all the research teams and other institutions collaborating on this study.

Following the credit taxonomy, we specify the contributors' roles: Ramón L. Espinel, Ph.D. – Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Project administration, Resources, Supervision, Validation, Writing – original draft. Nayeth Solórzano, Ph.D. – Formal analysis, Methodology, Software, Validation, Visualization, Writing – review and editing.

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## Treating rare diseases with justice: Implications of a human rights-based approach

### Tratamiento de las enfermedades raras con justicia: Implicaciones de un enfoque basado en derechos humanos

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Sent: 2025/02/10  
Accepted: 2025/06/03  
Published: 2025/06/30

#### Abstract

The importance of health for social justice has increased since the end of the 20th century, particularly following the recognition in the 1995 Copenhagen Declaration that "people are entitled to a healthy and productive life in harmony with the environment." However, a majority of people worldwide still do not enjoy good health. Numerous efforts have been made by the international community to address this situation in line with the principles of equity and social justice. The agenda 2030 serves as a remarkable example of these efforts, positioning health at the centre of the program, acknowledging the existence of social determinants of health, and affirming the necessity to tackle the causes of health inequities and attend to the needs of disadvantaged groups. Individuals with rare diseases face specific risks and challenges primarily due to unmet health needs stemming from a lack of research and development of suitable medical technologies. In this article, we explore the reasons explaining the injustices faced by these patients, as well as ways in which a human rights-based approach to people with rare diseases can provide arguments in favour of States' action. By considering the right to science as a complementary right to the right to health, we argue that States must promote the science for treating rare diseases and render applications of science accessible and affordable, thereby contributing to the realisation of a just and equitable society.

**Keywords:** Access to health products, health equity, right to health, right to science, social justice.

**Summary:** Introduction, Methodology: analysis approach, Findings and Discussion, Conclusions.

**How to cite:** Dagon, S. (2025). Treating rare diseases with justice: Implications of a human rights-based approach. *Revista Tecnológica - Espol*, 37(1), 104-120.  
<https://rte.espol.edu.ec/index.php/tecnologica/article/view/1282>



## Resumen

La importancia de la salud para la justicia social ha aumentado desde finales del siglo XX, en particular tras la Declaración de Copenhague de 1995: “las personas tienen derecho a una vida sana y productiva en armonía con el medio ambiente”. La mayoría de las personas en el mundo aún no gozan de buena salud. La comunidad internacional ha realizado esfuerzos para abordar esta situación, según los principios de equidad y justicia social. La Agenda 2030 constituye un ejemplo de estos esfuerzos, al situar la salud en el centro del programa, reconocer la existencia de los determinantes sociales de la salud, afirmar la necesidad de abordar las causas de las inequidades en salud y atender las necesidades de los grupos desfavorecidos. Las personas con enfermedades raras enfrentan riesgos y desafíos específicos, principalmente debido a las necesidades de salud insatisfechas derivadas de la falta de investigación y desarrollo de tecnologías médicas adecuadas. En este artículo, se exploran las razones que explican las injusticias a las que se enfrentan estos pacientes, así como las maneras en que un enfoque hacia las personas con enfermedades raras basado en los derechos humanos puede proporcionar argumentos a favor de que los Estados actúen. Al considerar a la ciencia como un derecho complementario del derecho a la salud, se argumenta que los estados deben promover el progreso científico para tratar las enfermedades raras y hacer que las aplicaciones de la ciencia sean accesibles y asequibles, contribuyendo así a la creación de una sociedad justa y equitativa.

**Palabras clave:** Acceso a productos sanitarios, equidad en salud, derecho a la salud, derecho a la ciencia, justicia social.

## Introduction

Rare diseases are "life-threatening or chronically debilitating diseases" (Council Recommendation, 2009, para. 1), resulting in high mortality rates and socioeconomic inequalities (Halley et al., 2023). Historically, the challenges faced by both the patients living with them and their families have rarely been viewed through the lens of social justice. This is surprising, considering the significant impact of such diseases on patients' quality of life and social well-being, as reported by patients themselves (Buckle, 2024), and the fact that the needs of these patients are largely ignored in almost all national health systems. Traditionally, indeed, health systems have prioritised health for all through the development of services and goods designed to address "the main health problems in the community" (Declaration of Alma Ata, 1978). Rare diseases, however, do not feature as one of a community's main health challenges. They are first characterised by a very low prevalence at a country level. In the United States of America (US) and Japan, for example, a rare disease is one that does not affect more than 200,000 (around 6 per 10,000) (Rare Disease Act, 2002) or 50,000 (around 4 per 10,000) (Japan Pharmaceutical Manufacturers Association, 2020) of the total population, respectively; in Europe, a disease is considered rare when it affects no more than five persons per 10,000 people (Regulation (EC) No 141/2000, 1999). Secondly, rare diseases are characterised by a high level of complexity. Most rare diseases are genetically related, but others, such as rare cancers, rare immune-related diseases, and rare poisonings, can be a result of "environmental exposure during pregnancy or later in life" (EESC, 2009, para. 3.1.4), including exposure to hazards in the workplace (Charbotel et al., 2014).

Treating rare diseases with justice means first acknowledging the particularities of the individuals concerned and, secondly, identifying the primary challenges they face and devising ways to address those challenges. The United Nations General Assembly (UNGA) in recent years has followed a social justice-based approach for patients with rare diseases, acknowledging the high number of patients globally – indeed, a recent estimation showed that 300 million persons out of a total population of 8 billion are affected by a rare disease (DESA, 2022b), of which

more than half are children. It has also identified the challenges they face in their lives and developed a strategy grounded in human rights and the principle of social justice (UNGA, 2021).

Its first Resolution on rare diseases, adopted in 2021, is firmly rooted in the main international human rights instruments such as the Universal Declaration of Human Rights and the International Covenant on Economic, Social and Cultural Rights (ICESCR), and recognises "the fundamental importance of equity, social justice and social protection mechanisms" (UNGA, 2021). It also acknowledges the specific social and health challenges that affect the quality of life and social well-being of these individuals across various domains, "including but not limited to health, education, employment, and leisure" (UNGA, 2021).

To tackle these challenges, the UNGA proposes a roadmap for States and the international community, grounded in both human rights and the foundational commitment made by all States in 2015 to pursue sustainable development and prioritise those furthest behind. The right to the highest attainable standard of physical and mental health (hereafter referred to as the right to health), the right to an adequate standard of living, and the right to education – especially for children – are explicitly referenced by the General Assembly (UNGA, 2021). Conversely, the right to access, participate in, and benefit from science (hereafter referred to as the right to science), which is also guaranteed by the ICESCR, is not mentioned.

The reading of this Resolution allows us to recognise the importance of access to necessary healthcare services (including products) as a central social determinant of health for people living with a rare disease. This is rather singular concerning the results of public health research in the 21<sup>st</sup> century, highlighting the fact that, although universal access to adequate and culturally appropriate healthcare services is a source of overall health gains, properly addressing health inequities implies placing more emphasis on addressing social inequalities (Bueno de Mesquita & Forman, 2023). The importance of health care for this group is linked to the complexity of the health-related challenges that are particularly intricate in the case of rare diseases.

However, a number of obstacles, often interrelated, hinder access to healthcare for patients living with a rare disease. The first of these concerns weaknesses in the essential constitutive elements of the health system in the patient's country of origin, including a shortage of specialised healthcare professionals and a lack of information and awareness about rare diseases among those healthcare professionals who are available (Domaradzi & Walkowiak, 2021); financial barriers for accessing goods and services, including long-term care (ILO, 2021); finally, the absence of the requisite proper diagnostic tools and medical treatment options, as shown by analyses revealing that diagnostic tools and special medicines are only available for 5% of rare diseases (EU Commission, 2020). Second, and on a more structural basis, access to healthcare is impeded by the lack of scientific research, which is, in turn, having an impact on the training of specialised healthcare professionals, on the very existence of suitable treatments for the numerous rare diseases already identified (between 5,000 and 7,000), and, finally, on decisions for the coverage of existing treatment costs (Dagon, 2011a; Dagon, 2011b).

Concerning this last point, access to treatment and healthcare services is generally dependent on scientific evidence as the basis for financial allowance decisions. "Orphan drugs" – or drugs developed for patients with rare diseases – are generally very expensive, and access to them may be impossible for patients in countries without appropriate healthcare coverage.

In countries where the costs of at least basic healthcare services and medicines are partially or completely covered by the national healthcare system or health insurance system, access may also be difficult, as reimbursement decisions for medicines are typically based on cost-effectiveness considerations informed by scientific evidence. This is the case of Switzerland, where the mandatory health insurance system reimburses the cost of medicinal products included on a list of pharmaceutical specialities that is constituted based on scientific proof of their effectiveness, therapeutic value, and economic character (Swiss Federal Health Insurance Act, 1994). In some exceptional cases, the proof of a "possibility of improvement" instead of the proof of a "high therapeutic benefit" might be sufficient to allow for coverage (Ordinance on Health Insurance, 1995).

### **Methodology: analysis approach**

Although a full exploration of all challenges encountered by patients suffering from a rare disease and their families – including but not limited to health– would be essential to allow for a complete understanding of their social, economic, or psychological causes, this article will focus solely on the healthcare-related challenges and the main human rights arguments. In the first part, we will explore the limitations of the approaches and strategies adopted so far to address the health needs of people with rare diseases (Part 1). We will then propose an analysis of recent changes at the global level in favour of health equity and justice and analyse the complementarity of specific human rights as a solid basis for patients' requests to their governments concerning the improvement of accessibility to and affordability of innovative tools and treatments (Part 2).

### **Findings and Discussion**

#### **Part 1 - Strategies for rare diseases: existing barriers to health equity**

Since the end of the 20<sup>th</sup> century, only a few States or regions that host leading research-intensive biopharmaceutical companies have addressed rare diseases and the related challenges patients face in accessing healthcare services. More recently, the international community has also paid attention to this issue. The analysis of these efforts reveals that while States are generally becoming more aware of the necessity to aim for the realisation of health equity and justice based on a human rights-based approach to public health issues, the fight against rare diseases has not been linked with such an approach for very specific reasons.

#### ***Strategies for rare diseases: the traditionally limited influence of human rights***

At national and regional levels, States' interest in combating rare diseases has taken the form of legislative instruments primarily aimed at encouraging the pharmaceutical industries to engage in Research and Development (R&D) for rare diseases. The first legislative act of this kind was the Orphan Drug Act (ODA), adopted by the US in 1983 (Orphan Drug Act, 1983), followed by a revision of Japan's Pharmaceutical Affairs Law in 1993, introducing provisions on the promotion of R&D and priority reviews for orphan drugs (Japan Pharmaceutical Manufacturers Association, 2020), and by the European Union (EU) in 1999, with the Regulation 141/2000 on orphan medicinal products (Regulation (EC) No 141/2000, 1999).

These acts contain similar incentives, including a reduction in fees payable to regulatory authorities for marketing authorisations, market exclusivity (at least for a few years), grants for research promotion, tax reductions, or special procedures for marketing authorisations (e.g., priority reviews for orphan drugs). For example, the US law (Caetano et al., 2021; Fagnan et al., 2014) provides seven years of market exclusivity for a drug designated as an orphan drug (Orphan Drug Act, 1983, § 527(a)(2)), grants and tax credits of up to 50%

for R&D expenses, and a waiver on user fees when applying to the Food and Drug Administration (FDA) (Orphan Drug Act, 1983, § 4(a)). The EU regulation provides a special contribution by the European Community, which allows partially or entirely waived fees for companies seeking to place an orphan drug on the market (Regulation (EC) No 141/2000, 1999). It also grants market exclusivity for 10 years to orphan drugs that have received marketing authorisation (Regulation (EC) No 141/2000, 1999). This market exclusivity effectively prohibits the Community and EU Member States from accepting other applications for marketing authorisation for the same therapeutic purpose (Regulation (EC) No 141/2000, 1999). Furthermore, targeted grants can also be allocated to support research and development (Regulation (EC) No 141/2000, 1999).

These laws have been supplemented by other instruments that address the challenges of conducting research in the context of rare diseases, particularly in cases involving limited numbers of adults and underage patients, by introducing procedures to facilitate the marketing of these specific drugs (Gupta et al., 2016). For instance, the EU introduced accelerated or conditional approval pathways allowing companies to obtain marketing authorisation based on simplified requirements for the quality, safety, and efficacy of these products (Commission Regulation (EC) 507/2006, 2006).

State and regional authorities have historically exercised caution in avoiding references to obligations arising from human rights, whether linked to the right to health or the right to science, as a justification for adopting the aforementioned legislation. While the US Act invokes a "public interest" (Orphan Drug Act, 1983, § 1(6)), the European regulation refers to the principle of equity and considers that "patients suffering from rare conditions should be entitled to the same quality of treatment as other patients" (Regulation (EC) No 141/2000, 1999, at op 2). This approach mirrors the traditional stance of the international community in the field of public health during the latter half of the 20th century and the early 21st century. Interventions by the UNGA in public health have traditionally been scarce up to the present day (Dagon, 2019).

However, the UNGA did intervene on an exceptional basis starting in 2000 and 2001, by including health issues in the Millennium Declaration (UNGA, 2000) and addressing the Acquired Immune Deficiency Syndrome (AIDS) epidemic caused by the Human Immunodeficiency Virus (HIV) (UN, 2001; ECOSOC, 2009). The UNGA has since focused its attention on health problems such as malaria (UNGA, 2001), sickle-cell anaemia (UNGA, 2008), tuberculosis (TB) (UNGA, 2023), non-communicable diseases (NCDs) (UNGA, 2018), rare diseases (UNGA, 2021), and other more general issues, such as global health as a foreign policy matter (UNGA, 2008), health as a central target for the realisation of the 2030 Agenda for Sustainable Development (UNGA, 2015) or universal health coverage (UHC) as an essential instrument for a healthier world for all (UNGA, 2019; UNGA, 2023b).

Except for HIV, only the more recent resolutions on TB, NCDs and UHC expressly frame the health issues at stake as human rights concerns. They also encourage States to adopt a strategy that relies on a human rights-based approach (HRBA) (London, 2008; Bustreo & Doebbler, 2020). The more recent Resolution on TB interestingly recognises the importance of the right to health in association with the right to science as essential human rights to be respected and promoted in this field (UNGA, 2023a).

### ***Traditional barriers to the implementation of an HRBA for rare diseases***

There are multiple reasons behind the absence of express references to human rights in general and the rights to health and science, more specifically, in international strategies and

national and regional legislative acts concerning rare diseases. The first reason is linked to the State's capacity to implement the numerous obligations related to both. Indeed, it should be understood that an obligation to promote these rights does not lead to the same consequences for all States; the existing socioeconomic differences between them render their promotion arguably a controversial goal since pharmaceutical R&D capacities are still scarce in some parts of the world (Vieira et al., 2023; Khan, 2021). This is even more true regarding the right to science, as underlined in 2011 by Chapman (Chapman, 2009). She considered that "poor countries and many middle-income countries lack the capacity to conduct scientific and technological research, to translate findings into useful applications, to evaluate and regulate their potentially harmful effects, to distribute them widely, and to make them affordable and accessible across geographic and populations boundaries" (Chapman, 2009, p. 31). The reality today is that only some countries host large R&D-based pharmaceutical companies (Schuhmacher et al., 2021).

This might change in the future, following the example of the successful development of capacities to produce the COVID-19 vaccine in South Africa, which resulted from global efforts to develop R&D in various regions of the world (Paremoer & Pollock, 2022). For the time being, however, only a few countries have the necessary capacities to conduct research for rare diseases and develop pharmaceutical products. Moreover, these capacities are protected through the global framework applicable to the protection of intellectual property rights, which has a significant impact on the availability and accessibility of all medicines (Hestermeyer, 2007). The complexity of the relationships between intellectual property regimes, human rights and the right to science, in particular, has been deconstructed by the Committee on Economic, Social and Cultural Rights (CESCR, 2020) as well as in recent literature (Yu, 2022; Plomer, 2021).

More importantly, a central barrier to the use of human rights arguments in favour of people with rare diseases and their specific healthcare needs is linked to the interpretations given in 2000 (CESCR, 2000) and 2020 (CESCR, 2020) to the rights to health and science by the CESCR, as well as by the Committee on the Rights of the Child (CRC) in charge of the implementation of the Convention on the Rights of the Child and of the right to health guaranteed in art. 24 (CRC, 2013).

The rights to health and science are intrinsically linked. It was only relatively recently that the right to science was developed (Mitchell, 2021) and its content concretely formalised (CESCR, 2020), while its implications in the context of health remain the subject of ongoing discussions and research (Donders, 2011; Chapman, 2009; Knoppers, 2024). Regarding its content, it is necessary to understand that this right may be interpreted as offering limited utility in the context of rare diseases, at least when considering the core obligations identified in the literature and the CESCR (CESCR, 2020). Indeed, the right to science is neither unlimited nor absolute (Donders, 2011; CESCR, 2020). This is particularly true in the field of health. There is indeed no general obligation for States to utilise all their resources to support every form of health-related research or to make all medical products and technologies available and accessible to address every health need under this right. On the contrary, and in line with the CESCR's interpretation, States must make choices and focus on priority healthcare needs, thereby prioritising prevalent diseases, those more commonly found within the population in terms of total number of cases. According to the CESCR, States must make sure that they use all available resources to "ensure access to those applications of scientific progress that are critical to the enjoyment of the right to health" (CESCR, 2020, para. 52). They also have to "ensure that in the allocation of public resources, priority is given to research in areas where there is the greatest need for scientific progress in health" (CESCR, 2020, para. 52).

The objective of fulfilling the priority healthcare needs of the population, which by definition excludes the specific needs of patients with (non-prevalent) rare disease, also clearly emerges from the interpretation given to the right to health by both the CESCR (Donders, 2011) and the CRC.

Under the CESCR in GC 14, the right enshrined in Art. 12.2 (d) ICESCR to health facilities, goods and services is to be understood as a right to equal and timely access to "appropriate treatment of prevalent diseases and illnesses" (CESCR, 2000, para. 17). Consequently, the "critical elements" for the enjoyment of the right to health are guided by this central objective. This is evident in how health technologies are identified: the Committee requires States to ensure the provision of the so-called "essential drugs" (CESCR, 2000, para. 17), defined by the WHO Action Programme on Essential Medicines as "those that satisfy the priority healthcare needs of a population (...) selected with due regard to disease prevalence and public health relevance, evidence of efficacy and safety and comparative cost-effectiveness" (WHO, 2021). This same rationale applies to the State's core obligations resulting from the right to health, which are related to the population's priority needs. For instance, the Committee explicitly states the obligation "to provide essential drugs" (CESCR, 2000, para. 43 (d)), "to adopt and implement a national public health strategy and plan of action, on the basis of epidemiological evidence, addressing the health concerns of the whole population" (CESCR, 2000, para. 43 (f)), "to provide immunisation against the major infectious diseases occurring in the community" (CESCR, 2000, para. 43 (b)), and "to take measures to prevent, treat and control epidemic and endemic diseases" (CESCR, 2000, para. 43 (c)).

The CRC, in its GC 15, adopts the same interpretation of States' obligations in relation to the right to health of the child, as guaranteed by Art. 24 of the Convention on the Rights of the Child (CRC, 2013). The CRC proposes a list of appropriate measures for the full implementation of children's right to health, specifically addressing prevalent health issues. The CRC, art. 24, paragraph 2 requires States to "put in place a process for identifying and addressing (...) issues relevant to children's right to health" (CRC, 2013, para. 32). States are therefore asked to conduct "an in-depth analysis of the current situation in terms of priority health problems and responses" and identify and implement "evidence-based interventions and policies that respond to key determinants and health problems" (CRC, 2013, para. 32).

Moreover, this approach frames the obligation to "take appropriate measures (...) to diminish infant and child mortality" enshrined in Art. 24, paragraph 2 (a), as an obligation to pay particular attention to specific causes of mortality for children under five, such as pneumonia, diarrhoeal disease and malaria (CRC, 2013, paras. 33-35). Similarly, the obligation "to ensure the provision of necessary medical assistance and health care to all children with an emphasis on the development of primary healthcare," enshrined in Art. 24, paragraph 2 (c), is interpreted as imposing an obligation upon States to "prioritise universal access for children to primary healthcare services" (CRC, 2013, para. 36), and to "make all essential medicines on the WHO Model Lists of Essential Medicines (...) available, accessible and affordable" (CRC, 2013, para. 37). Finally, art. 24, paragraph 2 (d) also includes an obligation that does specifically address the specific needs of patients with rare diseases: the obligation for States to "combat disease (...) through the application of readily available technology" (Convention on the Rights of the Child, 1989, para. 24 (2)(c)). This point is reiterated in the CRC reference regarding technologies for "immunisation against the common childhood diseases" or "essential antibiotics and antiviral drugs" (CRC, 2013, para. 41).

## **Part 2 - Time for a change of paradigm: implications of equity and justice for rare diseases**

Despite the considerable number of patients living with a rare disease worldwide, they are not defined as people who suffer from a disease commonly found within a population. Consequently, they have so far been deprived of the full and equal enjoyment of their rights to health and to science, rights that are particularly relevant for the achievement of health equity and social justice. In this section, we argue that this should change due to an evolving interpretation of States' obligations towards patients with a rare disease, resulting from a strong emphasis on social justice at the international level in recent years. An approach that links the right to health and the right to science has strong implications for these patients' future.

### ***Recognising Rare Disease Patients as a Vulnerable Group in Human Rights Law: an important step towards social justice***

Human rights instruments are designed to protect all individuals, particularly those who are more vulnerable to violations of their fundamental rights. To date, patients with a rare disease have not been recognised by human rights bodies or courts as a group requiring particular attention. In its GC 15, the CRC only considers children belonging to "the poorest parts of the population and in developing States" as being in a vulnerable situation (CRC, 2013, para. 86). Here, the Committee aligns with the literature and the identification of disadvantaged individuals as being "those at the bottom of the economical [sic] and social scale" (Chapman, 2009, p. 14), evidently subject to multiple social, economic, environmental, legal and political risk factors, and not those who are disadvantaged due to a genetic disorder or other specific disease. In the same vein, the CESCR, in its GC 14, identifies women, children, older persons, persons with disabilities and Indigenous persons as the ones who should receive special protection (CESCR, 2000).

However, today, many arguments support a change of paradigm. The first is based on the evolution of discrimination over time. In its 2009 General Comment on the principles of non-discrimination and equality as fundamental components of international human rights law, the CESCR stated that "the nature of discrimination varies according to context and evolves over time" (CESCR, 2009, para. 27). Accordingly, the lists of grounds developed in its general comments and concluding observations are not exhaustive, and other possible prohibited grounds – or sources of discrimination and marginalisation – can be recognised, and new groups requiring special protection may be identified. For example, individuals with HIV status have been progressively recognised as such a group due to the multiple restrictions imposed on their civil and political rights, as well as their economic, social and cultural rights (CESCR, 2009). Another example is given by the GC 25 with the recognition of lesbian, gay, bisexual, transgender, queer and intersex (LGBTQI) persons (Holzhacker, 2014) as a group deserving special protection, as have women, persons with disabilities, Indigenous people and persons – more particularly children – living in poverty (CESCR, 2009).

Patients living with a rare disease experience numerous forms of discrimination that are difficult to consider as "systemic" due to the rarity and specificity of their conditions at the national level. However, the lack of available and accessible diagnostic tools and medicines constitutes a considerable barrier to both their right to health and their right to science. This amounts to discrimination, which arguably justifies the recognition of these patients as requiring special protection, as well as the development of special procedures to facilitate the protection and promotion of their rights based on the procedures already mandated by the Human Rights Council on specific groups (children, Indigenous people, older people, etc.).

The second argument is linked to the recent attention given by the international community to the principle of social justice and the achievement of equity in health. While the

concept of equity in health has been at the centre of discussions conducted by the International Negotiating Body in charge of the development of a new pandemic legal instrument (WHO Collaborating Center, 2023) since 2022, the principle of social justice has been a cornerstone of the Sustainable Development Agenda 2030, adopted in 2015 by the UNGA (UNGA, 2015). The so-called 2030 Agenda does not expressly refer to either international human rights norms or the rights to health or science. However, it sets out the strategies to be jointly followed by each nation and the international community, strategies inspired by international human rights instruments (Ebbeson & Hey, 2022), to achieve a common vision of a "just, equitable, tolerant, open and socially inclusive world in which the needs of the most vulnerable are met" (UNGA, 2015, para. 8).

It is within this framework that patients with rare diseases have been recognised as a special group, whose specific needs must be taken seriously. More precisely, rare diseases must be taken into account for the full realisation of UHC, which is also a central component of the 3rd Sustainable Development Goal on health and well-being (Dagon, 2022). In 2019, the UNGA expressly acknowledged an obligation for States to address rare diseases as part of UHC (UNGA, 2019, para 34). It also defined UHC as ensuring "that all people have access, without discrimination, to nationally determined sets of the needed promotive, preventive, curative, rehabilitative and palliative essential health services, and essential, safe affordable, effective and quality medicines and vaccines, while ensuring that the use of these services does not expose the users to financial hardship, with a special emphasis on the poor, vulnerable, and marginalised segments of the population" (UNGA, 2019, para. 8).

Moreover, for the European Union, patients with rare diseases belong to the vulnerable "segments of the population" deserving special treatment. For instance, the strong link between solidarity, Universal Health Coverage (UHC), and rare diseases is evident in the EU's public health strategies following the COVID-19 pandemic (EU Parliament, 2020; EU Commission, 2021). The same is true for the High Commissioner for Human Rights (HCHR) in a report on the contribution of human rights to the conceptualisation of UHC (HCHR, 2019). The HCHR notes that "even when access to some form of health care exists, coverage usually mirrors health issues as experienced by the general population, with little or no attention paid to the specific needs and rights of persons living with rare diseases" (HCHR, 2019, para. 29). The HCHR also highlights that "the paucity of medical and scientific knowledge about rare diseases drives [the] marginalisation [of the patients], with the result that many people remain undiagnosed and therapies are difficult to develop" (HCHR, 2019, para. 29) Finally, according to the HCHR, "rare diseases often attract stigma and discrimination, and many persons living with a rare disease find themselves excluded from participation in employment and from integrating fully and productively into society." (HCHR, 2019, para. 29) As a consequence, the HCHR encourages States to scale up their efforts to achieve UHC by 2030, including "efforts to address (...) rare diseases (...) as part of universal health coverage" (HCHR, 2019, para. 34).

It is worth noting that the designation of groups as requiring special attention or as being "vulnerable" has been recognised as potentially leading to stigmatisation, misplaced paternalism, or even essentialism (Peroni & Timmer, 2013). This risk, inherent in the concept of vulnerability, must be taken seriously. However, in the case of rare diseases, such risks do not appear to be prominent. The primary source of discrimination stems from the lack of medical and scientific knowledge rather than the specific and personal attributes of each patient. Their particularities are rooted in the complexity and severity of the disease they suffer from, not in characteristics such as gender, socioeconomic status or nationality (recognised as forbidden sources of discrimination) (ICCPR, 1966, art. 26; ICESCR, 1966, art. 2) – although they may also experience discrimination related to these characteristics. Moreover, these



patients are not deprived of their independence and have shown strong capacities to address their vulnerabilities, both as individuals asserting their rights in court (Dagron, 2011b) and collectively as a group. For instance, lobbying efforts from grassroots patient groups in advancing human rights-based approaches were the driving force behind the legislative efforts analysed above. The advocacy of these groups has helped hold their governments accountable for protecting patients' rights to life and health (Dunkle et al., 2010). A change of paradigm in how the needs of patients with rare diseases are comprehensively addressed through a human rights lens constitutes a remarkable step forward. With the implementation of the right to science, specific actions are no longer seen as political choices but as legal obligations for States.

### ***Advancing equity in health for rare disease patients through human rights: what implications today?***

The recognition of patients living with a rare disease as a group with specific risks and needs creates positive (legal) obligations for States to address all sources of risks and promote (substantive) equality. In light of the UNGA Resolutions on rare diseases, TB or NCDs, the CESCR interpretation of the right to science (CESCR, 2020), and academic discussions on invoking this right in specific contexts (Frick & Dang, 2021), the call to address the health needs of patients with rare diseases through a human rights lens has significant implications.

Although complementary, these implications differ depending on whether we consider the implementation of the right to health in conjunction with the right to adequate standards of living or the implementation of the right to science. The UNGA 2021 Resolution on rare diseases expressly refers to the first set of rights and identifies a two-fold, complementary goal for States addressing rare diseases.

Concerning the right to health, the UNGA emphasises that States must strengthen their health systems to ensure access to healthcare services that are safe, of the highest attainable quality, accessible, available and affordable, timely, and both clinically and financially integrated (UNGA, 2021).

Regarding the right to an adequate standard of living, the Resolution considers that States must address the root causes of social inequality and discrimination. These include specific social challenges related to education, employment, and leisure; achieving gender equality, particularly in access to healthcare services, education, and decent work; and ensuring access to social protection and assistance, including universal and equitable access to quality health services without financial hardship (UNGA, 2021).

When considering the implementation of the right to science, States must adopt a more systematic approach that combines measures designed to guide, support and enable scientific progress. First, States must guide research toward achieving specific goals for patients living with rare diseases. This involves addressing the role of private companies in decision-making related to research and accessibility. Although the challenges faced by patients with rare diseases are primarily the result of biological specificities, they are also exacerbated by a research structure that prioritises market objectives over healthcare needs. The pharmaceutical industry tends to define its research priorities based on the potential marketability of new products, which in turn depends on the number of potential future consumers, a country's economic purchasing power, and the capacity of health systems to deliver treatments (Trouiller et al., 2002).

Given the central role of the pharmaceutical industry in the research and development of technologies and treatments for rare diseases, it seems more necessary than ever to advocate

for the greater recognition of the human rights-related responsibilities of pharmaceutical companies, as mentioned in the "UN Guiding principles on business and human rights" adopted in 2011 by the Human Rights Council (UN Human Rights Council, Resolution 17/4). In 2008, the UN Special Rapporteur on the right to health, relying on the principles of equality and non-discrimination as expressions of social justice, had already urged private companies to "give particular attention to the needs of disadvantaged individuals, communities and populations, such as children, the elderly and those living in poverty" (UN Special Rapporteur, 2008, guideline 5). Although his focus at the time was on neglected diseases, the reasoning applies equally to rare diseases today.

Second, States must support the research and development of diagnostic tools and treatments. Such support can be the result of legislative instruments, as previously mentioned, that promote the research and development of orphan drugs. It can also be the result of promoting international contacts and cooperation in the scientific field, as required by Art.15 (4) of the ICESCR. As scientific progress becomes increasingly dependent on data and information exchange between countries and regions, States should promote cross-border scientific collaborations, which should also include the sharing of research results, as well as cooperation between the private and public sectors and among national, regional, and international authorities involved in rare diseases strategies. Art. 15 (4) of the ICESCR expressly refers to the benefits derived from international cooperation in the scientific field, and the CRC emphasises that the realisation of the child's right to health, especially in developing countries, depends on such collaboration (CRC, 2013).

Notably, several collaborative efforts are already in place. These include platforms such as *Orphanet*, created in 1997 through a cooperative initiative involving eight countries, including France, Germany and Switzerland and supported by the European Union (Orphanet, 1997; Kolkhir, 2023), and the *International Rare Diseases Research Consortium* launched in 2011 (International Rare Disease Research Consortium, 2011). Both initiatives are dedicated to collecting data and disseminating information on rare diseases, making significant contributions to addressing the diagnosis and treatment of affected patients.

Finally, States should adopt measures that enable patients not only to access the applications of scientific research (diagnostic tools and treatments) and the related knowledge and information (including research findings and data) (CESCR, 2020, paras. 16-17; CRC, 2013, paras. 5, 28; Frick & Dang, 2021), but also to be directly involved. This inclusion is part of the "participation" dimension of patients' rights (Frick & Dang, 2021). Patients living with rare diseases – as well as persons with disabilities, as understood by the CESCR, or citizens more generally (CESCR, 2020) – have the right to participate in the decision-making process, including those related to research priorities and broader public health strategies concerning access to the benefits of research.

The combination of these sets of measures is essential. To date, support for research and development alone, as recommended by the 2021 UNGA resolution (UNGA, 2021), has not ensured that people living with rare diseases can fully benefit from scientific progress. This has been demonstrated in the US and the EU, where legislation on rare diseases primarily addresses the costs of R&D (through financial incentives and extended intellectual property rights) while still allowing the industry's freedom to define which research and diseases to address.

On the one hand, evaluations in both regions reveal a certain degree of commitment to supporting patients living with rare diseases. For instance, analyses of US legislation have

shown that the adoption of the ODA encouraged research into rare diseases, as evidenced by a notable increase in approvals for rare disease products (Miller & Lanthier, 2018). Furthermore, a 2020 analysis by the European Commission has shown that since the 1999 Orphan Regulation, there has been a significant increase in the availability of orphan medicines and investments in rare disease research and development (R&D) (EU Commission, 2020).

On the other hand, these same analyses highlight that this increase in the number of available drugs has not translated into broader coverage of specific patient needs (Miller & Lanthier, 2018). According to the European Commission's evaluations of regulations on rare diseases and paediatric research, "unmet medical need[s]" have not been properly addressed, as for the large majority of rare diseases, there still is no treatment available (EU Commission, 2020, p. 34). The report concluded that the legislative instruments "have not done enough to direct the development [of drugs] in [these] areas" (EU Commission, 2020, p. 34); it also noted that "product development tends to cluster around certain (more profitable) therapeutic areas." As a result, "the number of treatment options is expanding for some conditions", such as certain cancers (EU Commission, 2020, p. 41). In response, in 2022, the European Economic and Social Committee expressed its disappointment in the progress made and called "for a comprehensive European approach that takes into account all the needs of people with rare diseases" (EESC, 2022, para. 1.1).

### Conclusions

Patients living with a rare disease face not only fundamental discrimination, manifested in the lack of diagnostic tools and treatments and the resulting inability to enjoy their right to health and benefit from scientific progress, but also additional forms of discrimination based on socioeconomic status, gender, age, and other factors. They are also subjected to a deep injustice stemming from the specific characteristics of their condition.

Taking action to fulfil their human rights obligations means that States must intervene to strengthen their health systems, address the root causes of inequality and discrimination, and direct scientific research towards unmet needs. This includes supporting research and development, particularly through the strengthening of international cooperation, and ensuring patients' access to diagnostic tools and treatment alongside their participation in the decision-making process.

Acting in accordance with the principles of social justice demands that States prioritise the needs of patients with rare diseases, even when doing so may challenge cost-efficiency metrics used in broader public health policies. Access to quality health services and essential medicinal products without financial hardship is a significant challenge for a large part of the world's population today (DESA, 2022a; ILO, 2021). Even in high-income countries, trade-offs are always present in healthcare, as no system operates with unlimited resources. Until now, States have favoured those whose needs they consider the most pressing based on epidemiological information and central objectives, such as maternal and child health, health security, and epidemic control (CESCR, 2000). However, when guided by specific values such as solidarity, health equity and social justice, adopting an HRBA to healthcare introduces additional obligations into the equation. The specific healthcare needs of patients with rare diseases must be given the same level of priority as those of any other group whose needs have traditionally been viewed as most urgent. In light of ongoing global health reforms, it is time to integrate rare disease justice into mainstream health and human rights strategies.

## Acknowledgements

The author wishes to express her gratitude to the participants and organisers of the Symposium on the Right to Science with a Focus on Health (in particular to Samantha Besson, Gérard Escher and Bartha Knopper), which took place at the Brocher Foundation in Switzerland in December 2021, for their extensive discussions on the right to science. Special thanks to Patrick Taran for his insightful contributions to social justice and to Pauline Roy and Elizabeth Joanne Schwarczer for their bibliographic research and language editing support.

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## How WASH Supports Social Justice in a Changing Climate: The Importance of Water

## Cómo WASH sustenta la Justicia Social en un clima cambiante: La importancia del agua

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Sent: 2025/01/10  
Accepted: 2025/04/25  
Published: 2025/06/30

### Abstract

This paper explores the relationship between social justice, the water, sanitation, and hygiene (WASH) nexus, and the centrality of water to both, all within the context of climate change. Our changing climate has placed considerable pressure on the global hydrological system, altering traditional rainfall patterns and increasing the frequency and severity of natural disasters. Ensuring adequate and sustainable access to fresh water for communities around the world is essential for human life and health. The human right to health is seriously compromised when sanitation and hygiene services are inadequate. It is essential that these issues are included in discussions of social justice. In conclusion, the proposed solutions to address the needs of the WASH nexus and climate adaptation overlap. Climate adaptation itself is thus seen as a human rights concern and another facet of the social justice debate.

**Keywords:** sanitation, hygiene, health, climate justice, ecosystem services, water, human rights.

**Summary:** Introduction; Methodology; Social Justice, Climate Change and Climate Justice; WASH as Socially Just; Climate Change, Water and the WASH System; Discussion; Conclusions.

**How to cite:** Zerrouk, E. (2025). How WASH Supports Social Justice in a Changing Climate: The Importance of Water. *Revista Tecnológica - Espol*, 37(1), 121-133.  
<https://rte.espol.edu.ec/index.php/tecnologica/article/view/1274>

## Resumen

Este artículo analiza cómo se relaciona la justicia social con el agua, el saneamiento, la higiene (WASH) destacando el papel central del agua en estos enfoques, en el contexto del cambio climático. El clima varía y ha ejercido una presión considerable sobre el sistema hidrológico global, cambiando los patrones tradicionales de lluvia y aumentando la frecuencia y gravedad de los desastres naturales. Garantizar el acceso a agua dulce adecuada y sostenible para las comunidades del mundo es esencial para preservar la vida y la salud de las personas. El derecho humano a la salud se ve seriamente comprometido cuando los servicios de saneamiento e higiene son inadecuados o insuficientes. Por ello, es fundamental promover la inclusión de los grupos vulnerables en los debates sobre justicia social. En conclusión, las soluciones propuestas para abordar las necesidades del nexo WASH y la adaptación al cambio climático presentan importantes áreas de superposición. En este contexto, la adaptación climática se reconoce como una preocupación relacionada con los derechos humanos y como una dimensión del debate sobre la justicia social.

**Palabras clave:** saneamiento, higiene, salud, justicia climática, servicios ecosistémicos.

## Introduction

What elements make a society *just* has been the purview of scholars, politicians, philosophers and poets for generations. Answers can be found in many religious traditions, cultural beliefs and legal doctrines. Commonalities include the alleviation of poverty and hunger, the establishment of freedom of belief, the unbiased application of the rule of law, the protection of individual health, the need for a sustainable environment, to live in peace and security, and for education to be available to all, amongst others. Essentially, a just society protects basic human rights and freedoms without prejudice. This idea is upheld by international Human Rights Law and other international instruments to be discussed throughout this paper. The concept of social justice takes these principles as the core of its ethos. This paper will investigate what needs to be at the core of social justice, and how the protection of the most basic of human rights, those of health, water, and sanitation, could be the key. Without these basic rights, there can be no growth, and other essential human rights can be undermined. Thus, the WASH nexus is potentially the most essential determinant to social justice. At the heart of WASH is water, a basic element without which there can be no life. Water, which touches every aspect of our lives, is also a basic human right. But “climate change is placing pressure on the global hydrological system and undermining the WASH nexus. To adapt to these changes, a social justice approach to WASH is needed, as well as the centering of water and social justice in the climate change discourse.

This study aims to investigate these key issues by focusing on overlaps within the nexus of WASH - climate change - social justice and identifying the embedded social justice elements in each distinct sub-section of the nexus, therefore unifying the narrative. The central questions to be addressed are as follows:

1. How do social justice and climate change relate? In a world experiencing the shifts brought about by a changing climate, how can we ensure the narrative of social justice is present in climate change talks and vice versa? Is Climate Justice at this intersection?
2. If the most basic human dignities are only assured when sufficient water, sanitation and hygiene are present, then how do we link each of these more closely to social justice and view them as essential to a just society?

3. At the core of WASH is water, without which the nexus cannot function. But in the face of climate change and the various pressures that water faces, how is water central then to the social justice discourse?

### Methodology

This paper takes an interdisciplinary approach to its research, mixing qualitative and quantitative analysis:

- A literature review of relevant and current materials available on the intersection of the subjects of: water, sanitation, hygiene, health, climate change and social justice has been undertaken.
- A review of key international legal frameworks concerning the above key topics was required to ensure the relevance of discussion and suggestions.
- From an epistemological perspective, in-depth research into terms, such as justice and social justice, and how they are used was essential to the analysis of respected topics and to the production of a narrative that is cohesive.

### Social Justice, Climate Change and Climate Justice

Social Justice, and its respective concerns, is generally accepted as placing human rights at the center of discussions, in a way that is non-discriminatory. At the national level, local level, and interpersonal level, it can also be framed as a term used to describe what is considered to be social justice. Thus, the meaning of social justice is dependent on the societal, religious, and organisational perspectives of those using the term. Social justice does not, then, have one concrete, agreed-upon definition, but many different, nuanced definitions that are heavily dependent upon the agenda of those instrumentalizing the notion. For example, an organisation such as the International Labour Organization (ILO), as its name suggests, focuses on fair and decent work as a way to ensure “Social Justice for a Fair Globalization.” The ILO adopted as a principal framework this concept in June 2008. In 1998, the United Nations declared that February 20<sup>th</sup> would be the World Day of Social Justice, and took yet another, broader approach to defining what social justice means. While we may not all agree on a single definition of Social Justice, we do, however, have international, and national legislature that establishes what is commonly accepted as socially just. Through the same mechanisms, most societies will be in agreement on the basic elements of what makes or is needed to establish a just society. This claim is supported by the adoption, ratification, and subsequent integration into national law of international human rights Conventions, International Labour Standards and other legally binding instruments. Conversely, for these international instruments to have been voluntarily accepted by so many States demonstrates that the basic substance of what makes a just society was fairly commonly acknowledged: a society that protects, implements and realizes human rights for all.

Of these universal human rights, to name but a few, are the right to life and a safe environment (Article 3 of the *Universal Declaration of Human Rights*), decent and fair work (Article 23 of the *Universal Declaration of Human Rights*), the rights of the child (Convention on the Rights of the Child 1989), the right to health (Article 25 of the *Universal Declaration of Human Rights*), the right to education (Article 26 of the *Universal Declaration of Human Rights*), and the right to clean water and improved sanitation (*Convention on the Law of the Non-navigational Uses of International Watercourses 1997*). However, not all of these rights were recognized at the same time, and in the majority of the world, the protection of all of them is still not guaranteed. The aim of social justice then (even without a unified definition), can be seen as the desire to ensure that these basic human rights are protected in the here and now and

without discrimination. But, what of the future generations; is intergenerational inequity a part of Social Justice, and in what makes our current societies just?

The subject of climate change and its relation to human rights fits nicely at the intersection of social justice and intergenerational inequity. Climate change mitigation and adaptation in themselves can be said to be human rights concerns. This is because the cascading effects of climate change affect every element of society and have the potential to further undermine efforts to ensure basic human rights in the present day. The temporal aspect of climate change, as a reality that will persist past the lifetime of those most responsible for its influence, means that intergenerational inequity is central to the climate change discourse. Even though intergenerational inequity may be an outlier on the topic of social justice, its relation to climate change and the future of the human rights of our youngest population earns it serious consideration.

It is from the same intersection that the term Climate Justice arises and needs to be mentioned here. The United Nations Development Program (UNDP, 2023) defines Climate Justice as: “putting equity and human rights at the core of decision-making and action on climate change” (ibid). Climate Justice, then can be seen as centring the climate change discourse around social justice or, ensuring social justice in a changing climate. There are of course then many elements to Climate justice, of which one is based around “the polluter pays principle,” however, for this paper, we will mention three elements as laid out by the UNDP (most specifically the first and third principles): “structural inequalities, socioeconomic inequalities, and intergenerational inequity” (ibid). Structural inequalities are those based on an individual’s socioeconomic position, gender, age, and race, thus, as we will discuss later with WASH, women and indigenous groups are often disproportionately affected by the effects of climate change. Socioeconomic inequalities are defined by the ability of a State, region, community or individual, to adapt to and mitigate the effects of climate change and are unequal across the globe (ibid). In terms of intergenerational inequity, the UNDP’s definition looks at how, many of the current generation, and the future generations have not contributed greatly to climate change but will bear the consequences of it (UNDP, 2023). If turned around to make social justice itself the focus of the discourse, climate justice asks us to consider the following: in our current context of a planet in flux due to climate change, any discussions on Social Justice need to take into account the cascading effects that this context creates.

To address climate change and its global impact, the Sustainable Development Goals (SDGs) of 2015-2030 were introduced. These arose after the unequal progress made around the globe on the Millennium Development Goals (MDGs). Although not explicitly human rights goals in and of themselves, the SDGs nevertheless address many of the separate, and often overlapping, human rights goals that are key to achieving Social Justice. Of the seventeen goals taking “urgent action to combat climate change and its impacts” (UNDESA), is Goal 13. But climate change adaptation in the form of calls to ensure sustainable development and management of resources is seen in many others. For example, Goal 16 is to “[p]romote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels” (ibid). Thus, we see how both the approach of Climate Justice and a climate change-aware implementation of Social Justice overlap.

### **WASH as Socially Just**

The three elements of water, sanitation and hygiene, are key determinants of the success of a community and essentially underpin social justice. For, what sort of quality of life can be expected if either of these three elements are inadequate? Put together they are referred to as

WASH, a term used commonly to emphasize the interconnectivity of the subjects. WASH is pivotal to a just society as well as to the application of the idea of social justice. Improved water, sanitation and good hygiene (along with food), are the primary defence against disease, child mortality, and low life expectancy. Without these basic elements establishing, and protecting, almost every other human right is frustrated. As such, SDG Goal 6 explicitly states that as part of the overarching aim to create a just world, we must “[e]nsure availability and sustainable management of water and sanitation for all” (ibid). Goal 3 of the SDGs is to “[e]nsure healthy lives and promote well-being for all at all ages” (ibid). These two goals, among others, underscore the importance of the discrete elements of WASH to create a socially just future, as three of them protect three of the most basic human rights: the right to water, the right to sanitation, and the right to health. Digging further into each element of WASH and its impacts on daily life, it becomes clear how they may undermine or support many other human rights.

### **Water as Key to WASH and Social Justice**

“Water is social justice; social justice is water” (Symmes, 2022), states the International Water Management Institute (IWMI). If social justice is ensuring the human rights of people without discrimination, then ensuring equal access to sustainable clean water for all would need to be a priority. However, water was only recognised in hard international law as a basic human right in 2014 through the coming into force of the UN *1997 Convention on the Law of the Non-navigational Uses of International Watercourses*. However, many national laws and other key international law instruments, like the UNECE *Convention on the Protection and Use of Transboundary Watercourses and International Lakes*, which came into force in 1996, laid the foundation for recognising this essential right. SDG Goal 6 also calls for safe drinking water to be secured for all.

When discussing sustainable freshwater for all, there are different dimensions to consider; these are water quality, water quantity and water availability (or access). In terms of water quality, safe or improved water sources are those that are free from contaminants and pollutants and, therefore, fit for human consumption. However, around 700 million people, or 10% of the population worldwide, drink from unimproved and/or contaminated water sources. As such, water is a key indicator of social inequity, whereas access to clean water is an indicator of equity.

It is estimated that 20L of water per capita per day is needed for survival needs, i.e., to drink and for food preparation. This is for emergencies only (refer to Figure 1). This amount is an estimate as climate and conflict situations may require much higher figures. For example, insufficient quantities of water and contamination of water sources are the earliest and main causes of illness for displaced populations after and during disasters (WHO 2013). For regular daily life, however, far more than the minimum 20L of water is required (refer to Figure 1). Water is required to meet sanitation and hygiene needs, such as clothes washing and general cleaning, as well as in the performance of cultural and religious activities.

Access to improved and reliable water is unequal across the globe and is dependent on socio-economic factors as well as geography. Less than 3% of the planet’s water is freshwater and of that, almost 70% is inaccessible (glaciers, snow etc.). The rest is mostly located underground, with less than 0.5% existing as surface water (Black, 2016). Many national and international/transboundary watercourses are not able to supply growing populations’ freshwater needs. This century water use grew “at more than twice the rate of population increase (ibid). Rising demand reduces the availability of water per area, be that for personal use, agriculture (70% of average worldwide use), or industry. Demand is also fueled by

changes in lifestyle and expectations and shifts between agricultural and industrial activities. Additionally, the ability of water sources to naturally purge themselves of impurities is overloaded by contamination in populated regions, thus reducing again the amount of clean water available. For example, in India per capita availability of water has decreased to 1,500 cubic meters from 4,000 cubic meters in fifty years (ibid). This has occurred due to a mixture of the aforementioned reasons, with the additional strain brought on by climate change to weather patterns.

**Figure 1**

*Hierarchy of Water Requirements (after Maslow's Hierarchy of Needs) According to WHO Technical Notes on Drinking-Water, Sanitation and Hygiene in Emergencies (WHO, WEDC. (2013))*



Some rural communities across the globe must rely on ‘tanked-in’ water. It is an often unreliable and expensive way of trying to secure freshwater. Additionally, for many communities, the scarcity of freshwater close to home is felt disproportionately by women and children. When the closest freshwater source is a distance away (two hours walk or more for some rural regions), it is the job of the women or children to fetch and carry the water. This comes at the cost of time at school, work, or personal development. The unavailability of sustainable water sources close to home is yet another way that the need for water, first and foremost, limits the application of other basic human rights.

Just as the WASH nexus is essential to establishing social justice, and should be applied in the context of what is socially just, the right to water is crucial to both. Access to clean and sustainable freshwater sources is necessary to address sanitation and hygiene concerns. Water underpins WASH. Improved sanitation and proper hygiene practices begin and end with water. This means that to create a decent sanitation system at the point of human contact, water is required, and to maintain a decent sanitation network is to protect that same water from contamination. With safe hygiene practices, we see the same to be true, as water is required to ensure personal hygiene, food preparation and everyday cleaning requirements. The water used for all these needs must be in a state that aids in the alleviation and prevention of illness and is not instead the carrier of it. Without access to clean and sustainable water sources, there can be no life.

### **Sanitation and a Just Society**

According to WHO, only 25% of countries “are on track to achieve their national sanitation targets” (WHO 2022). This means that with the current trends, 67% of the population

of the world will have safe and improved sanitation systems by the goal year of 2030, “leaving 2.8 billion without” (WHO 2022). An improved sanitation facility is one that separates “human waste from human contact” (WHO, 2024). The right to such levels of sanitation is considered a human right internationally, and ensuring the establishment of this right for all is part of the SDGs. However, around 3.5 billion people worldwide lack access to “safely managed sanitation services” (WHO). Among these, women and girls are disproportionately affected. The unavailability of safe toilets poses a safety risk, as trips to relieve oneself may require entering areas that are outside of communal areas, isolated and more discreet. This is especially a problem for women and girls at night when they may become a target for sexual predators. Safely managed sanitation services are essential to control the flow of contamination to freshwater sources, and are a deterrent to open defecation. Open defecation, especially of children, is a disease risk, however, it remains the only option in communities where sanitation facilities are not readily available or secure.

According to the World Bank “in total, an estimated 500 million [women and girls] lack access to menstrual products and adequate facilities for menstrual hygiene management (MHM).” (World Bank Group, 2022)

*“Gender inequality, discriminatory social norms, cultural taboos, poverty and lack of basic services like toilets and sanitary products can all cause menstrual health and hygiene needs to go unmet” (UNICEF).*

Thus, ensuring MHM needs are met requires a multifaceted approach, however, access to improved sanitation facilities is a large part of the problem. Many studies reveal concerns around how menstruation affects girls and female teachers at schools, (as well as women at work in general). This is especially true in low-income countries where almost half of the schools lack proper WASH facilities. It is also the case in many developing countries that stigma, and lack of facilities, lead to low school attendance. A study of ‘adolescent girls in India found that a quarter of the girls did not attend school during menstruation because of the lack of adequate toilets’ (Van Eijk et al. 2016). In another study, it was found that 57% of adolescent girls surveyed in South Sudan stayed home during menstruation because of a lack of private places to change at school (Tamiru et al. 2015). The goal of gender equality and the right to education is foiled in these instances by inadequate WASH systems, lack of a supportive environment, and community awareness.

Currently, 90% of sewage in developing countries is dumped untreated in watercourses. This is without any of the ‘conventional’ sewage treatment processes that are standard in developed states. The treatment and management of sewage requires investment in sanitation services and education and awareness programs for communities living near affected freshwater sources. However, the lack of improved and safe sanitation services at home or within a community is often a reason for watercourse contamination, and the use of the contaminated water without proper treatment is a cause of disease and poor health.

One example of a water-borne illness that spreads due to poor sanitation, is cholera (among other diarrhoeal diseases), which is caused by the consumption of water or food containing the bacterium *Vibrio cholerae* (WHO, December 2024). The spread of cholera is associated with poor hygiene practices, limited safe water access, and the lack of good sanitation facilities (WHO, December 2024). “As of 2019 estimates, there are 9 million cases of typhoid fever annually, resulting in about 110,000 deaths per year. Typhoid risk is higher in populations that lack access to safe water and adequate sanitation, and children are at highest risk” (WHO, 2023). Many vector-borne diseases spread due to stagnant and/or unclean water

located in the proximity of human populations. This is because, a prime carrier of disease, mosquitoes, breed in such waters. The situations that lead to the spread of these diseases, in other words, to a compromised WASH system are varied, and could be due to the displacement of populations, climate-related events such as floods and drought, a lack of financial means, and geographical location of a community” (WHO, December 2024). However, investing in improved sanitation in each of these situations is the first step in protecting the health of communities.

### **Hygiene and a Just Society**

Hygiene can be defined broadly as practices taken to keep yourself and others healthy. These practices may necessarily extend beyond the individual to their household, community and surrounding environment. The Centers for Disease Control (CDC), of the United States of America, separates hygiene into four main categories: personal hygiene, infant feeding hygiene, diaper hygiene and everyday cleaning (CDC, 2024).

In terms of basic personal hygiene, as of 2022 WHO estimates that approximately two billion “people lacked handwashing facilities with soap and water at home” (WHO, 2024). Handwashing facilities are essential in the prevention of hand-to-mouth transmitted diseases. Salmonella, meningitis, and hepatitis are but a few diseases that pass from person to person, and can be prevented from spreading with good hygiene (and systematic vaccination programs). Incorporating handwashing facilities into community freshwater upgrade projects would support the elimination of hand-to-mouth transmitted diseases and also make the cleaning of cooking implements easier. Teaching the making of soap using locally accessible ingredients can provide work and also decrease the cost of soap, therefore making it more accessible. Educating relevant communities on the harm of bathing, and the disposal of water used for ablutions, in drinking sources is another way to reduce contamination of clean water sources. By the same token, teaching that only flowing, or purified water, should be used for personal hygiene purposes prevents the contraction of disease from contaminated and/or polluted water.

Infant feeding hygiene, along with the administration of infant vaccines, is key in preventing many diseases that cause infant deaths. Careful cleaning of feeding implements and the hands of food providers decrease the chance of diarrhoea-causing pathogens reaching infants. “Diarrhoeal disease is the third leading cause of death in children 1-59 months of age” (WHO, March 2024). It is also the main cause of malnutrition in children under five years of age (ibid). Many cases can be prevented with safe drinking water and good everyday cleaning practices in the home.

Diaper hygiene has three parts to it. The first is the cleanliness of the infant, and ensuring that the child has no contact with fecal matter. The second is the care taken by the changer of diapers to wash their hands and any materials that may have come in contact with fecal matter etc. The third concerns the disposal of the diapers. As with menstrual sanitary products, diapers make up a large portion of global landfills. The use of biodegradable products, and the appropriate use and washing of re-usable diapers helps to reduce the waste load of communities. In general terms a diaper is considered a biological hazard, and much like healthcare related waste, communities need to plan their disposal. In terms of cleanliness of the infants and the carers, proper hand and cloth washing facilities are needed, as well as the availability of soap as discussed earlier.



## Health and the Right to Safe and Decent Work

Although WASH does not explicitly use the word health in its acronym, it is implied (It should be noted that some of the earliest uses of the acronym WASH originally used 'Health' as the 'H,' but this was later changed to 'Hygiene.'). The World Health Organization (WHO) defines health as more than just being free from disease or infirmity, but as a “state of complete physical, mental and social well-being”. This holistic, cradle-to-the-grave, approach is a foundation for the building of a just society, and only possible with a strong WASH system.

The intimate relationship between sustainable development and public health was highlighted during the Covid-19 global pandemic. The human impact of the pandemic was devastating as it brought many communities to a standstill which have yet to recover. The economic impact is also still being felt as global supply chains continue to be disrupted, and lag behind demand.

The human right to safe and decent work is the emphasis of the ILO's commitment to “Social Justice for a Fair Globalization.” Part of this is the commitment to ensuring that worker health is a primary concern of employers and society in general. The relationship between health and economic growth is well-documented. Research done by the McKinsey Global Institute estimates that the global GDP reduces by 15% each year due to poor health (Remes, etal. 2020). However, the positive feedback loop of good health and economic growth is such that: a healthy workforce leads to higher productivity, greater participation in the workforce (and for longer), and fewer days lost to medical leave. Thus, the investment in worker safety and health reaps positive returns immediately. According to research, this can mean that for every \$ 1 USD invested in the health of a community, not just the workers, \$ 2.70 USD can be gained in economic benefits (MGI, 2024). Ensuring the health of workers and the surrounding community is a pragmatic and mutually beneficial goal. It contributes to a socially just society, where the individual's health is prioritized and contributes to the goal of securing safe and decent work for all.

## Climate Change, Water and the WASH System

Ensuring clean water, improved sanitation and hygiene for all is an age-old challenge. Climate change driven by global warming, however, has made the situation far more complex. changes in weather patterns and extreme weather events have made rainfall less predictable. The melting of glaciers has changed the timing of annual runoff, and also reduced the natural recharge of surface waters and aquifers. The over-extraction of water from aquifers (groundwater), has also led to a permanent decrease in water availability, a concern considering that approximately a fifth of water used comes from aquifers. Although shifts in water availability and flows are changing across the globe, the severity of the change and the impact it has is geographically and climatically dependent and vary from water basin to water basin.

Flooding is a boon for many countries, a periodic, predictable increase in river swells, leading to well-irrigated fields and higher crop yields, for example, in the Nile delta. With climate change, the intensity, frequency, timing and location of flooding are worsening. Uncontrolled, unusual flooding poses a threat to lives and livelihoods. As devastating as floods can be, their first victim is often sanitation infrastructure. Sewage system overflow and other lavatory facilities being hit by the flood will spill waste into the streets and contaminate freshwater sources. This contamination leads to the direct transmission of disease and harmful substances and the increase of vector-borne illness for the time it takes for all stagnant waters to clear in the aftermath.

Along coastlines, sea-level rise is leading to inundation of saltwater (saltwater intrusion), and the destruction of farmlands and freshwater infrastructure. The salination of freshwater resources reduces the availability of water for use in agriculture and for sanitation, hygiene, and living requirements. Small Island States, many of which are on the list of the UN's Least Developed Countries (LDC), are at risk of losing their homes due to climate change. Entire communities established on atolls are slowly being submerged. Their case of being deprived of both home, livelihood, and facilities is another clear example of why social justice needs to include climate change as a concern for current and future generations and why the approach of climate justice is useful.

The more arid regions of the world accustomed to periodic droughts are seeing them occur more frequently and for longer stretches. Many LDCs exist in the driest latitudes. Ensuring improved sanitation, hygiene and health is also challenging in these communities with naturally scarce water availability. Just as with flooding, extreme storms, and sea level rise, these changes in water quality and quantity harm economic activity and livelihoods, and will affect those already living in challenging circumstances the hardest, i.e., displaced populations, the impoverished, children, aged and infirm. Escaping poverty is highly linked to having adequate water for agricultural activities and sufficient quantities close enough to home to allow for children, especially girls, to attend school.

### Discussion

The United Nations World Water Development Report 2020, *Water and Climate Change*, states that the “challenges of development, poverty eradication and sustainability are intricately interwoven with those of climate change mitigation and adaptation, especially through water” (UNESCO, 2020). Thus, establishing a just society centred around human rights needs to be developed within our current climate-shifting context. Water is a common element of concern across sectors, as the key to the WASH nexus and a basic human right in and of itself.

Many practical and reasonable ways exist to address climate adaptation for WASH systems. Although specific solutions vary depending on the geographical and socioeconomic circumstances of each community, there are key common elements. The first is looking for natural or nature-based solutions to adaptation. Conservation measures that protect and repair existing wetlands are one such approach. Wetlands are natural water purification systems and serve to slow water flows. Agreements such as the *Ramsar Convention on Wetlands* and the work of organisations such as the International Union for the Conservation of Nature (IUCN) and the World Wildlife Foundation (WWF), in this area have demonstrated the value of wetlands in protecting communities from disaster-level floods, creating new livelihood sources, and treating unclean water. In general, greater biodiversity in areas around human populations leads to greater resilience in the face of floods, droughts, and disease (of crops and livestock especially). Wetlands also aid in the recharge of aquifers as they slow water run-off. Creating wetlands around urban areas has also proven beneficial for this purpose. In general, a healthy environment helps to protect the well-being of the community and individuals physically and mentally. This is also one of the reasons behind the Green Cities movement, which attempts to use nature-based solutions for urban sanitation, water, air pollution and mental health concerns. Humanity's benefits from nature, especially in its wilder forms, are broadly termed ecosystem services. The discourse around ecosystem services mixes environmental rights and human rights approaches. Placing the natural world at the base of social justice and as a source of solutions for many human rights issues.

Whether in areas with relative water abundance or scarcity, water reclamation is another method to improve access to clean water. When collected and treated properly, wastewater, aka grey water, has many uses. If reclaimed water is used to service the needs of industry and agriculture, it frees other freshwater sources for WASH needs. Singapore's stormwater collection and wastewater treatment system is an example of innovation in water reuse, serving a State with high water demands and not enough supply nationally. However, the reclamation of water need not be only on such a grand scale. Rainwater harvesting kits at the local level are another example. Investment in sanitation and water infrastructure is essential in order to apply solutions such as large water reclamation projects, creating artificial wetlands and restoring existing wetlands. Other climate change adaptive, WASH-supporting infrastructure solutions are, for example, the creation of covered reservoirs, artificial recharge of existing aquifers, community and in-home toilet systems, and water purification centres.

Education is an important tool in human rights efforts. Inversely, education, as a human right itself, is required to create a just society. As discussed, in the areas of sanitation and hygiene, at the community and individual level, information campaigns to alleviate stigma and superstition around menstrual hygiene would support school attendance amongst girls, increase opportunities for women at work, and reduce the risks around specific illnesses arising from inadequate menstrual products. Educating communities about the risks associated with open defecation, and the entry of waste into water sources have been successful, as witnessed in Nepal (Kendra et al, 2017), through the work of activists such as Shrestha (also known as 'Mr Toilet'), and UN-Habitat. A community understanding the relationship between sanitation, hygiene and the spread of disease is key.

### Conclusions

*“The Rockefeller Foundation-Lancet Commission on Planetary Health recognizes that human health and the health of our planet are inextricably linked[,] and that our civilization depends on human health, flourishing natural systems, and the wise stewardship of natural resources. With natural systems being degraded to an extent unprecedented in human history, both our health and that of our planet are in peril”* (UNFCCC, 2023).

The concept of Planetary Health places health at the centre of the climate change discourse. It also links intergenerational equity and environmental rights. Canadian provincial healthcare organisations such as those of Ontario and British Columbia (PHC, 2024), along with Britain's National Healthcare Service (NHS), have adopted Planetary Health as a core ethos. These organisations look for ways to mitigate and adapt to climate change by reducing their emissions and waste while growing sustainably to face future challenges. Movements such as planetary health at the institutional level encapsulate the linkage between social justice, climate change and WASH. The spreading of this type of framing across national, and sub-national, healthcare bodies internationally would be a significant step in the right direction.

As stated by WHO, globally there is a need to speed-up progress in the realm of WASH. 2.8 billion people still living without improved sanitation (WHO 2022) in five years is too significant a number. The inequality of investment in this sector per/capita globally is a large part of the reason. This disparity is caused by both existing global economic inequalities and the geo-economic goals of many national development funds. However, the lack of, or inefficiency of existing sanitation infrastructure is only a part of the equation in regions of water scarcity. Thus, access to reliable and safe drinking water, and water for hygiene purposes, is a problem to be resolved in tandem. The linking of these issues through the WASH nexus approach needs to be incorporated into all development projects that touch on either element. National policy needs to incorporate this nexus approach into the development of their future

plans for development. These policies should include education programs that stress the interrelation of health, water, sanitation, hygiene and climate change impacts.

Climate risk adaptation measures, like disaster risk measures, need have WASH at the center of discussions. Visa versa, WASH as a nexus entirely needs a more prominent position in the climate debate. The stress that climate change places on national and local WASH systems is a concern for developing and developed countries alike. Sharing of research on the enhancement of WASH systems is key and self-serving. In a globalized world of cross border movement, ensuring the resilience of neighbouring and regional WASH systems aids in the prevention of, and the spread of pandemics.

### Acknowledgements

The completion of this article would not have been possible without the support and patience of my colleagues and friends at GMPA, Patrick A. Taran and Olga Kadysheva. Their encouragement and faith were instrumental in the finishing this work.

I would also like to acknowledge the valuable time working with forward-thinking and proactive colleagues Anthony Munster, Executive Director of projects, Planning and Facilities, and Mehrdad Gharibnavaz, Energy Manager on Planetary Health *making healthcare more sustainable*, at Providence Health Care (PHC), in B.C, Canada, who gave me innumerable insights into the connectivity of the WASH system and climate change.

Special thanks also to the Geneva School of Diplomacy and International Relations (GSD) for incorporating my Blue Diplomacy course into their curriculum and believing in the need to educate our future leaders and diplomats on the importance of WASH.

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## Migrant Associations: Enhancing Migrant Agency and Advancing Social Justice

### Asociaciones de migrantes: Fortaleciendo la capacidad de acción de los migrantes y promoviendo la Justicia Social

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Sent: 2025/03/18  
Accepted: 2025/06/09  
Published: 2025/06/30

#### Abstract

Migrant associations play a crucial role in enhancing migrant agency and advancing social justice by fostering social, economic, and political empowerment. This article develops a conceptual framework that integrates theories of migrant agency, social justice and migration, examining how migrants navigate structural constraints while actively shaping their own mobility and integration experiences. Drawing on existing literature and the author's Doctoral dissertation, it also presents a state-of-the-art review of migrant associations, highlighting their functions, challenges, and impact. The study explores the multifaceted role of migrant associations in empowering migrants across different domains. Social and cultural empowerment is achieved through the preservation of cultural identity, language programs, and social integration initiatives. Economic empowerment and labor rights advocacy focus on skill development, employment support, and advocacy for fair wages and working conditions. Legal and political empowerment is facilitated through legal aid, advocacy for migrant rights, and political mobilization to influence policies affecting migrant communities. Migrant associations further contribute to social capital and community building by strengthening networks, fostering solidarity, and bridging ties between migrant groups and host societies. Additionally, these organizations play a vital role in crisis response, providing emergency relief. The findings underscore the importance of legal recognition of human and labour rights, as well as policy frameworks that support and collaborate with migrant-led organizations to ensure inclusive and just societies. Ultimately, this article argues that migrant associations are not only essential for migrant agency but also key actors in the broader struggle for social justice.

**Summary:** Introduction, Methodology, Conceptual Framework, Migrant Association: Enhancing Migrant Agency and Advancing Social Justice, Conclusions.

**How to cite:** Castillo Rueda, V. (2025). Migrant Associations: Enhancing Migrant Agency and Advancing Social Justice Order. *Revista Tecnológica - Espol*, 37(1), 134-155.  
<https://rte.espol.edu.ec/index.php/tecnologica/article/view/1293>

**Keywords:** Migrant Empowerment, Rights, Social Capital, Advocacy, Community Building.

### Resumen

Las asociaciones de migrantes desempeñan un papel crucial en el fortalecimiento de la agencia migrante y la promoción de la justicia social, fomentando el empoderamiento en los ámbitos social, económico y político. Este artículo propone un marco conceptual que integra teorías sobre agencia migrante y justicia social, explorando cómo los migrantes enfrentan restricciones estructurales mientras construyen activamente sus trayectorias de movilidad e integración. A partir de la literatura y de la tesis doctoral del autor, se revisa el estado del arte sobre asociaciones de migrantes, analizando sus funciones, desafíos e impactos. Estas asociaciones impulsan el empoderamiento social y cultural mediante la preservación de la identidad, programas lingüísticos e iniciativas de integración. En lo económico, promueven la capacitación, el acceso al empleo y la defensa de condiciones laborales justas. Desde lo político y legal, ofrecen apoyo jurídico, defienden derechos y movilizan a las comunidades migrantes para influir en políticas públicas. Además, fortalecen el capital social al tejer redes, fomentar la solidaridad y construir puentes con las sociedades de acogida. Su rol es igualmente fundamental en contextos de crisis, brindando ayuda humanitaria y apoyo de emergencia. El estudio subraya la importancia de marcos normativos que reconozcan los derechos humanos y laborales de las personas migrantes, y que respalden legal y políticamente a sus organizaciones. En última instancia, se argumenta que las asociaciones de migrantes son actores clave no solo en la construcción de su propia agencia, sino también en la lucha colectiva por sociedades más justas e inclusivas.

**Palabras clave:** Empoderamiento migrante, derechos, capital social, incidencia política, construcción de comunidad.

### Introduction

Migration is a defining phenomenon of the contemporary world, shaping societies economically, politically, and culturally. Migrants face significant structural challenges – not only during their journey, but also in their daily lives within countries of residence, including legal barriers, labor exploitation, social exclusion, and limited access to essential services. However, migration is not solely defined by constraints; migrants also actively shape their own experiences and outcomes, demonstrating agency in navigating complex socio-political environments. This article examines the critical role of migrant associations in enhancing migrant agency and advancing social justice, providing a comprehensive analysis of how these organizations empower migrants across various domains.

To ground this discussion, the article develops a conceptual framework integrating theories of migrant agency, social justice, and migration studies. Migrant agency refers to the capacity of migrants to act independently and make choices despite the constraints imposed by legal, economic, and social structures (Glick Schiller & Çağlar, 2011; de Haas, 2014). Social justice, as articulated by Rawls (1971), Fraser (1995) and Sen (2009), involves the full respect for and realization of human rights, including rights at work, resources, and opportunities, ensuring that all individuals regardless of their migration status can participate fully in society. Migrant associations, which are grassroots or formal organizations established by and for migrants, serve as vital spaces where migrant agency is expressed and where social justice is pursued (Cordero-Guzmán, 2005; Portes et al., 2007). The state of research on migrant associations highlights their diverse functions, from service provision and advocacy to political mobilization and cultural preservation (Fennema, 2004; Lacroix, 2010).

This article explores how migrant associations enhance migrant agency and advance social justice through various mechanisms. Firstly, social and cultural empowerment is facilitated through initiatives such as language programs, cultural events, and identity preservation, which help newly arrived and longtime resident migrants navigate the local environments while maintaining ties to their heritage. Secondly, economic empowerment and labor rights advocacy play a crucial role in securing fair employment conditions, promoting entrepreneurship, and combating workplace exploitation. Thirdly, legal and political empowerment is achieved through legal aid, awareness campaigns, and political mobilization efforts that advocate for migrants' rights and policy reforms. Additionally, migrant associations contribute to social capital and community building by fostering networks that provide emotional and material support while also strengthening ties between migrant communities and host societies. Lastly, these organizations are instrumental in humanitarian support and crisis response, offering emergency aid, housing assistance, and essential services to migrants in vulnerable situations.

By analyzing the functions and impact of migrant associations, this article argues that these organizations are not only essential for the integration and well-being of migrant communities, but also serve as key actors in broader struggles for social justice. Recognizing and supporting their work is crucial in developing more inclusive and equitable societies. Through a review of existing literature and empirical case studies, this study highlights the transformative potential of migrant associations as vehicles of empowerment, solidarity, and systemic change.

### **Methodology**

This study builds upon the author's doctoral research on Andean migrant associations' engagement in both host and home countries, specifically focusing on the experiences of Bolivian, Colombian, Ecuadorian, and Peruvian migrant organizations in the Cantons of Geneva and Vaud, Switzerland.

Additional research focuses on migrant agency and social justice and migration. This article integrates primary and secondary data collection methods to examine how migrant associations enhance migrant agency and contribute to social justice.

### **PhD dissertation**

#### ***Primary Data Collection***

For the PhD dissertation, primary data was collected through a mixed-methods approach, including:

- Semi-structured interviews with twelve presidents of the 12 Andean migrant associations active in the Cantons of Geneva and Vaud in Switzerland, to gain insights into their organizational strategies, challenges, and their role in host and home countries.
- A survey distributed among members of migrant associations to gather quantitative data on their activities, perceptions, and the effectiveness of their initiatives.
- Participant observation, allowing for a deeper understanding of the associations' internal dynamics, decision-making processes, and interactions with migrant communities.



### ***Secondary Data Collection***

To contextualize and complement the primary data, a desk review of relevant literature and policy documents was conducted. This included:

- Academic publications on transnationalism and migrant associations.
- Reports from international organizations and NGOs addressing migrant associations' roles in advocacy, integration, and rights protection.
- Policy documents from Swiss authorities and international bodies to examine the institutional environment in which these associations operate.

### **Research on migrant agency and social justice**

Building on the doctoral research, additional secondary data analysis was undertaken to establish the role of migrant associations in enhancing migrant agency and advancing social justice. This involved a review of literature on migrant agency theories, social justice frameworks, and migration, allowing for a broader theoretical grounding. To illustrate the role of migrant associations in enhancing migrant agency and advancing social justice, the author draws on examples of Latin American migrant associations in Europe, the United States, and Latin America, complementing the findings of her doctoral research.

By combining qualitative and quantitative methods, this article provides a comprehensive understanding of how migrant associations function as key actors in social justice movements and migrant empowerment.

## **Conceptual Framework**

### **Migrant Agency**

Migrant agency refers to the capacity of migrants to act independently, make choices, and exert influence over their own migration experiences despite structural constraints such as legal restrictions, economic barriers, and social exclusion (Glick Schiller & Çağlar, 2009). In migration studies, agency is often discussed in relation to migrants' ability to navigate migration policies, labor markets, social networks, and integration processes (Bakewell, 2010).

Scholars distinguish between individual agency and collective agency. Individual agency refers to the strategies that migrants personally adopt to navigate and overcome obstacles, such as securing informal employment, adapting to legal systems, or cultural differences (Mahler & Pessar, 2006). Collective agency, on the other hand, emerges through social movements, migrant organizations, and transnational networks that advocate for migrants' rights and social inclusion (Faist, 2000).

Scholars such as Emirbayer & Mische (1998) highlight agency as a temporally embedded process involving past experiences, present engagement, and future-oriented aspirations. In the context of migration, De Haas (2010) argues that agency operates within structural opportunities and constraints, with migrants actively shaping their migration trajectories, settlement processes, and transnational networks.

### ***Structural Constraints***

Despite their agency, migrants operate within powerful structural constraints, including restrictive immigration laws, labor exploitation, and social discrimination (De Haas, 2010). Some scholars argue that agency is constrained by state policies that categorize migrants into hierarchical legal statuses, limiting their ability to access rights and services (Anderson, 2010).

For instance, the concept of “bounded agency” (Evans, 2007) suggests that migrants' decisions are not entirely free but are shaped by legal frameworks, economic inequalities, and social hierarchies. Migrants with precarious legal status, such as undocumented workers or asylum seekers, may exercise agency in limited ways, such as engaging in informal labor markets or creating mutual aid networks (Bloch, Sigona & Zetter, 2014). However, migrants also demonstrate strategic agency by using legal loopholes, engaging in advocacy, and mobilizing networks to challenge exclusion (Schapendonk, 2018).

### ***The Role of Social Capital and Networks***

Social networks and social capital play a crucial role in enabling migrant agency by providing access to jobs, legal support, and community resources (Portes, 1998). Migrants rely on both bonding social capital (ties within their ethnic communities) and bridging social capital (connections with broader society) to improve their socio-economic conditions (Putnam, 2000). Cederberg (2012) highlights how migrant networks can facilitate economic mobility and political participation, particularly for marginalized groups. However, excessive reliance on bonding capital within ethnic enclaves can also limit opportunities for integration into the broader society (Vermeulen, 2006).

Furthermore, transnational networks allow migrants to sustain ties with their countries of origin while negotiating new identities in host societies (Levitt & Glick Schiller, 2004). Hometown associations and diaspora organizations exemplify how migrant agency extends beyond national borders, influencing development in both countries of origin and residence (Orozco & Rouse, 2007).

### ***Migrant Agency in the Context of Social Justice and Advocacy***

Migrants exercise agency not only in individual survival strategies but also in collective struggles for social justice. Migrant-led organizations play a critical role in mobilizing communities, advocating for legal rights, and fighting discrimination (Morales & Giugni, 2011).

The role of digital agency is also gaining attention, as migrants use social media platforms to organize protests, share information, and access resources (Leurs & Prabhakar, 2018). This new dimension of migrant agency enables even those in precarious situations to engage in advocacy and resistance.

Somerville et al. (2008) argue that migrant associations contribute to political empowerment by increasing migrant participation in governance. In Switzerland, for instance, migrant-led organizations have influenced policies related to asylum-seeker protections and anti-discrimination laws (Bolzman & Fibbi, 1991). Migrant agency is exercised in multiple ways, including economic participation, political activism, and community engagement. Migrant associations are key platforms through which collective agency is mobilized, enabling migrants to advocate for rights, access resources, and participate in social and political life in both origin and host countries.

## **Social Justice and Migration**

### ***Definition of Social Justice***

Social justice refers to the respect for, protection of and realization of all human rights for all persons in society. It seeks to eliminate systemic inequalities and discrimination related to race, gender, class, nationality, and other social categories, ensuring that all individuals have access to the same opportunities and protections. Several scholars define social justice in different ways:

- John Rawls' (1971) theory of justice aims to reconcile the tension between individual liberty and social equality, advocating for a system that prioritizes fairness and emphasizing equal access to basic liberties, opportunities, and resources for all members of society, particularly those who are least advantaged in society.
- Nancy Fraser (1995) argues that social justice involves both redistribution (economic fairness) and recognition (cultural and identity-based equality).
- Amartya Sen's (1999) capabilities framework highlights the importance of individual freedoms and capabilities in achieving justice.

### ***Social Justice Principles***

Various scholars and organizations have contributed to defining the principles of social justice. Below are the key principles:

- **Human Rights and Dignity:** Social justice is fundamentally tied to the respect for, protection, promotion and realisation of all human rights, ensuring that all persons in society are treated with dignity (UN DESA, 2006). This includes the right to work, freedom of movement, and protection from discrimination.
- **Equity:** It refers to the fair distribution of resources and opportunities, taking into account historical and structural disadvantages that different groups face (Rawls, 1971). Unlike equality, which provides the same treatment for all, equity acknowledges that individuals have diverse needs and circumstances that require targeted interventions (Fraser, 1997).
- **Access:** It ensures that all individuals, regardless of their socio-economic background, migration status, or ethnicity, have the ability to utilize essential services, including education, healthcare, housing, and employment (Sen, 2009). Restricted access to these services creates systemic inequalities that hinder social justice.
- **Participation:** Social justice requires active and meaningful participation of all individuals in political, economic, and social life (Young, 1990). Migrants, for example, should have a voice in policymaking processes that affect their lives and be included in decision-making structures.
- **Diversity and Recognition:** Recognizing and valuing diversity ensures that the cultural, linguistic, and social identities of marginalized groups are acknowledged and respected (Taylor, 1992). Fraser (1997) distinguishes between redistribution and recognition, arguing that social justice must address both economic inequalities and cultural misrecognition.
- **Redistribution of Resources:** Economic justice is a core component of social justice, emphasizing the need to redistribute wealth, opportunities, and power to ensure a fairer society (Harvey, 1973; Piketty, 2014). This principle is particularly relevant in migration contexts, where migrant workers often face economic exploitation and below- living- wage disparities.
- **Accountability and Fair Governance:** Social justice requires mechanisms of accountability to ensure that governments, institutions, and corporations uphold human rights, international labour standards and fair policies and practices (Stiglitz, 2012). Transparent governance structures that involve marginalized communities in decision-making help in fostering just societies.

### ***Migration and Social Justice: A Rights-Based Approach***

Migration has been a defining aspect of human history, shaping societies, economies, and cultures worldwide (UN DESA, 2022). While migration offers opportunities for individuals and communities, it also presents significant challenges, particularly in ensuring that migrants' rights and dignity are protected. A social justice approach to migration emphasizes the need for policies that promote equity, inclusion, and human rights, regardless of a migrant's legal status (UNHCR, 2023).

Migrants often face systemic barriers that limit their access to employment, healthcare, education, and legal protection. These challenges are exacerbated by intersecting factors such as gender, race, ethnicity, and socioeconomic status (IOM, 2022). Refugees, asylum seekers, and undocumented migrants are particularly at risk of exploitation, discrimination, and exclusion from social and legal protections (MPI, 2022).

According to the International Labour Organization (ILO, 2021), migrant workers frequently experience labor market segmentation, where they are concentrated in low-wage, insecure, or informal employment sectors. Many also lack access to social security benefits, making them vulnerable to economic shocks. In addition, migrants face significant healthcare disparities, with many unable to access adequate medical services due to their legal status or financial barriers (WHO, 2022).

### ***The Role of Social Justice in Migration Policy***

A social justice framework seeks to address these inequalities by advocating for policies that uphold human dignity and rights. Right-based migration policies should:

- **Ensure Legal Protections and Respect for Human Rights:** Migrants, regardless of their status, asylum seekers and refugees must have access to legal pathways for residency and protection from exploitation. Asylum seekers must have access to fair asylum procedures (UNHCR, 2023).
- **Promote Economic Justice:** Migrant workers deserve fair wages, safe working conditions, and equal access to labor and social protections (ILO, 2019).
- **Guarantee Access to Essential Services:** Healthcare, education, and housing should be accessible to migrants, regardless of immigration status (WHO, 2022).
- **Combat Xenophobia and Discrimination:** Anti-migrant narratives contribute to exclusion and violence. Governments and civil society must work to foster inclusive and rights-based policies (MPI, 2022).

### ***Gender, Migration, and Social Justice***

Gender plays a critical role in shaping migration experiences. Women and marginalized gender groups face additional risks, including gender-based violence, labor exploitation, and limited access to reproductive healthcare (UN Women, 2019). The International Organization for Migration (IOM, 2023) highlights that women migrant workers, especially domestic workers, often face abusive working conditions and lack legal protections, making them more vulnerable to exploitation.

A gender-responsive approach to migration policy is essential. The ILO Convention No. 189 on Decent Work for Domestic Workers (ILO, 2019) sets international labor standards to protect migrant domestic workers, emphasizing fair wages and safe working conditions. Similarly, the Global Migration Data Analysis Centre (GMDAC, 2023) stresses the need for gender-sensitive migration policies that address the unique challenges faced by migrant women, including access to healthcare, child protection, and legal assistance.

### ***Global Responsibility and Human Rights***

Migration governance must align with international normative human rights frameworks, in particular the three international 'migration governance' conventions: the International Convention on the Protection of the Rights of All Migrants Workers and Members of Their Families (ICRMW), and ILO Convention 97 on migration for employment and ILO Convention 143 on migrant workers. The ILO international labor standards apply to all migrant workers and should be incorporated in national law to uphold decent work for all workers.

Governments, international organizations, and civil society must collaborate to uphold the adoption and domestication of international conventions on the rights of all migrants/migrant workers. In this regard, migrant associations have a role to play as advocates for rights-based policies, holding governments accountable and ensuring that migrants' voices are heard in policy dialogues. Through representation and empowerment, they help migrants understand and claim their rights, fostering active civic participation. Furthermore, by building solidarity across transnational networks and forging alliances with labor unions and civil society, they strengthen collective action toward better migration governance and social justice.

The Population Division of the United Nations Department of Economic and Social Affairs (UN DESA, 2025) reports that in 2024, the global number of international migrants was 304 million and female migrants constituted 48 per cent of this population. Addressing migration through a rights-based approach requires long-term commitments to humanitarian protection, economic integration, and anti-discrimination measures.

A socially just migration framework acknowledges migrants' dignity and contributions while addressing systemic inequalities. It requires inclusive policies, international cooperation, and a shift away from restrictive and punitive migration laws toward rights-based, humane solutions. Migration should be recognized as a driver of development and social progress, benefiting both migrants and the communities that host them (World Bank, 2022).

### **State of the Art on Migrant Associations<sup>1</sup>**

The study of migrant organizations, including associations, is complex due to the multiple elements involved and the absence of an agreed-upon definition of this phenomenon. Some scholars focus on the definition and the role of a migrant association (Fennema, 2004; Moya 2005; Schrover and Vermeulen, 2005; Cordero, 2005), others focus on the migrant organizing process (Cordero, 2005; Lacroix, 2010; Vermeulen, 2006), and yet others combine the phenomenon with the study of social capital and networks (Cederberg, 2012; Eggert & Pilati, 2014; Fennema, 2004;) or with the political opportunity structure (Bolzman & Fibbi, 1991; Danase, 2001; Fennema & Tillie 1999; Jacob & Tillie 2004, Hooghe, 2005, Morales & Giugni, 2011; Tackle, 2013). Other scholars concentrate on the complementary nature of migrant organizations' activities in both origin and destination countries (Portes *et al.*, 2007), their active role on integration (Portes *et al.*, 2007; Somerville *et al.*, 2008) or on development (Fox & Bada, 2009, Lacroix 2010, Lacroix, 2016; Orozco & Garcia, 2009, Orozco & Rouse, 2007).

Another complexity is the diverse terms used to describe migrant organizations, such as ethnic organization (Fennema, 2004; Hoogue, 2005), migrant community base organization (Cordero-Guzman, 2005), hometown association (commonly used in the US, e.g. Lacroix 2010; Orozco & Garcia, 2009; Orozco & Rouse, 2007; Somerville *et al.*, 2008), and migrant

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<sup>1</sup> This section is an extract of the author's PhD dissertation on Andean migrant associations' host and home country engagement. Lessons from the Cantons of Geneva and Vaud, Switzerland, University of Geneva.

association, indistinctly of organization type<sup>2</sup> (Camozzi, 2011; Caponio, 2005; Cattacin & La Barba, 2007; Moya, 2005; Vermeulen, 2006).

### ***Defining migrant associations***

It is important to recognize that migrant associations are one form of migrant organizations, which can take many forms, and often coexist in a given society (Breton, 1964; Moya, 2005; Sardinha, 2009; Vermeulen, 2006). Examples include credit and business associations, mutual benefit societies, religious, sport, educational, dance, gastronomy and recreational groups, hometown and women's associations, student organizations, solidarity and political and advocacy groups. There are also migrant organizations established by migrants and those established for migrants (Vermeulen, 2006). This study focuses on migrant associations, defined by Fennema (2004) as those migrant organizations with affiliates or members.

Schrover and Vermeulen (2005), as well as Moya (2005), question the extent to which an organization can be labelled as a migrant association. Is it because its members are migrants, or because most of them are descendants of migrants? Does it refer to associations established by first-generation migrants with mixed membership, or those founded by natives but with mostly migrant membership? Such a line of questioning leads to the fundamental question of when a migrant association should no longer be classified as a "migrant" association, but rather convert to an organization of some other label, such as an ethnic association. Does it depend on whether they are founded or managed by second or third generation-migrants? These are complex considerations, and, as reflected in the previous section, there is no consensus on a precise definition by scholars working in this area.

Given the characteristics of the target group and focus of this study, *migrant associations are defined as membership organizations formed by individuals from the same country of origin with the aim to provide social services mostly to migrants from the same or similar migrant group* (Cordero-Guzman, 2005, Somerville *et al.*, 2008). They explicitly integrate ethnic or national origin identity and cultural components into their mission, activities, and services (Cordero-Guzman, 2005).

### ***Factors stimulating the formation of migrant associations***

Factors related to the migrant group, as well as the host society, influence and stimulate the formation of migrant associations (Cordero-Guzman, 2005, Vermeulen<sup>3</sup>, 2006). According to Vermeulen (2006), the migration process shapes the collective identity of migrant groups, which raises the demand for migrant associations, or contributes to disruption in migrants' lives that increases the demand for a safe environment which, in turn, increases the demand for migrant associations. Other key considerations that influence the migrant organizing process include the specific characteristics of the migrant population, such as their size, demographic composition, socioeconomic status and cultural attributes. The active or passive attitude towards migrant associations by countries of origin can also influence the formation of migrant associations.

<sup>2</sup> Credit and business associations, mutual benefit societies, religious, sport, educational and recreational groups, hometown and women associations, student organizations, solidarity institutions and political and advocacy groups (Breton, 1964; Moya 2005; Vermeulen, 2006; Sardinha, 2009).

<sup>3</sup> The author researched and documented the structural determinants of the migration organizing process comparing three migrant groups in two different cities (Turks in Amsterdam, Turks in Berlin and Surinamese in Amsterdam) and provided evidence of the influence of migrant group, host society and internal dynamics within groups of organizations in the migrant organizing process.

According to Vermeulen (2006), several factors play a role in the host society in the migrant organizing process. For instance, the economic opportunity structure can impact the labour position of migrants at the local level, motivating them to organize and establish migrant associations, or to join existing ones. Similarly, migrant accessibility to institutions such as churches, labour unions and welfare organizations can affect the formation of migrant associations: If migrants have easy access to these organizations and their services, the need to create a migrant association declines. Finally, scholars identify the political opportunity structure, or official stance authorities have towards migrants and their organizations, as a critical factor (Danase, 2001; Hooghe, 2005; Morales & Giugni, 2011; Schrover & Vermeulen, 2005; Tackle, 2013; Vermeulen, 2006).

### ***Key characteristics of migrant associations***

Migrant associations play a key role in providing a space (not necessarily physical) for people from the same ethnic or national origin to gather, play, dance and reminisce (Moya, 2005), constituting a key source for socialization, conviviality, mutual aid and identity renewal. They also assist with the migrant process, contributing to the socio-economic integration of migrants into the host society by providing a diversity of social services and community programmes, including advocating for their ethnic groups needs and concerns and representing them in host society political and policy processes, while promoting and preserving connections between migrant communities in the host country and their country of origin and vice versa (Cordero-Guzman, 2005; Moya, 2005; Odmalm, 2004).

Migrant associations frequently replace support systems traditionally provided by the family and the community migrants left behind, and provide a space for membership recreation, capacity development and awareness raising of their rights (Castillo & Obadiaru, 2012). They help migrants to unite and adapt to the often-complicated living conditions in the host society, supporting them to exercise their 'voice' in their host country as well as their 'loyalty' for their countries of origin (Lamba-Nieves, 2018). Migrant associations can be large and well-established, small and ephemeral, more or less formally structured, with very specific objectives, such as promoting the integration of migrant women in the labor market in a particular city, or with relatively broader objectives, such as promoting the culture of a particular country in the host society.

As such, it is evident that migrant associations have a diverse character. It is also important to recognize that they are dynamic, and these characteristics can change over time (Lamba-Nieves, 2018; Schrover and Vermeulen, 2005). For instance, objectives and their specificity can evolve, as can the formality of the associations' structure and processes.

Developing and managing an association is time-consuming and requires that some members invest substantial time in planning and implementing activities and events, fundraising, and networking with other migrant associations, civil organizations and/or public authorities. Association board members and other volunteers often work beyond normal working hours, after their regular jobs elsewhere. Their involvement is usually without financial compensation, unless the association has developed a stable structure and financial solvency (Castillo & Obadiaru, 2012; Matthey & Stainer, 2009).

Migrant associations normally have limited financial means, with funds generated primarily through activities, donations or membership fees, and sometimes, public

contributions. They also have time limitations, as most active members in charge of managing the association and organizing activities are volunteers, providing in-kind service.<sup>4</sup>

### ***Tensions within and between migrant associations and with civic organizations and authorities***

Tensions and conflicts within and between migrant associations are not uncommon, and similar challenges often arise between these associations and other civil society organizations or authorities. Tension within migrant associations is largely due to power struggles or differences regarding decisions over associations' objectives and activities (Cammozi, 2011) and between migrant associations or with other civic organizations as a result of competition for support from a target population and funding available (Fennema & Tillie, 1999; Odmalm, 2004; Sardinha, 2009; Schover & Vermeulen, 2005; Vermeulen, 2006). Tension between migrant associations and authorities results from migrant mistrust of host country institutions, when political participation and representation to consultative bodies do not give real power to migrant associations, or when migrant associations' citizen engagement performs unpaid tasks that should be the responsibility of local authorities (Mantovan, 2013<sup>5</sup>, Moret & Dahinden, 2009, Vermeulen, 2006). While these sources of tension vary, they are nevertheless important factors to consider for the functioning of migrant associations.

### ***Migrant associations' role on integration: Their commitments and practices in the host society***

Migrant associations play a central role in the settlement process and the integration of migrants into the host society in a several ways, including: membership and services provided to members and others (Kindler *et al.*, 2015); the socialization of migrants in the host society; provision of advice and related support for employment and housing (socio-economic integration); introducing cultural practices specific to the host country (cultural integration); the dissemination of relevant information in relation to migrant rights, and the provision of services for migrants and the institutions that offer those services (political integration).

At the same time, migrant associations facilitate potential active citizenship in the host society through engaged participation within the association, provide networking opportunities with community organizations, and act as a point of contact and coordination between migrants, local government and other institutions (Somerville, Durana, Terrazas, 2008). As Shrover and Vermeulen (2005) point out, even when associations are not notable in activity and influence, they are still relevant for understanding migration and integration processes.

While some scholars (and policymakers) support the positive influence migrant associations have on integration, others claim that migrant associations can hinder the development of personal relationships with host country natives and retard the process of integration<sup>6</sup> given that they are established along ethnic lines (Sardinha, 2009).

Putnam's distinction between bonding and bridging social capital is helpful when considering the dichotomy between positive or negative influences of migrant association on integration (Putnam, 2000). Basically, bonding capital brings together people who are alike, such as family, friends and where 'strong ties' are present Whereas bridging capital brings together people who are different from each other, such as distinct social or ethnic groups, where the ties between them are weak (Kindler, 2015). If the migrant association is a vector of bonding capital exclusively, it might hinder the integration process of its members, isolating

<sup>4</sup> "In kind" refers to goods, services, and transactions not involving money or not measured in monetary terms.

<sup>5</sup> Mantovan, "Cohesion without Participation: Immigration and Migrants' Associations in Italy."

<sup>6</sup> Sardinha uses the term "cultural adaptation."



them from the host society. On the other hand, if the association is a vector of bridging capital, it can support the integration process of its members.

Even more influential than a migrant association's type and degree of social capital, is the degree of support from host societies to migrant associations. According to Schrover and Vermeulen, (2005), in contexts where migrants are seen as 'foreign temporarily residents' and state policy limits its role in integration to legal procedures, migrant association activities are often unwelcome or even perceived as threatening, and consequently banned or strongly controlled. In contrast, in societies that are more receptive and open - 'migrant societies' - migrants are approached as citizens with easier access to nationality, and migrant associations' activities are regarded as helpful in the integration process and very often funded.

As Cordero-Guzman (2005) points out, one of the key challenges for migrant associations is to achieve both the process of integration while at the same time, recognising and preserving their cultural practices. However, migrant associations do not see any contradiction in simultaneously assisting their members with the process of integration in the host society and also preserving the cultural and ethnic identities associated with customs, ethics, traditions and norms. This dual task makes them rather dynamic because they need to integrate and adjust themselves to new cultural practices brought in by new members, and further adhere to the requirements and pressures from the changing environment where they operate.

### ***Migrant associations' homeland engagements: Their commitments and practices in countries of origin***

Most migrant associations are in contact with their countries of origin either sporadically or on a more regular and structured basis. According to Van Ewijk & Nijenhui (2016), they can play a variety of roles such as intermediaries between home and host societies: for lifecycle events, such as marriage, child birth, and funerals; for payments of community taxes back home; for political activism, undertaking advocacy work, affiliating with a political party or participating in political elections; as a charity organization, raising resources to support a specific projects; as professional development organization, carrying out development projects, such as providing short-term aid in the form of disaster relief or through government matching-funds programmes (Munoz & Collazo, 2014); or by stimulating development through knowledge networks, sharing and transfer through highly skilled migrants (Meyer, 2007).

When migrant associations focus on contributing to development in their countries of origin, they usually pool together resources to be invested in basic infrastructure and communication projects. These funds transferred to countries of origin are known as 'collective remittances', and while they are low in number in comparison to individual remittances, they nevertheless are an important source of aid with the potential to impact the quality of life of a wider population than individual recipients of remittances (Orozco, Garcia-Zanello, 2009). It is worth noting that this kind of collective initiatives not only focus on the financial support, but also on collective social remittances which "are exchanged by individuals in their role as organisational members and are used in organisational settings such as hometown associations, church groups or political parties" (Levitt and Lamba-Nieves, 2011, p. 13).

In order to increase the impact and sustainability of development projects and programmes, migrant associations often establish partnerships with governmental and non-governmental organizations, or the private sector (Haas *et al.*, 2009), as well as with local informal and formal counterparts, such as family members, local civic society organizations

(e.g. NGOs), or even an organization established by the migrant association, specifically for project implementation (Van Ewijk & Nijenhui, 2016). The engagement with migrants and their associations for development has become an important strategy of many countries of origin. However, as De Haas (2006) points out, it is important for those states, as well as engaging development agencies and other partnering development actors, to create durable alliances with migrant associations. This includes such elements as a joint agenda or strategy to address shared priorities; collaboration with their existing initiatives and joint investment schemes for social and economic projects; strengthening networks and knowledge sharing; providing capacity building and technical assistance for community development and advocacy for human rights, and legal support for justice for community members.

According to Faist and Fauser (2011), the potential of this strategy lies in the role of migrants through migrant associations, their transnational practices and networks, in addition to the NGO's support. However, this potential development role of migrant associations is not without risk because scaling up their role and responsibilities could be 'overwhelming and counterproductive' and undermine their capacity for empowerment. Related, migrant associations often face organizational restraints or weakness (Delgado Wise, 2014) and can be perceived by development agencies and states as mere operators and not as participants in the design and decision-making process (Lacomba & Escala Rabadan, 2013). They support themselves with interventions, but it can be hard to support migrant associations' work with local communities without the local community's ownership towards the proposed projects (Orozco, Garcia-Zanello, 2009). There can also be harmful competition between migrant and non-migrant groups (Lamba-Nieves, 2018). In addition, migrant associations' projects can also be constrained by restrictive migration policies and conditioned international cooperation aiming at controlling migrants' flows (Faist & Fauser, 2011).

Nevertheless, the dual 'presence' of migrant associations in both origin and destination societies gives them a privileged position as they know both realities; while this is not a guarantee for success, it does offer potential for development partnerships if collaboration and implementation are well planned, monitored, and evaluated, with shared responsibility and local ownership.

### **Migrant Associations: Enhancing Migrant Agency and Advancing Social Justice**

Migrant associations play a crucial role in empowering migrants and advancing social justice by offering information or referral for essential services, facilitating integration, advocating for their rights, and fostering social and political participation. Their efforts contribute to strengthening migrant agency, ensuring socio-economic and social inclusion, and improving access to legal protections. Below are the main ways in which migrant associations contribute to enhancing migrant agency and advancing social justice:

#### **Social and Cultural Empowerment**

Migrant associations serve as spaces where migrants can maintain their cultural identity while integrating into the host society. These organizations offer language courses, cultural events, and social activities that help migrants navigate their new environment while preserving their heritage (Cordero-Guzmán, 2005; Kindler et al., 2015). By fostering a sense of belonging, they strengthen the psychological well-being of migrants, reducing isolation and marginalization (Portes et al., 2007). These migrant-led organizations also address social justice by advocating for housing rights and access to social services. Migrants often face barriers to housing and healthcare (Eggert & Pilati, 2014).

The social and cultural empowerment role played by migrant associations can be analyzed in the following key areas:

- **Cultural identity preservation, community building:** Migrant associations provide a sense of belonging and solidarity, helping migrants connect with others from similar backgrounds. These organizations help migrants maintain and celebrate their cultural identity while also promoting intercultural exchange with the host society. This support network reduces isolation and strengthens social cohesion.
- **Access to information and referral for services:** Migrant associations provide vital information about local laws, customs and opportunities, helping migrants navigate their new environments effectively. They often facilitate referrals to essential services such as health, housing, education, and employment.
- **Support for undocumented migrants:** Associations often assist undocumented migrants by providing legal aid, emergency housing, and employment support.

In the UK, the Latin American Women's Rights Service (LAWRS), an organization that supports Latin American migrant women, many of whom work in precarious, low-wage jobs as cleaners, nannies, or in the hospitality sector, and empowers migrant women by providing safe spaces for gender-based violence survivors, offering language courses, and supporting cultural initiatives. Similarly, in Switzerland, Colombia Vive, a cultural and solidarity-focused association based in Lausanne, Switzerland, promotes Colombian culture and fosters social connections within the Colombian community residing in Switzerland and enhances cultural exchange while advocating for better integration policies for Colombian migrants. Also in Switzerland, Asociación Bolivia 9 and Asociación Cultural Peru, aim to valorise the identity, traditions and culture of their respective country of origin and favour their members' integration process. These associations also support migrants in vulnerable situations by facilitating referrals to relevant authorities or civil society organizations that can provide the necessary services and assistance.

### **Economic Empowerment and Labour Rights Advocacy**

Many migrant associations focus on labor rights advocacy, job training, and economic self-sufficiency. Migrants, especially those in precarious jobs, face exploitation, wage theft, poor working conditions, and high risks to occupational safety and health. These migrant-led organizations also address economic inequalities by advocating for fair labor conditions as migrants often face discrimination in the labor market and exploitation by employers (Eggert & Pilati, 2014).

Research by Eggert and Pilati (2014) highlights that migrant associations often act as intermediaries between workers and employers, helping to establish fair employment conditions. Fennema and Tillie (1999) further argue that associations contribute to migrant economic mobility by creating job networks and skill development programs, increasing their employability in host societies.

Migrant associations' economic empowerment and labour rights advocacy role can be analyzed in the following key areas:

- **Employment support and skills development:** Migrant associations offer job training, career counselling and entrepreneurship programs that enhance employability.

- **Microfinance and business support:** Some associations provide financial assistance, microloans, or business development programs to help migrants start and sustain businesses.
- **Labor rights and fair wages:** Many migrant associations advocate for fair working conditions, protection against labor exploitation, and access to job opportunities for migrants.

In Spain, the Asociación Rumiñahui Hispano-Ecuatoriana, an organization aiming to promote the integration of Latin American migrants in Spain and defend their rights, provides legal assistance on immigration and employment issues, offers training programs to improve employability and professional skills. Similarly, in the UK, the Latin American Women's Rights Service (LAWRS) runs employment workshops to help women gain financial independence, as they often face exploitation, gender-based violence and immigration challenges. In Chile, Asociación de Emprendedores Migrantes (ASEM), an organization founded by and for migrants, promotes the economic inclusion of migrant communities through entrepreneurship, facilitating access to small loans and financial resources, offering workshops, mentoring and capacity building programmes focused on business development, financial literacy and digital marketing.

### **Legal and Political Empowerment**

Migrant associations play an essential role in advocating for migrants' legal rights and increasing their political participation. Many associations provide legal aid, guidance on immigration processes (Somerville et al., 2008). These migrant-led organizations serve as key actors in advocating for policy changes and challenging discriminatory laws. By mobilizing communities and engaging in political activism and civic life, these organizations help shape migration policies and legal frameworks that uphold human rights (Morales & Giugni, 2011).

Morales and Giugni (2011) argue that migrant associations contribute to social justice by bridging the gap between migrant communities and political institutions. In societies that embrace multiculturalism and migrant participation, associations serve as mediators, ensuring that migrant perspectives are included in policy-making processes. According to Schrover and Vermeulen (2005), the extent to which migrant associations can influence legal and political frameworks depends on the political opportunity structure of the host country. In countries where migrant organizations are recognized as legitimate political actors, they are more effective in advancing legal protections for migrants.

Migrant associations' legal and political empowerment role can be analyzed in the following key areas:

- **Legal assistance, protection and human rights advocacy:** Many associations provide legal aid services to help migrants with residency, work permits, asylum applications, and other legal matters. They also work to defend migrants' rights, influence migration policies, and challenge discriminatory practices, xenophobia and human rights violations.
- **Empowering migrants as civic and political actors:** Migrant associations encourage political engagement by supporting migrants' voting rights, representation in local governments, and participation in decision-making processes.
- **Grassroots mobilization:** Many migrant associations organize protests, petitions, and community-led initiatives to push for more inclusive policies.

In the United States, Alianza Americas, a network of Latin American and Caribbean migrant-led organizations works to influence immigration policies while providing legal workshops to undocumented migrants. For instance, one notable example is their advocacy for the expansion of Temporary Protected Status (TPS) designations in the US. In January 2021, Alianza Americas, alongside other organizations, met with U.S. Representative Darren Soto (D-FL) and Senator Tim Kaine (D-VA) to discuss expanding TPS for individuals from countries experiencing crises, such as Haiti, Guatemala, Honduras, El Salvador, Nicaragua, Colombia, and Ecuador. This advocacy contributed to policy discussions and decisions regarding TPS designations. The network organization has developed the toolkit “Know Your Rights”, elaborated by its member organizations and allies in their fight for migrant rights to help keep their communities informed and protected.

### **Social Capital, Community Building and Solidarity**

Migrant associations also empower individuals by creating strong community networks that facilitate both bonding and bridging social capital (Putnam, 2000). Cederberg (2012) highlights the role of migrant associations in creating both bonding and bridging social capital. Bonding capital strengthens internal community ties, while bridging capital fosters connections with the wider society, facilitating integration and reducing discrimination. Migrant associations that successfully engage in both forms of capital-building contribute to social cohesion and justice.

Migrant associations contribute to social justice by fostering community solidarity and mutual aid, which are essential for reducing marginalization and exclusion. Through networks of support, migrants gain access to resources, information, and protection against discrimination (Putnam, 2000). A study by Kindler et al. (2015) emphasizes that associations that engage in bridging capital activities—such as policy advocacy, intercultural dialogue, and networking with local institutions—are more effective in supporting long-term integration and empowerment.

Migrant associations’ social capital, community building and solidarity role can be analyzed in the following key areas:

- Bridging migrant and host communities: Migrant associations foster dialogue and cooperation between migrants and local populations, reducing stereotypes and promoting mutual understanding while fostering their integration.
- Collaboration with relevant actors: They serve as intermediaries between migrants and government agencies, NGOs, and other support networks.

In Switzerland, the Asociación Colombia Vive play a bridge role between the Colombian and other Latin American migrants and the Swiss society, providing information to their members about how to navigate the Swiss administrative, cultural, political and economic realities. In Spain, Fedelatina, a federation of Latin American migrant associations, promotes equal rights through policy advocacy, anti-discrimination initiatives, and cultural programs that foster integration into Spanish society. In addition, it facilitates collaboration between migrant communities and Spanish institutions to improve access to education, healthcare, and legal rights.

### **Humanitarian support and crisis response**

During crises, migrant associations play a vital role in providing humanitarian aid, ensuring that vulnerable migrants receive the necessary support to survive and rebuild their lives. Their efforts are particularly important in contexts where state support is inadequate or

inaccessible to migrants (Lacroix, 2016). During the COVID-19 pandemic, many migrant-led organizations stepped up to provide food aid, medical services, and financial assistance to undocumented migrants who were excluded from government support programs.

According to Sardinha (2009), migrant associations that engage in humanitarian work not only address immediate needs but also contribute to long-term social justice by advocating for systemic changes that protect vulnerable populations.

Migrant associations' humanitarian support and crisis response roles can be analyzed in the following key areas:

- **Emergency relief and assistance:** Migrant associations play a critical role during crises (e.g., natural disasters, economic downturns, or public health emergencies) by providing food aid, shelter, and medical support to vulnerable migrant populations.
- **Mental health and well-being:** Many associations offer counseling, community support groups, and wellness programs to help migrants cope with trauma, discrimination, and social isolation.

In Spain, the *Asociación Por Ti Mujer*—a non-profit organization based in Valencia—works to address the structural barriers that limit the full citizenship and rights of migrant women, particularly those who are survivors of gender-based violence or at risk of psychosocial exclusion. During the COVID-19 pandemic, the organization provided crucial mental health support to migrant women, helping them navigate heightened vulnerabilities during the crisis. (Tutistar, Muñoz. & Polo, 2022)

### **Conclusions**

Migrant associations play a pivotal role in enhancing migrant agency and advancing social justice. By fostering social inclusion, advocating for human and labor rights, providing legal assistance, and facilitating political participation, these organizations empower migrants to navigate structural barriers and claim their rights. Their efforts not only mitigate economic vulnerabilities, legal insecurities, and social exclusion but also contribute to the broader goal of building more equitable and inclusive societies.

Beyond individual empowerment, migrant associations drive systemic change by aligning their advocacy efforts with key social justice principles, including non-discrimination, equality of treatment, equity, recognition, and participation. Rather than functioning solely as service providers, these organizations enable migrants to become active agents in shaping their communities. Through education programs, employment support, and legal aid, they enhance migrants' capabilities and facilitate their full participation in society. Moreover, by challenging discriminatory policies and practices, migrant associations promote greater equity and inclusion within host communities.

The study of migrant associations is inherently multifaceted, encompassing their contributions to integration, social capital formation, and transnational engagement. As catalysts for both individual and collective empowerment, these organizations strengthen social networks, preserve cultural heritage, and foster solidarity among migrant communities. However, their ability to sustain and expand their initiatives is often constrained by limited funding and institutional support, which presents a significant challenge to their long-term impact.

Despite these challenges, migrant associations remain fundamental in advocating for migrants' rights and supporting their integration into host societies. Their work underscores the need for policy frameworks that recognize and collaborate with migrant-led organizations to ensure more inclusive and just societies. As migration continues to shape global landscapes, the role of migrant associations in empowering individuals, fostering social cohesion, and driving systemic change will remain indispensable.

Future research should further examine the innovative strategies that migrant associations employ to navigate financial and institutional constraints, as well as explore how these organizations can enhance their impact across diverse sociopolitical contexts. Ultimately, migrant associations are not only vital for enhancing migrant agency but also for advancing broader struggles for social justice, equity, and human rights.

### Acknowledgements

The author sincerely appreciates Global Migration Policy Associates (GMPA) for the invitation to contribute to this RTE special section on social justice. A special thanks to Patrick Taran, GMPA President, for his invaluable insights and our enriching conversations on the significance of this topic.

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## Addressing the Challenges of Female Migrant Workers Through the Concept of Social Justice

### Abordaje de los retos de las trabajadoras migrantes a través del concepto de Justicia Social

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Sent: 2025/01/22

Accepted: 2025/04/24

Published: 2025/06/30

#### Abstract

This study examines the experiences of female migrant workers through the lens of social justice, analyzing the systemic barriers that hinder their inclusion and equitable treatment in global labor markets. These workers are disproportionately concentrated in low-wage, insecure, and informal employment sectors, where they face intersecting challenges such as gender discrimination, economic exploitation, racial inequality, and limited access to labor rights. These structural injustices not only marginalize female migrant workers but also perpetuate cycles of exclusion and inequality. Adopting an interdisciplinary and intersectional approach, this article emphasizes the need to expand social justice frameworks beyond economic redistribution to incorporate cultural recognition and political inclusion. It argues that addressing these multidimensional inequalities requires targeted policy interventions and inclusive labor systems that reflect the lived realities of migrant women. By integrating global and local perspectives, the study highlights the importance of fostering equitable opportunities and strengthening protections for female migrant workers, and challenging broader societal hierarchies that reinforce exclusion. Ultimately, this research contributes to the ongoing discourse on migration and social justice by offering actionable insights into the structural reforms needed to empower female migrant workers and reduce global inequalities. The findings advocate for a comprehensive approach that prioritizes human rights, promotes

**Summary:** Introduction, What is Social Justice, Migration and Gender, Conceptualizing Women Migrant Workers in the Framework of Social Justice, Conclusions.

**How to cite:** Düzgün, E. (2025). Addressing the Challenges of Female Migrant Workers Through the Concept of Social Justice. *Revista Tecnológica - Espol*, 37(1), 156-173.  
<https://rte.espol.edu.ec/index.php/tecnologica/article/view/1276>

fairness and dignity, and dismantles the systemic injustices that continue to place this group at risk of exclusion.

**Keywords:** Female migrant workers, gender, migration, labor market inequalities, social justice.

### Resumen

Este estudio examina las experiencias de las trabajadoras migrantes desde la perspectiva de la justicia social, analizando las barreras sistémicas que dificultan su inclusión y su trato equitativo en los mercados laborales globales. Estas trabajadoras están desproporcionadamente representadas en sectores de empleo de bajos salarios, precarios e informales, donde enfrentan desafíos interseccionales como la discriminación de género, la explotación económica, la desigualdad racial y el acceso limitado a los derechos laborales. Estas injusticias estructurales no solo marginan a las trabajadoras migrantes, sino que también perpetúan ciclos de exclusión y desigualdad. Adoptando un enfoque interdisciplinario e interseccional, este artículo enfatizó la necesidad de ampliar los marcos de justicia social más allá de la redistribución económica para incluir el reconocimiento cultural y la inclusión política. Sostiene que abordar estas desigualdades multidimensionales requiere intervenciones políticas específicas y sistemas laborales inclusivos que reflejen las realidades vividas por las mujeres migrantes. Al integrar perspectivas globales y locales, el estudio destacó la importancia de fomentar oportunidades equitativas y fortalecer las protecciones para las trabajadoras migrantes, al tiempo que aborda las jerarquías sociales más amplias que refuerzan la exclusión. En última instancia, esta investigación contribuyó al discurso en curso sobre migración y justicia social al ofrecer perspectivas prácticas sobre las reformas estructurales necesarias para empoderar a las trabajadoras migrantes y reducir las desigualdades globales. Los hallazgos abogan por un enfoque integral que priorice los derechos humanos, promueva la equidad y la dignidad, y desmantele las injusticias sistémicas que continúan poniendo a este grupo en riesgo de exclusión.

**Palabras clave:** trabajadoras migrantes, género, migración, desigualdades en el mercado laboral, justicia social.

### Introduction

Unlike broader notions of justice, *social justice* is a relatively modern concept that emerged during the Industrial Revolution, influenced by socialist, social democratic, and Christian democratic views on societal organization. It has weak foundations in Anglo-Saxon political thought and is notably absent from major international instruments, including the UN Charter, the Universal Declaration of Human Rights (UDHR), and the two core human rights covenants—the International Covenant on Civil and Political Rights (ICCPR) and the International Covenant on Economic, Social and Cultural Rights (ICESCR), both adopted in 1966. Although frequently referenced in the 1995 Copenhagen Declaration and Program of Action, it received little attention in the 2000 UN Millennium Declaration (United Nations, 2006, p. 2). It is not explicitly mentioned in the 2030 Agenda or its 17 Sustainable Development Goals (SDGs) (United Nations, 2015). Nevertheless, it is widely recognized that social justice is embedded across the Goals as a cross-cutting principle. This underscores the pressing need to integrate social justice more deeply and directly into global frameworks to effectively combat persistent inequalities and promote equitable opportunities for all.

As a conceptual framework, social justice offers critical tools for understanding and addressing these inequalities. However, its definition remains deeply contextual, shaped by

historical, cultural, and political circumstances. Its origins can be traced to ancient religious traditions, where social justice principles appear in the Judaic Old Testament, Christian writings, the Quran, and other religious philosophies, with early formulations dating back as far as 3,000 years (Thakur, 1996, pp. 29–41). These traditions articulated core principles of fairness, dignity, and collective well-being, laying the ethical groundwork for later philosophical and theoretical developments. These foundational principles shaped the evolution of modern justice theories, particularly those addressing redistribution and equity. Building on this legacy, early modern perspectives, such as John Rawls' (1971) theory of justice as fairness, prioritized economic redistribution as the foundation of justice. While this approach established a robust theoretical basis for addressing economic inequalities, it fails to fully address the multifaceted realities of marginalized groups, particularly female migrant workers. Contemporary theories, including those advanced by Nancy Fraser (2003), expand the scope of social justice to encompass cultural recognition, political participation, and the dismantling of institutionalized oppression. These multidimensional frameworks are essential for analyzing the intersections of migration, gender, and labor, providing deeper insights into the structural barriers that perpetuate inequality.

Migration and social justice are deeply interconnected, reflecting broader dynamics of economic inequality, cultural hierarchies, and political representation within society. As migration has become increasingly recognized as a global phenomenon, it has transformed economies, redefined borders, and generated extensive debates on integration, displacement, and the systemic challenges faced by marginalized populations. Female migrant workers face particular vulnerabilities, disproportionately concentrated in low-wage and informal sectors where they encounter intersecting injustices shaped by gender discrimination, economic exploitation, and racial bias (Hamilton-Jiang et al., 2022, pp. 2-5). Their experiences reveal persistent structural inequities in global labor systems.

This study seeks to examine the challenges faced by female migrant workers through the lens of social justice, drawing on Fraser's theoretical contributions and broader feminist perspectives. Focusing on key barriers, including economic marginalization, restricted labor rights, and political exclusion, the research develops a comprehensive framework for redefining and implementing social justice principles to empower this vulnerable population. By centering migrant women's experiences within contemporary social justice discourse, the study argues that meaningful progress in this field requires a multidimensional and intersectional approach.

This study adopts a conceptual methodology grounded in theoretical analysis of scholarly literature, international legal frameworks, and institutional reports to illustrate this approach. By integrating economic, cultural, and political dimensions, the analysis highlights the importance of comprehensive frameworks that address material inequalities (such as unequal pay, limited access to social protection, and exploitative working conditions) while advancing recognition and representation. This dual focus contributes to the ongoing debate on migration and social justice and offers concrete policy interventions for fostering equity in today's interconnected world. These include ratifying ILO Convention C-189 to improve working conditions for domestic workers (ILO, 2011) and including migrant women's voices in national policy processes, as highlighted in the UN Women's Report on racially marginalized migrant women (Hamilton-Jiang et al., 2022).

### **What is Social Justice?**

Social justice, a concept frequently encountered worldwide, lacks a universally accepted definition. This absence of conception has endowed it with a flexible structure,

enabling its adoption across diverse political discourses. Consequently, social justice can be examined at various levels of political discourse and interpreted from different perspectives, further complicating attempts to establish a universally understood definition. Nevertheless, the normative roots of social justice can be traced back to political philosophy. Other disciplines, such as sociology, social psychology, law, legal studies, and human geography, have significantly contributed to both its theoretical development and the identification of its core components (Khechen, 2013, p. 1).

The origins of the term *justice* in Western civilization can be traced back to the Judeo-Christian religious tradition. Politically and philosophically, the concept of *justice* is prominently featured in Classical Greek philosophy, particularly in Aristotle's *Nicomachean Ethics* (Crisp, 2014) and Plato's *The Republic* (Reeve, 2004). These works later became foundational texts for the development of the social sciences and philosophy. Thinkers such as Karl Marx, Thomas Hobbes, and John Stuart Mill subsequently expanded on the concept, exploring the requirements for a just society (Sabbagh & Schmitt, 2016, p. 1). While the concept of *justice*, often viewed as a precursor to social justice, has ancient roots, social justice itself is a distinctly modern term with unique content and scope that diverges significantly from the justice concepts of antiquity.

To define the concept of *social justice*, it is crucial to consider the theoretical efforts made in this domain. Numerous theories in the literature aim to conceptualize social justice within a normative framework. Among them, John Rawls, one of the most influential political philosophers of the second half of the 20<sup>th</sup> century, has had a profound impact. Scholars often associate social justice with Rawls' emphasis on redistribution, framing it as a central element of his theory. The publication of *A Theory of Justice* in 1971 marked a pivotal defense of the welfare state, establishing a theoretical foundation that contrasted sharply with the rise of neoliberalism following Margaret Thatcher's election as Prime Minister of the United Kingdom in 1979 and Ronald Reagan's presidency in the United States in 1980. Rawls' theory brought egalitarian liberalism, as opposed to utilitarianism, to the forefront of political theory. He described his approach as *justice as fairness*, focusing on the redistribution of basic rights and duties within social institutions.

Rawls proposed two fundamental principles to govern a just society. The first is the *equal liberty principle*, which asserts that every individual is entitled to equal basic freedoms. The second, addressing *social and economic inequalities*, consists of two conditions: inequalities are permissible only if they are tied to institutions operating under the fair equality of opportunity principle and if they benefit the least advantaged members of society, as articulated in the *difference principle*, which holds that social and economic inequalities are justifiable only when they work to the benefit of the most disadvantaged. To support these principles, Rawls introduced the concepts of the *original position* and the *veil of ignorance*. The latter posits that a just society ensures a fair distribution of resources necessary for a decent life, regardless of factors such as socioeconomic, physical, or psychological conditions. The veil of ignorance requires individuals to determine principles of justice impartially without knowledge of their personal circumstances (Mursal & Dong, 2022, p. 5).

Several scholars have expanded upon Rawls' theory. Beitz (1979, pp. 149–150) extends the difference principle to the international level, proposing the *global difference principle*, which advocates for justice between individuals worldwide rather than within states alone. Similarly, Barry (1991) contends that wealthier states must redistribute resources to less affluent ones, though he acknowledges the general reluctance of individuals to support greater freedom of movement (Black, 1996, p. 67).

Other contemporary theorists, such as David Miller, Walter Garrison Runciman, and William Galston, have also connected social justice to distribution, focusing on what should be distributed and how. For instance, Miller links social justice to the distribution of benefits and burdens, emphasizing their examination within societal contexts (Khechen, 2013, p. 1). Diverging from Rawls, Walzer (1983) suggests that moral responsibilities extend not only to individuals but also to states and communities. He likens states to families, asserting that citizens bear moral obligations toward certain external groups. Once accepted into a state, individuals should be granted full membership, as a sense of belonging is essential to social justice (Black, 1996, p. 68).

David Harvey is a significant contributor to the theorization of social justice, particularly through his emphasis on its *territoriality*. According to Harvey, justice must address inequalities at both individual and regional levels, ensuring redistribution not only among individuals but also across groups, organizations, and geographic territories. He underscores the importance of needs, contributions to the common good, and merit as fundamental criteria for achieving equitable distribution (Harvey, 1973).

Amartya Sen's capability approach represents a major contribution to the theorization of social justice. Sen connects social justice with the development of human capabilities. While he aligns with John Rawls' concept of justice as fairness, he critiques Rawls' excessive focus on establishing just institutions. In his seminal work *The Idea of Justice* (2009), Sen shifts the focus toward the impact of these institutions on individuals' lives and freedoms, emphasizing their outcomes rather than fairness alone. He first introduced the capability approach in the early 1980s, notably in *Equality of What?* (1980) and further developed it in *Commodities and Capabilities* (1985). He later expanded and popularized this framework in *Development as Freedom* (1999), advocating for the recognition of capabilities as fundamental rights. By broadening the discourse from income poverty to the more encompassing concept of capability deprivation, Sen introduces a new dimension to social justice theory. He defines his approach as comparative realization, contrasting it with the transcendental institutionalism traditionally associated with justice theories (Osmani, 2010, p. 604).

Subsequent perspectives on social justice have expanded the concept beyond material redistribution to include factors such as social participation, political roles, equality of conditions, and recognition of diverse identities (Pulido, 2022, p. 5). Feminist political philosopher Nancy Fraser delineates two core dimensions: *distributive justice*, which focuses on the equitable allocation of resources and opportunities, and *recognition justice*, which prioritizes the acknowledgment and respect of identity, social status, and cultural diversity (Fraser, 1997). While Fraser acknowledges the importance of distributive justice, she argues that there is a second form of inequality—misrecognition—that must also be addressed. She contends that social justice is undermined not only by economic disparities but also by hierarchical social structures that privilege certain groups and by unequal power dynamics. Fraser emphasizes the cyclical nature of social injustices, noting that inequalities in social participation are both a cause and a consequence of material injustices (Fraser, 1989, 1997, 2000, 2003). In *Scales of Justice: Reimagining Political Space in a Globalising World* (2008), Fraser identifies three dimensions of social injustice: the economic (involving the distribution of resources and opportunities), the cultural and legal (concerning hierarchies such as race and gender), and the political (addressing representation and participation).

Another influential theorist who moves beyond the distribution paradigm in defining social justice is Iris Marion Young. Critiquing the limitations of distribution-focused approaches, Young contends that social justice must also involve the elimination of



institutionalized domination and oppression. She highlights the systemic oppression experienced by women and specific racial and social groups, identifying five distinct faces of oppression: exploitation, marginalization, powerlessness, cultural imperialism, and violence (Young, 2020).

In conclusion, social justice has been defined and theorized from several different perspectives, reflecting a significant evolution in political theory. Initially centered on economic redistribution, the concept has expanded to include recognition, addressing cultural diversity and multiculturalism, as theorized by scholars such as Charles Taylor (1994), Axel Honneth (1995), and Iris Marion Young (2020), though this article focuses more closely on Fraser's and Young's contributions. Philosophers like John Rawls emphasize the redistributive aspect, focusing on economic inequalities, while others have broadened the discourse to include recognition of cultural diversity. Consequently, social justice theories can be categorized into two primary paradigms: the redistribution of resources and the recognition of cultural differences. As Fraser and her followers argue, these paradigms are not mutually exclusive but rather complementary. The challenge, then, lies in integrating these paradigms into a cohesive framework (Khechen, 2013, pp. 2–3). As discussed in this article, a complementary approach to social justice is particularly crucial for addressing the unique challenges faced by migrant women workers.

### **Migration and Gender**

Migration is a phenomenon that has persisted throughout human history. Among the various theoretical approaches in migration studies, the push-pull model—originally developed by Everett Lee (1966)—is one of the most frequently cited. It explains migration as a process influenced by labor demand in receiving countries (pull) and labor surplus in sending countries (push) (Yılmaz & Ledwith, 2017, p. 5). However, Lee's model reflects the gender norms of its time, often portraying men as rational decision-makers and women and children as passive dependents, a perspective that has since been critiqued by gender-sensitive scholarship (Lutz, 2019, p. 16). Research shows that women were active participants in transatlantic migrations and were also recruited for various industries in West Germany, often exceeding the employment rates of domestic women. This contradicts the stereotype of non-employed housewives (Lutz, 2019, p. 16). In addition, individuals fleeing war or political instability, such as refugees and asylum seekers, are often compelled to seek employment for survival, making survival, alongside economic factors, one of the primary drivers of migration (Yılmaz & Ledwith, 2017, p. 37).

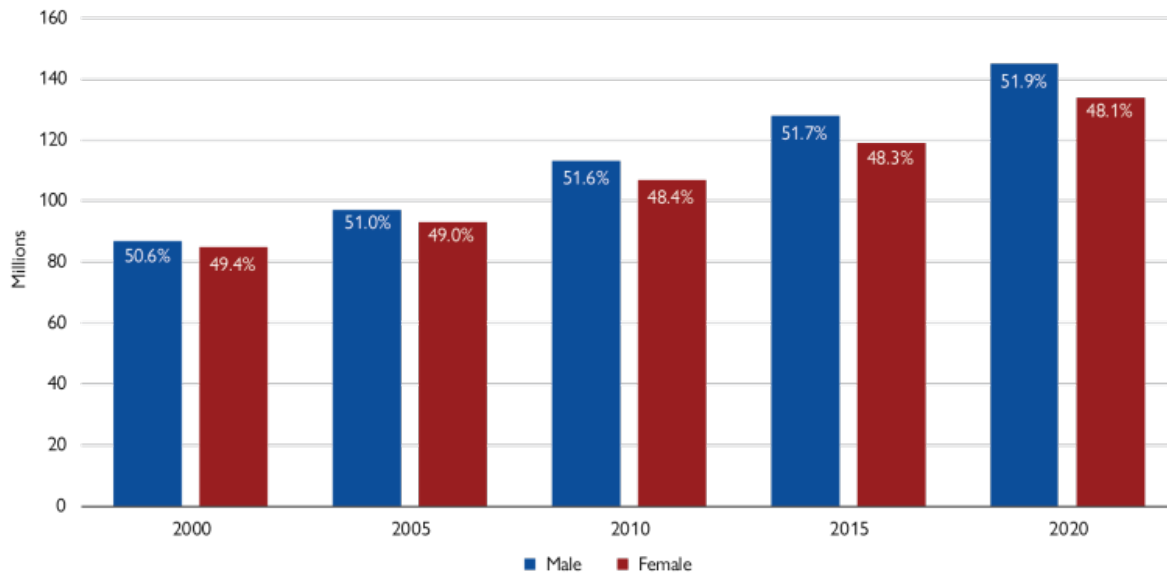
Although migration dates back to ancient times, the 20<sup>th</sup> century marked a significant transformation, establishing it as a truly global phenomenon (Lutz, 2019, p. 13). In recent years, migration has become a critical political issue, fueling debates on integration, displacement, safety during migration, and border management. Broadly defined, migration involves the movement of men and women from their usual place of residence, either within a country or across international borders. This study focuses on international migration, which refers to the crossing of national borders with the intent to reside in a host country for an extended period (IOM, n.d.-a). According to the International Organization for Migration, there were an estimated 281 million international migrants globally in 2020, representing 3.6 % of the world's population. Over the past five decades, the global migrant population has steadily increased (IOM, 2024).

Currently, there are slightly more male migrants than female migrants worldwide. In 2000, male migrants comprised 50.6 % of the global migrant population, compared to 49.4 % for female migrants (88 million versus 86 million, respectively). By 2020, this ratio shifted to

51.9 % male and 48.1% female, with 146 million male migrants and 135 million female migrants (IOM World Migration Report, 2024). Although the proportion of female migrants has decreased by 1.3 percentage points since 2000, women still account for nearly half of all international migrants.

**Figure 1**

*Gender Distribution of International Migrants (2000–2020)*



Source: IOM World Migration Report, 2024.

The substantial proportion of female migrants underscores the necessity of incorporating a gender perspective into migration studies. This approach is essential for understanding the unique challenges and experiences faced by migrant women, many of which are closely tied to gender-based inequalities. However, an assessment conducted by the Migration Governance Indicators (MGI) across 84 countries revealed that fewer than one in four countries (23 %) incorporate a gender perspective in their national migration strategies (IOM, n.d.-b). Neglecting the gender-specific needs of migrants not only limits their access to equal opportunities but also hinders their ability to fully contribute to host societies.

The inequalities and injustices faced by female migrants, particularly in comparison to male migrants, are critical issues that demand analysis through a social justice lens. The principle of inclusivity within social justice necessitates the implementation of policies that address the needs of all individuals, regardless of gender. Moreover, it is imperative to expand this analysis beyond binary frameworks to acknowledge the unique struggles of LGBTQ+ individuals. However, this study focuses specifically on one of the most vulnerable groups, female migrant workers, by analyzing their experiences from a social justice perspective.

Traditional migration studies in the literature classify migration into several distinct categories, including voluntary migration (for example, work, au pair programs, marriage, and professional training), forced migration (for example, due to political, religious, or ecological reasons, persecution of LGBTQ+ individuals, displacement caused by armed conflict or environmental crises, or forced prostitution), betterment migration (seeking improved living standards), expert or career migration (also referred to as elite migration), internal and international/intercontinental migration, as well as permanent, temporary, circular, and transnational migration (Lutz, 2019, p. 14). However, within these traditional studies, female migrants were largely neglected for many years, often perceived not as autonomous agents but

as dependents or companions of male' guest workers'—such as wives, daughters, or caregivers—rather than as migrants in their own right (Lutz, 2019, p. 16).

Understanding the concept of *gender* is essential for analyzing the social injustices faced by migrant women. Gender, in its broadest sense, refers to a system of historically constructed patterns of unequal power relations between men and women, encompassing socially defined notions of masculinity and femininity (Connell, 2013). The term *gender* entered academic discourse with Ann Oakley's foundational research in 1972 (Holmes, 2007, p. 42). Additionally, Simone de Beauvoir played a crucial role in the development of gender studies through her influential work. Her famous statement, "One is not born, but rather becomes, a woman," emphasizes the idea that gender is not a biological condition but a socially constructed identity.

By the 1990s, Judith Butler, an American feminist philosopher and a prominent figure in queer theory, introduced transformative perspectives on gender analysis. In her seminal book *Gender Trouble*, Butler challenged the conventional distinction between sex and gender, asserting that sex, like gender, is a socially constructed concept. She replaced the deterministic notion that *biology is destiny* with the claim that *culture is destiny* (Butler, 1999).

A review of the literature on migration and women reveals that research focusing on women's experiences began to emerge in the late 1970s. This scholarly evolution can be traced back through three key stages. The first stage critiques the male-dominated perspective of migration studies, calling for the visibility of migrant women. The second stage investigates the specific roles, challenges, and experiences of women as migrants. The third stage explores feminist topics such as the construction of masculinity and femininity, the dynamics of privacy and publicness, and the power structures within gender relations. Poststructuralist, postcolonial, and queer theories were especially instrumental in expanding the literature on migration and gender (Nawyn, 2010, pp. 750-51).

In summary, migration research has undergone a significant transformation as scholars have increasingly examined the intersection of migration and gender, influenced by feminist theories on the social construction of gender. These theoretical developments marked a turning point in understanding how gender shapes migration at individual, household, and societal levels. They have also illuminated the ways in which gender identities, roles, and power relations influence migrant agencies, decision-making processes, migration patterns, and experiences throughout the migration cycle (IOM, n.d.-b). Since the late 20<sup>th</sup> century, particularly with the rise of feminist scholarship in the 1980s, the field of migration studies, once dominated by a male-centric lens, has evolved to incorporate gender as a core analytical framework (Lutz, 2019, p. 2). As a result, women are now recognized and studied as independent agents within migration research rather than solely in relation to their male counterparts (Lutz, 2019, p. 3).

### **Conceptualizing Women Migrant Workers in the Framework of Social Justice Legal Framework for Women Migrant Workers**

Women migrant workers face numerous systemic injustices, including economic exploitation, limited access to labor rights, and heightened vulnerability to abuse and discrimination— as extensively documented in field research on female migrant domestic workers, who report extreme overwork, confinement, and physical abuse—particularly in contexts where legal protections are weak or unenforced (Amnesty International, 2014; ILO, 2016). Recognized normative protections and rights for all workers, particularly those specific to women migrant workers, are essential for addressing these challenges and advancing social

justice. International human rights laws and labor standards provide a critical framework to uphold these rights. Key instruments include the United Nations (UN) Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) and International Labour Organization (ILO) Conventions Nos 111, 189, and 190. These instruments play pivotal roles in ensuring decent working conditions, safeguarding against workplace harassment, and promoting gender equality in labor markets worldwide.

Adopted by the UN General Assembly on December 18, 1979, CEDAW is a landmark international treaty that establishes a comprehensive framework for eliminating gender-based discrimination and advancing women's rights globally (United Nations, 1979). CEDAW Article 11(1) affirms women's rights to work, equal employment opportunities, free choice of profession and vocational training, equal pay, social security benefits, and healthy and safe working conditions while also providing specific protections for reproductive health. Additionally, Article 11(2) outlines measures that must be taken to prevent discrimination against women on the grounds of marriage or maternity and to ensure their effective right to work (CEDAW, 1979).

Secondly, the ILO's foundational instrument on non-discrimination, the *Convention Concerning Discrimination in Respect of Employment and Occupation, 1958 (No. 111)*—which entered into force on 15 June 1960 and has been widely ratified by member states—establishes the framework for eliminating workplace inequalities on seven specified grounds, including sex. In many cases, its provisions are also extended to address discrimination based on migrant status by ratifying countries (ILO, 1958).

Moreover, two recent ILO conventions—No. 189 and No. 190—play a vital role in safeguarding the rights of women migrant workers. Adopted in 2011 and entering into force on 5 September 2013, the *Convention Concerning Decent Work for Domestic Workers (No. 189)* offers specific protections for domestic workers. It outlines fundamental rights and principles and obliges member states to implement measures aimed at ensuring decent work conditions for this group. As the first international convention to explicitly address the rights of domestic workers, Convention No. 189 serves as a critical instrument in advancing the rights of both female and male migrant workers. Its preamble explicitly acknowledges that domestic work remains undervalued and largely invisible, predominantly performed by women and girls—many of whom are migrants or members of marginalized communities—who face heightened risks of discrimination, exploitative working conditions, and other human rights abuses (ILO, 2011).

Adopted in 2019 and entering into force on 25 June 2021, the *Convention Concerning the Elimination of Violence and Harassment in the World of Work (No. 190)* establishes a comprehensive framework to prevent and address violence and harassment in professional settings. Recognizing such acts as violations of human rights and threats to equality, dignity, and decent work, the Convention emphasizes the creation of a work culture rooted in mutual respect and human dignity. It promotes an inclusive, integrated, and gender-responsive approach to tackling the root causes of violence and harassment, such as gender stereotypes, discrimination, and imbalanced power relations. Notably, it acknowledges the disproportionate impact of gender-based violence and harassment on women and girls and underscores the shared responsibility of governments, employers, and workers in fostering zero-tolerance environments. Although the Convention does not explicitly target migrant workers, its provisions are universal in scope, offering essential protections to vulnerable groups, including migrants, who are often exposed to elevated risks in precarious labor conditions (ILO, 2019).

Beyond these two conventions, several other international instruments further strengthen the rights of migrant workers (ILO, 2011). While this list focuses on key Conventions, it is worth noting that many are accompanied by *Recommendations*, which provide complementary guidance on implementation (ILO 1981; ILO, 1997).

- Migration for Employment Convention (Revised), 1949 (No. 97);
- Migrant Workers (Supplementary Provisions) Convention, 1975 (No. 143);
- Workers with Family Responsibilities Convention, 1981 (No. 156);
- Private Employment Agencies Convention, 1997 (No. 181);
- Employment Relationship Recommendation, 2006 (No. 198); and
- The ILO Multilateral Framework on Labour Migration: Non-binding Principles and Guidelines for a Rights-Based Approach to Labour Migration (2006).

Associated Recommendations:

- Workers with Family Responsibilities Recommendation, 1981 (No. 165)
- Private Employment Agencies Recommendation, 1997 (No. 188)

*The Violence and Harassment Convention* (2019) (No. 190) establishes a comprehensive framework to prevent and address violence and harassment in the world of work, recognizing these acts as human rights violations and threats to equality, dignity, and decent work. The Convention underscores the importance of fostering a work culture based on mutual respect and human dignity while advocating for an inclusive, integrated, and gender-responsive approach to tackle root causes such as gender stereotypes, discrimination, and unequal power dynamics. It acknowledges the disproportionate impact of gender-based violence and harassment on women and girls and highlights the shared responsibility of governments, employers, workers, and their organizations in fostering zero-tolerance environments.

Importantly, it is the first international binding treaty to address the effects of domestic violence on employment (ILO, 2019). While it does not explicitly target migrant workers, it refers to the UN's International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families, and Article 11 calls on ratifying states to ensure that violence and harassment in the world of work are addressed in relevant national policies, including those related to migration. In addition, the Convention's provisions are universal, offering crucial protections to all vulnerable groups, including migrants, who often face increased risks in precarious work settings. Its accompanying Recommendation No. 206 reinforces this inclusion, with Paragraph 10 stating, "Members should take legislative or other measures to protect migrant workers, particularly women migrant workers, regardless of migrant status, in origin, transit and destination countries as appropriate from violence and harassment in the world of work."

Ratification is the formal process by which a state accepts a convention as a legally binding instrument. In contrast, recommendations are not subject to ratification and instead provide non-binding but authoritative guidance. As with other international labor standards, Conventions No. 189 and 190 serve as foundational frameworks for the development of national laws and policies. Upon ratification, these conventions create binding international legal obligations for the ratifying states (ILO, n.d.-b). ILO's supervisory system monitors compliance by periodically reviewing whether ratifying countries are fully implementing the provisions to which they have committed. The significance of international labor conventions in promoting social justice for women migrant workers cannot be overstated. These

Conventions, alongside human rights laws, soft-law labor standards, and other international instruments, serve as essential foundations for developing concrete, enforceable national laws and policies.

In addition to international labor conventions, various institutional initiatives and organizational frameworks also contribute to advancing social justice globally and enhancing its practical visibility. Among these, the recently established Global Coalition for Social Justice marks a significant milestone. Launched by ILO's Director-General Gilbert F. Hounbo and endorsed by the Organization in November 2023, the Global Coalition seeks to address poverty, inequality, and social tensions while fostering cohesive and productive societies. Rooted in the ILO's century-long foundational principles, the Global Coalition has received strong support from leaders across the world, including the UN Secretary-General (ILO, n.d.-a). The explicit use of the term "social justice" in its name, along with its inclusive vision, distinguishes it from other initiatives. The Advancing Social Justice Report (ILO, 2023, pp. 8-9) informs the Global Coalition's efforts by defining social justice in terms of human dignity, fairness, equality, and having a voice and the agency to shape one's own life. It also outlines the ILO's four key dimensions of social justice: universal human rights and capabilities, equal access to opportunities, fair distribution, and just transitions.

Beyond the Global Coalition for Social Justice, other significant institutional initiatives contribute to the visibility and impact of social justice. These include NGOs such as the Centre for Social Justice (Centre for Social Justice, n.d.) and UNESCO's Social Justice Chairs (UNESCO Chair for Comparative Research on Cultural Diversity and Social Justice, n.d.). Together, these initiatives work to define and operationalize social justice in meaningful and impactful ways from their respective perspectives.

In summary, the legal framework for protecting women migrant workers is grounded in a comprehensive array of international treaties, including CEDAW and ILO Conventions Nos. 111, 189, and 190, which provide essential protections for labor rights, workplace equality, and safety. Also, the Global Coalition for Social Justice and efforts by NGOs collectively strive to advance social justice on a global scale. Together, these frameworks establish a robust structure for addressing systemic injustices and promoting fair and equitable labor conditions for women migrant workers worldwide.

### **Barriers to Justice for Women Migrant Workers**

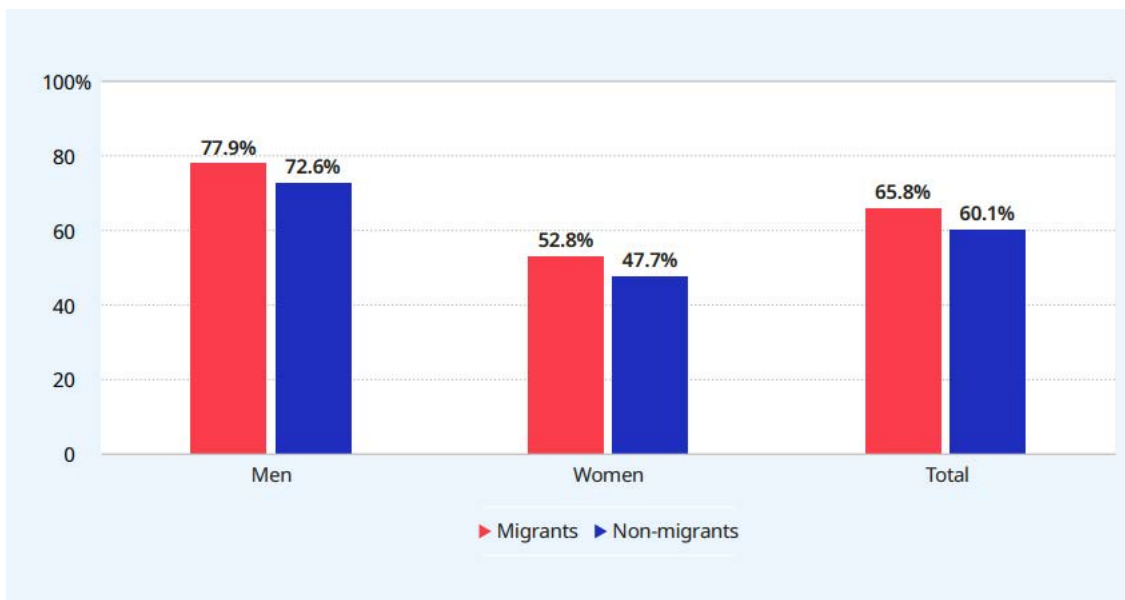
Since the 1980s, research on international migration has highlighted the growing number of women migrating independently as workers. This trend gave rise to the concept of the *feminization of migration*, which gained prominence following the publication of a special issue on women in the *International Migration Review* in 1984 (Tittensor & Mansouri, 2017, p. 11). Alongside this, another significant concept emerged: the *feminization of employment*. Some scholars argue that the feminization of labor migration is a defining feature of contemporary global migration patterns (Piper, 2003, p. 726).

Women are often pushed into roles within gendered welfare states, driven by care crises, which frequently result in their concentration in lower-status jobs, such as domestic work or the sex industry (Piper, 2003, p. 726). This demonstrates how labor markets, shaped by gender norms, perpetuate discrimination by channeling women into specific types of work and denying them voice and agency. These patterns show that the concept of "feminization of migration" reflects not just a rise in numbers but structural gender inequalities within global labor markets.

In 2019, there were approximately 70 million female migrant workers, accounting for 41.5% of the total international migrant workforce. Despite this substantial figure, men continued to outnumber women among migrant workers, representing 58.5% of this labor group. These figures refer solely to international migrant workers, as reported by the International Labour Organization (ILO, 2021-a, pp. 21–22), and should be distinguished from broader migrant population data such as the IOM's 2024 report, which states that men accounted for 51.9% of all international migrants in 2020. The lower representation of women among international migrant workers can be attributed to two primary factors: (1) a smaller proportion of working-age women within the migrant population and (2) lower labor force participation rates among female migrants compared to their male counterparts. Many women migrate for family-related reasons rather than for work and encounter additional barriers such as gender discrimination, limited social networks, and challenges in balancing work and family life. These obstacles contribute to their lower participation rates in both migration and the labor market.

**Figure 2**

*Global labor force participation rate of international migrants and non-migrants by sex, 2022 (percentage)*



Source: ILO, 2022 Global Estimates on International Migrant Workers, Figure ES4.

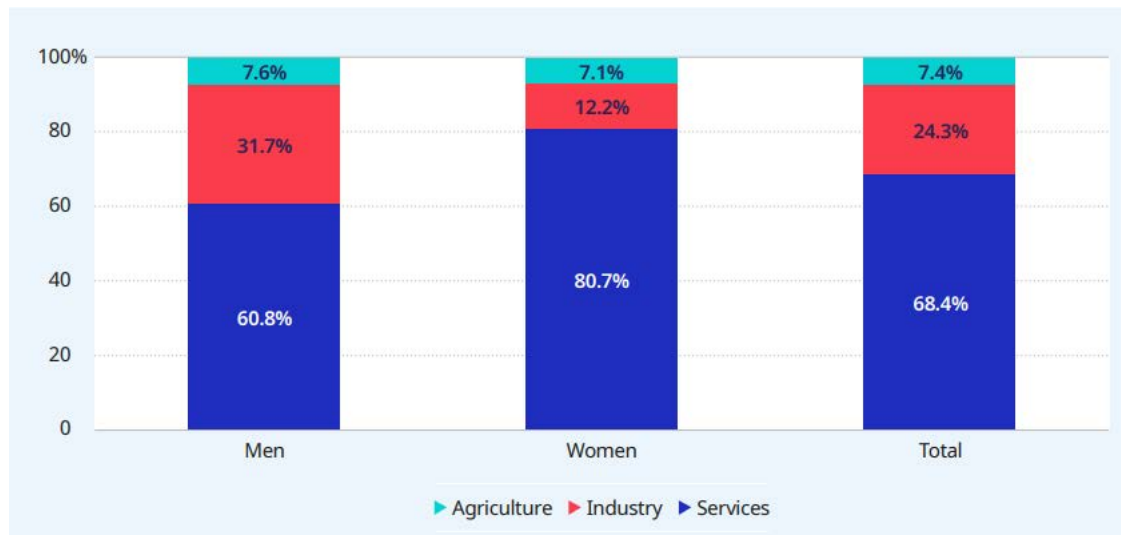
A common challenge for women migrant workers is their confinement to low-skilled, low-paid, and informal jobs, particularly in undervalued care services (Piper, 2003, p. 726). Globally, women constitute over 80% of the workforce in domestic and care work. While men also work in domestic roles, particularly as gardeners, drivers, security staff, or butlers, women dominate the field (Yilmaz & Ledwith, 2017, p. 11).

In the Global North, the increasing demand for domestic and care services is primarily met by low-cost, flexible female labor from economically struggling non-Western countries. Consequently, female migrant workers are heavily concentrated in these sectors. This trend referred as *the maid trade* (Carling, 2005; Yilmaz & Ledwith, 2017, p. 8), *international division of reproductive labor* (Parreñas, 2001, p. 561), *global nanny chain* (Hochschild, 2000, p. 33) or *transnational political economy of care* (Williams, 2012, p. 364; Gallo & Scrinzi, 2016, p. 1) exposes workers to gender-specific challenges, including limited access to

information, social protection, and governance frameworks. These challenges further impede their ability to secure decent work and exercise labor rights.

**Figure 3**

*Distribution of employed international migrants by sex and broad category of economic activity, 2022 (percentage)*



Source: ILO, 2022 Global Estimates on International Migrant Workers, Figure ES9.

They are especially vulnerable to exploitation, such as trafficking for sexual purposes, and are subjected to various abuses, including physical, psychological, and sexual violence, excessive working hours without fair compensation, and outright wage theft. For example, a recent survey of migrant women in Australia revealed that 51% had experienced workplace sexual harassment. However, fear of jeopardizing their immigration status or facing punitive actions deterred most of them from reporting these incidents (Herbert & Thorne, 2024). Moreover, restricted access to health and education services, coupled with family separation, profoundly affects their well-being and that of their children (UN Women, 2016, p. 10). Finally, the discrimination faced by female migrant workers in the domestic and care work sector often intersects with race and class, as white, middle-class professional women frequently delegate caregiving roles to migrant women from the Global South. (Dedeoglu, 2014, pp. 27–28).

The discrimination faced by migrant women workers is not limited to the domestic and care work sector. Other service sectors also employ a significant number of migrant women who encounter low job security, high flexibility, irregular employment, poor working conditions, low wages, and minimal social prestige (Dedeoglu, 2014, pp. 27–28). Another significant sector employing migrant women is manufacturing. Globalization has intensified competition among countries to provide corporations with the most affordable and compliant labor, driving substantial demand for female migrant workers (Oishi, 2005, p. 3). Additionally, international criminal networks have expanded the global *sex industry*, further increasing the demand for migrant women (Oishi, 2005, p. 4). This has created yet another sector where migrant women face numerous challenges, including violence, exploitation, and oppression.

As these examples illustrate, female migrants experience various forms of injustice in the labor market. Being largely confined to low-wage, insecure jobs and subjected to multiple forms of exploitation underscores the fact that social justice remains unachieved in this domain.



To address these issues, inclusive and multidimensional policies are essential to ensure social justice for migrant women in the labor market.

For example, the theory of social justice advanced by Nancy Fraser (2003) provides a valuable framework for addressing these issues. Fraser's conceptualization of social justice emphasizes the intersection of economic inequalities, cultural hierarchies, and political underrepresentation. The injustices faced by migrant women are evident across all three dimensions outlined by Fraser. Her concept of distributive justice highlights how migrant women are often relegated to low-wage, insecure, and temporary jobs, depriving them of equitable access to economic opportunities. Similarly, her notion of recognition justice addresses the systemic disregard for the social status of migrant women, who are frequently marginalized based on their gender and ethnicity. These women are often classified as part of the *lower class* in societies dominated by white, middle-class men, rendering them invisible in both the labor market and broader social structures. Furthermore, Fraser's concept of *political justice* underscores the lack of political representation for migrant women, who are frequently excluded from platforms and decision-making spaces that could allow them to advocate for their rights. Political inequalities are also evident in their underrepresentation in trade union structures. In Asia and the Pacific, for example, women represent only 34.1% of trade union membership, significantly below the global average of 42.4%, illustrating the structural barriers that limit their political agency and collective bargaining power (ILO, 2021-b, p. xxiv).

Moreover, the four dimensions of social justice outlined in the ILO Director-General's 2023 report—universal human rights and capabilities, equal access to opportunities, fair distribution, and just transitions—can be meaningfully mapped onto Fraser's triadic model. For instance, *fair distribution* aligns with Fraser's distributive justice; *equal access and capabilities* intersect with both recognition and political justice, while *just transitions* speak to the institutional changes required to ensure full political inclusion.

In this context, Fraser's social justice framework serves as a critical tool for identifying the root causes of the multifaceted injustices faced by migrant women and for proposing pathways toward a more equitable and inclusive society. For example, the Swiss canton of Geneva has implemented a voucher system to regularize domestic work and extend social protection coverage to migrant women, even those with irregular status, thereby advancing distributive justice in practice. Similarly, regularization initiatives in Italy and a bi-national agreement between Paraguay and Argentina demonstrate how distributive and political justice can be pursued through inclusive labor policies (ILO, 2015, pp. 6–9).

### Conclusions

Social justice, as a framework, offers critical insights into addressing the systemic barriers faced by female migrant workers. This article has illuminated the intersection of migration, gender, and labor through the lens of social justice, highlighting the economic, cultural, and political inequalities that perpetuate exclusion and marginalization. By emphasizing the disproportionate representation of female migrant workers in low-wage, insecure, and informal employment sectors, this study underscores the urgent need for inclusive policies and practices that promote fairness, dignity, and equity in global labor markets.

The analysis presented here advocates for a multidimensional approach to social justice that transcends economic redistribution to encompass cultural recognition and political inclusion. Such an approach is essential for dismantling the structural hierarchies that impede the social and economic empowerment of female migrant workers. Addressing these intersecting inequalities requires global and local frameworks that not only acknowledge but

actively work to eliminate the discriminatory practices that act as structural barriers to justice—such as gendered labor segregation and exclusion from decision-making—and instead promote positive measures aligned with Fraser's model, including recognition of cultural identities, equitable distribution of labor protections, and enhanced political participation. Moreover, these frameworks must prioritize actionable measures, including robust legal protections, inclusive labor rights, and platforms for political representation, to ensure that female migrant workers are equipped with the tools necessary for meaningful participation in society.

This article also emphasizes the importance of integrating diverse perspectives into migration studies, particularly those of marginalized groups such as LGBTQ+ individuals, who often face compounded vulnerabilities. While this study has focused specifically on female migrant workers, adopting a broader lens that encompasses varied gender identities would enrich the discourse and contribute to more comprehensive solutions.

Ultimately, achieving social justice for female migrant workers requires sustained engagement and collaboration among policymakers, academics, and civil society, and crucially, with women migrant workers representatives themselves. By addressing the root causes of systemic injustices and implementing holistic strategies, it is possible to foster equitable opportunities and empower those most at risk of exclusion. This research calls for continued exploration of migration and social justice, with the hope of inspiring transformative change that upholds dignity, rights, and equity for all individuals, regardless of their sex, in the global labor markets.

### Acknowledgments

The author wishes to express gratitude to Patrick Taran, President of Global Migration Policy Associates (GMPA), and Olga Kadyshcheva, GMPA Associate, for their invaluable guidance and support in the development of this article.

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## Is the State of Morocco a Social State? ¿Es el estado en Marruecos un estado social?

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Sent: 2025/03/18  
Accepted: 2025/06/20  
Published: 2025/06/30

### Abstract

The human development situation in Morocco in 2025 has evolved from the relative euphoria that characterized this North African country in the early 2000s. The National Initiative for Human Development (INDH), launched in 2005 by King Mohammed VI was intended to spread a social safety net under Moroccans left behind by "growth finally on track". The *Fiftieth Anniversary Report* took stock of the country's 50 years of independence since 1956 and indicated paths for developing its economy and transforming its society by 2025. The report assessed that the country was at a crossroads and had the means to embark on the path of national ambition shared by all, articulated around human development. This article reviews the *social state* as a framework for analyzing the subsequent discourse and practice of the social state in the Kingdom of Morocco. It presents two definitions of a social state, and draws on a wide range of economic and social data to examine in depth the socio-economic realities of the country's population. The analysis compares and contrasts those realities with the government's stated intentions and public policies to highlight significant gaps in obtaining social justice for a large proportion of the population. Based on comparative analysis of data referencing the definitional framework, the article demonstrates that, despite strong rhetoric promoting inclusion and human development, government plans and programs on the ground fall short of their proclaimed goals. The conclusions identify factors for the lack of progress towards a more socially just country and society.

**Keywords:** State, social justice, human development, women, unemployment, social deficits.

**Summary:** Introduction, Methodological note, What is the social state?, Morocco in economic figures and social conditions, Conclusions.

**How to cite:** Lahlou, M. (2025). Is the State of Morocco a Social State? *Revista Tecnológica - Espol*, 37(1), 174-193. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1292>

## Resumen

La situación del desarrollo humano en Marruecos en 2025 evoca la relativa euforia que caracterizó a este país norteafricano a principios de la década de 2000. La Iniciativa Nacional para el Desarrollo Humano (INDH), lanzada en 2005 por el rey Mohammed VI, pretendía establecer una red de seguridad social para los marroquíes que se habían quedado del “crecimiento por fin en marcha”. El Informe del Cincuentenario realizó un balance de los 50 años de independencia e indicó vías para desarrollar su economía y transformar su sociedad para 2025. El informe argumentó que el país se encontraba en una encrucijada y contaba con los medios para emprender el camino de la ambición nacional compartida por todos, articulada en torno al desarrollo humano. Este artículo presenta dos definiciones de estado social y reúne un amplio panorama de datos económicos y sociales para examinar en profundidad la realidad socioeconómica de la población. El análisis compara esa realidad con las intenciones y políticas públicas declaradas por el gobierno, destaca importantes brechas en el logro de la justicia social para una gran proporción de la población. Con base en el análisis comparativo de datos, el artículo demuestra que, a pesar de la firme promoción de la inclusión y el desarrollo humano, los planes y programas gubernamentales en la práctica distan de lograr lo que proclaman. Las conclusiones identifican los factores que explican la falta de progreso hacia una sociedad más justa.

**Palabras clave:** Estado, justicia social, desarrollo humano, mujeres, desempleo, déficits sociales.

## Introduction

The human development situation in Morocco in 2025 harkens back to the relative euphoria that characterized this North African country, located just 14 km from Europe, in the early 2000s. At the time, the National Initiative for Human Development (INDH), launched in May 2005 by King Mohammed VI, was supposed to spread a "social safety net" under the feet of Moroccans left behind by "growth finally on track". That same year, a summary document known as the "Fiftieth Anniversary Report" took stock of the country's 50 years of independence (acquired in 1956) and, above all, indicated possible paths for developing its economy and transforming its society by 2025. The report argued that the country was at a crossroads and had the means to embark resolutely on the path of a great national ambition, shared by all, and centered on human development. Now, 20 years later, despite vocal promotion of inclusion and human development, government plans and programs on the ground continue to fall short of their declared objectives.

Among Arab countries, and in the Maghreb region itself, Morocco is often portrayed as an exception, as a democracy. An economic and social democracy, with a "multi-party system", periodic local and national elections, and a parliament that has formally functioned since the early 1960s, even if it lacks significant political power and control.

However, real powers in the country are held by the King, who is neither subject to election nor politically accountable, even though he presides over the Council of Ministers - which decides the State's economic and social policies - and he is the head of the army, the head of the justice authority and the head of the National Security Council, etc. (Royaume du Maroc, Constitution of 2011, Art. 41 - 59)

Another manifestation of this "Moroccan exception" was illustrated by the form and consequences of what has been called the "Arab Spring", which was initiated and led in Morocco in early 2011 by the "February 20" movement. This movement - supported by socialist opposition parties and numerous human rights associations, as well as some

associations for the unemployed - led major demonstrations in almost 150 cities, particularly in the most important ones such as the capital Rabat, Casablanca, Fez and Tangiers.

The demonstrations denounced situations of precariousness and social exclusion that had become untenable for a large part of the population across the country, in both urban and rural areas. The main demands of the demonstrators were political. These included reform of the state, independence of the judiciary, separation of politics from business and politics from religion at the head of the state - in other words, the creation of a civil state. They were also of a social nature, aiming to reduce inequalities within Moroccan society, notably with less injustice, more jobs, more schools and health care centers, more dignity, less corruption, less inequality between men and women, and so on.

In this article, we present the definition of a "social state" and review the main economic and social data in Morocco, along with their political underpinnings. Such data indicate that, while the country's leaders proclaim inclusion and human development, government programs/plans on the ground have, to date, led to nearly the opposite of what they proclaim to achieve.

### **Methodological note**

This article examines the nature of the social state as a framework for analyzing the discourse and practice of the social state in the Kingdom of Morocco. It brings together a broad panorama of economic and social data to examine in depth the socio-economic reality of the country's population, comparing it with the official discourse of the government. The analysis compares and contrasts the reality represented by the data with the government's stated intentions and public policies, to highlight significant gaps in real efforts to promote social justice for a large proportion of the country's population. Based on this in-depth comparison, the conclusions identify the factors responsible for the lack of progress towards a more socially just country and society, as well as the situation of a long-developing country.

### **What is the social state?**

In the following section, we briefly present two models of the social state as well as the Moroccan model.

#### **The welfare-state model**

This is a model of political and economic organization in which the State plays a central role in the protection and well-being of its citizens. In addition to the so-called regalian missions of internal and external security, such a state performs three major functions:

1. **Social protection:** The State guarantees social assistance and benefits (unemployment benefits, pensions, family allowances, RSA, etc.) to reduce inequalities and protect the most vulnerable, thereby guaranteeing social cohesion.
2. **Access to public services:** The state finances, or guarantees the financing of, and organizes essential services such as health (social security), education (public schools, universities) and essential infrastructure (roads, railroads, ports and airports, electricity, water and sanitation networks, etc.).
3. **Economic regulation:** the State intervenes in the economic sphere to limit market excesses, impose rules on companies (minimum wage, safety regulations, labor laws) and reduce initial inequalities in the distribution of national income through the redistribution of wealth, notably via a progressive, fair and efficient tax system.



This model developed especially after the Second World War, with states assuming greater responsibility for the process of economic development and the well-being of their citizens<sup>1</sup>. However, since the 1980s, many countries have reduced the role of the welfare state under the influence of so-called neo-liberal policies (notably under Prime Minister Margaret Thatcher in the UK - 1979-1990, and Ronald Reagan in the USA - 1981-1989).

### **The social-democratic (or universalist) state model**

It is characterized by:

- A high level of social protection that covers the entire population, regardless of an individual's labour market status or family situation;
- A wide range of public and social services;
- A major demarketing effort (i.e., making non-tradable goods and services available to the population, such as water, health and education), through compensation systems (redistribution of wealth) and the setting of strict rules - in terms of wages, social protection and working conditions - for economic players;
- The aim is to achieve greater equality between citizens, so as to reduce social stratification and ensure a degree of social justice.

In reality, these two models are hardly dissociated from each other, and in any case, they converge in the sense that both aim - at a given stage of development of the liberal market economy - to ensure social cohesion, a basic immaterial factor necessary for the development of any economy, alongside the physical factors of labor, capital and natural resources.

### **The Moroccan model**

Without referring ideologically or theoretically to either of the above two models, the social state, as supported by the liberal government that the King of Morocco has put in place from September 2021, boils down to a Government Program comprising a set of promises. The latter "indicate the social dimension of future public policies, which can be deduced from the government's commitments to create one million net jobs over the next 5 years (between 2021 and 2026), activate comprehensive social protection, lift one million families out of the cycle of poverty and fragility, the protection and expansion of the middle class, the creation of economic and social conditions for the emergence of a middle class in the rural world, and the universalization of primary education for the benefit of all children from the age of four, with the establishment of permanent and effective governance for quality control; and the reduction of social and spatial disparities"(Akhannouch, 2021).

A review at Morocco's economic and social performance up to the year 2024 reveals the gap between the commitments made and the results achieved over the years. In other words, a fragile economy, dependent on variations in annual rainfall levels, and a precarious, highly unbalanced social sphere.

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<sup>1</sup> Such characteristics are generally attached to the economic school referring to the British economist John Maynard Keynes. J.M. Keynes (1883-1946) rose to fame with his book "The General Theory of Employment, Interest and Money" (1936), which led to his appointment as Financial Adviser to the Crown and Governor of the Bank of England. As head of the British delegation, he played a decisive role in the Bretton Woods conference, which led to the creation of the International Monetary Fund (IMF) and the World Bank, and thus to today's global financial system.

### Morocco in economic figures and social conditions

Assessing the human development situation in Morocco in 2025 requires any objective observer, or researcher in the economic and social sciences, to take account of the relative euphoria that characterized this North African country in the early 2000s.

At the time, the National Initiative for Human Development (INDH), launched in May 2005 by King Mohammed VI - who came to power following the death of his father in 1999 - aimed to create a social safety net for marginalized populations, at a time when it was felt that economic growth was finally beginning to take a stable course. In the same year, a synthesis document, known as the "Human Development Report" or "Fiftieth Anniversary Report", drawn up by a host of economists, sociologists and other academics, took stock of the country's 50 years of independence (gained in 1956) and, above all, indicated possible paths for developing its economy and transforming its society by 2025.

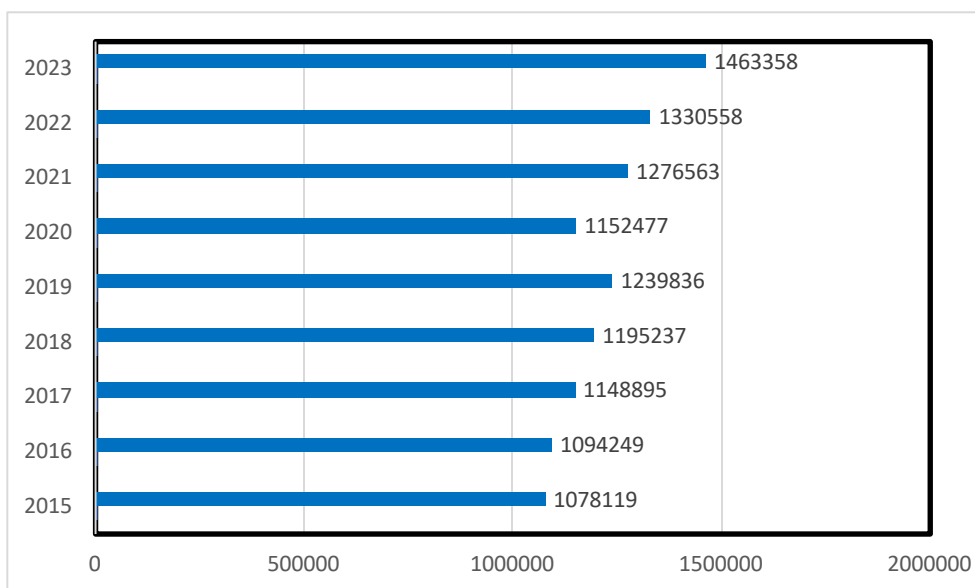
In its foreword, the report argued that "Our country (Morocco) is at a crossroads. It now has the means to embark resolutely on the path of a great national ambition, shared by all, and built around human development. To achieve this, the national community has an ardent obligation to make coherent choices, accelerate the pace and deepen the scope of reforms, and make a definitive break with the practices and behaviors that have hitherto thwarted its development" (Royaume du Maroc, 2005, p.31).

#### Morocco's economic figures: weak growth over the long term, uneven growth in the short term

As the graph below shows, Morocco's Gross Domestic Product (GDP) - the total wealth produced by the country - is estimated to have risen by almost 36% in 8 years. In 2023, average GDP per capita will be just over 3,700 dirhams, or around 3,500 euros. This corresponds to 1/35<sup>th</sup> of the GDP per capita in Switzerland, and 1/9<sup>th</sup> of the average per capita in the European Union. However, price rises have exceeded 30% over the same period, with food price inflation of over 20% in 2022 alone (HCP, 2024). This has had a direct impact on the purchasing power of the poorest and most vulnerable sections of the population, estimated to number over 20 million.

**Figure 1**

*Gross domestic product (GDP) in current dirham between 2015 and 2023*



Source: [www.hcp.ma](http://www.hcp.ma)

Furthermore, as shown in the table below, the annual growth rate of overall GDP remains strongly correlated with agricultural GDP. The latter remains totally dependent, year after year, on the evolution of rainfall. In other words, the evolution of the Moroccan economy's main aggregate - where agricultural value added accounts less than 13% of GDP - remains intimately linked to changes in climatic conditions. Nature, that is.

**Table 1**

*GDP growth between 2017 and 2023*

Year	Agricultural GDP	Non-agricultural GDP	Total GDP
2017	+21,5	+3,2	+5,2
2018	+5,6	+2,8	+3,1
2019	-5,0	+4,0	+3,0
2020	-8,1	- 6,9	-7,0
2021	+17,8	+6,6	+7,8
2022	-11,3	+3,4	+1,5
2023	+ 1,4	+3,5	+3,4

Source : Bank Al Maghrib. <https://www.bkam.ma/>

In parallel with this finding, a national survey of household incomes carried out between 2019 and March 2020 - just before the Covid 19 health crisis - highlighted a marked inequality in the distribution of per capita income, according to living environment and population category. In 2020, per capita income in rural areas represented less than 2/3 (62%) of per capita income in urban areas, while the wealthiest 20% of the population had more than half (53.3%) of national income, compared with 5.6% for the least well-off 20% (HCP, 2024).

Such magnitudes - with their continued dependence on climatic hazards, their absolute and dynamic weakness and their unbalanced structure between regions and social categories - speak volumes about the financial capacities that the Moroccan public authorities have given themselves to achieve the work of a "social state", i.e. human development.

So, broadly speaking, nothing very significant in terms of social development seems to differentiate the periods before and after 2000. Above all, Morocco, now with a population of almost 37 million (HCP, 2024), has remained under constant threat of "the occurrence of a serious external or internal crisis" (according to the same fiftieth anniversary report), as happened with the global financial crisis of 2008/2009, with the Arab Spring movements of 2011, with the Coronavirus crisis – first identified in China at the end of 2019, and began to affect North Africa on March 2, 2020, when the first case of contamination by the virus was confirmed in Morocco - or with the inflationary effects that followed the start of the Russian (and Western) military intervention in Ukraine in February 2022.

### **Morocco's social shortcomings: the consequences of the government's economic and political choices**

Despite the economic weaknesses mentioned above, or because of them - as a kind of projection towards a dreamed-of but still unattainable future - Morocco adopted a constitutional text 15 years ago, following the "Arab Spring" protests in its cities, making social issues a cornerstone of state action.

Also, it is specified in Article 31 of the Constitution adopted on 1 July, 2011 that:

"The State, public institutions, and local authorities endeavour to mobilise all available resources to ensure that all citizens, irrespective of gender, have equitable access to the conditions necessary for the full enjoyment of their rights:

- to health care;
- to social protection, medical coverage and mutual or state-organized solidarity;
- to modern, accessible, quality education;
- to education on attachment to Moroccan identity and unchanging national constants;
- to vocational training and physical and artistic education;
- to decent housing;
- to the work and support of public authorities in the search for employment or self-employment;
- to access to public office based on merit;
- to access to water and a healthy environment;
- to sustainable development."

### ***The health crisis of 2020/2021: a full-scale revelation of Morocco's social deficits***

The apparent courage of such a constitutional proclamation - in which the State undertakes to do everything in its power to give the population access to the essentials of basic services and benefits, education, employment and water - will quickly come up against the wall of the country's social reality, and the contradictory nature of the policies pursued there over previous years/decades.

The closure of all land borders by the Moroccan authorities, and the concomitant suspension of air and sea transport of people, suddenly turned Morocco into a kind of island where all its inhabitants found themselves locked in, forced to live in autarky. All of a sudden, this gave rise to a widespread fear of their country's weaknesses, of its dependence on foreign countries, which had extraverted its economy and made openness to foreign markets a dogma. But it also made many citizens realize that they belong, in the final analysis, to the same human and social group, and that none of them can find - at least for a while - an escape elsewhere, whether for healthcare, study or work.

As a result, the perception of society as a whole has suddenly become different, a mixture of fear and empathy towards those living in confined conditions made extremely difficult by the state of financial and social precariousness in which they were already living before the crisis. A state covered by what looks like political propaganda through recurring tunes of "everything's fine", and in any case, "everything's better than with our neighbors". (In the Maghreb and the rest of Africa).

And it is precisely in the context of this new perception that many Moroccans have begun to understand, for example, that the informal sector is far too predominant in the country's economy, and that most of the jobs available are informal, insecure, low-skilled and low-paid. The same Moroccans have also begun to feel that the imbalances in the distribution of the wealth produced by the country are very great. Far too great to be sustained indefinitely. And, intuitively - as if scalded by the upheavals of the Arab Spring - the State perceived the danger that the strict confinement of the entire population, decided on from mid-March 2020, could result in violent movements by the poorest sections of the population, effectively unemployed and/or without sufficient income, Hence the huge deployment of security forces all over the country's main cities, where citizens also noticed the sporadic presence of army tanks, a sort of confirmation that it's not far from social injustice and deficits to violence and revolt (Lahlou et al, 2022).

### *The faces of social fault lines in Morocco*

In 2005, a summary of the aforementioned fiftieth anniversary report stated that: "An uncompetitive economy, with a volatile and insufficient rate of growth, would lead to a worsening of unemployment at national level, with strong repercussions on poverty, vulnerability and exclusion. In urban areas, one working person in four and one graduate in three would be unemployed in 2025 if the growth rate remained at its trend level. Unemployment would continue to affect more women and young people. The informal sector would develop in response to the shortcomings of the modern sectors of the economy and as an alternative means of regulating the effects of globalization. Budgetary room for manoeuvre is likely to shrink, especially as the windfall from privatizations gradually dries up. This could have an even greater impact on government investment spending and progress in infrastructure" (Royaume du Maroc, 2005).

And in fact, for the purely economic aspect, as mentioned above, as for employment and unemployment, health, schools, migration or basic public services such as access to water, the a priori "pessimistic" predictions set out in part here have been met with short-term policies. These were (are) carried out under the supervision of the administration, broken down by sector, with no overall coherence and, above all, never subject to control.

In what follows, we briefly review relevant data relating to employment and unemployment, health, education, migration and access to water.

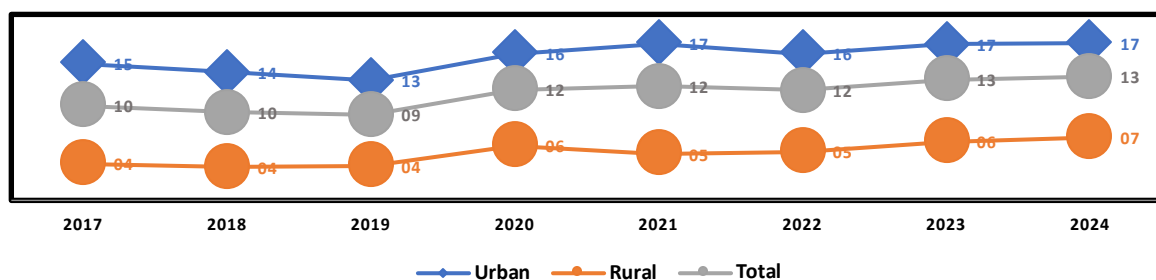
### *Employment and unemployment*

As a link between economic growth and employment trends in an economy, the prevalence or otherwise of unemployment indicates both the success and failure of the policies pursued at both levels. In Morocco, both the persistence of a high unemployment rate, and even its worsening over the last period, as well as its structure by category, express a situation of failure to absorb the demand for labor expressed by the population. This is despite the fact that the activity rate (people actually employed or looking for work as a proportion of the total population) at national level is just under 43%, and that the rate for women is just over 18% (18.3%), i.e. just under one woman in five is actually employed or looking for work.

Overall, by the end of 2024, the number of unemployed people in Morocco had risen to 1.645 million (13.7% of the working population), compared with 1.549 million (12.9% of the working population) in 2023. This level of unemployment, the highest ever recorded in the country, has risen over the past seven years by almost 30%, from 10.2% in 2017 to 13.3% in 2024 (and even to 13.7% in December of the latter year – see Figure 2 below).

**Figure 2**

*Unemployment rate in Morocco between 2017 and 2024 by place of residence (in %)*



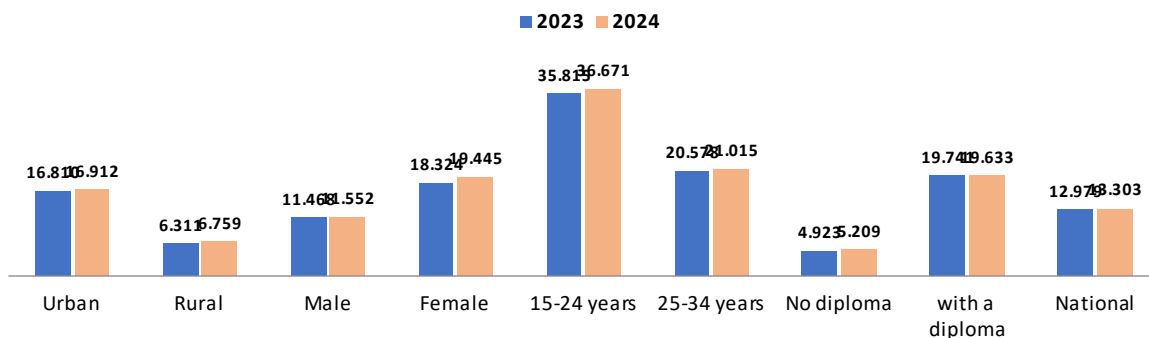
Source: HCP, Rabat. 2024

As for Figure 3 below, it shows two important facts, both of which are imbalances to the detriment of young jobseekers, as well as women. While the national average unemployment rate was 13.3%, the unemployment rate for 15-24 year-olds was almost triple that in the same year, at 36.7%.

In 2024, the female employment rate stood at almost 20% (19.4%), i.e. one woman in five. Taking into account the female activity rate, itself below 20%, this means that less than 16% of Moroccan women of all ages are actually employed.

**Figure 3**

*Unemployment rate between 2023 and 2024 for certain categories of the population (in %)*

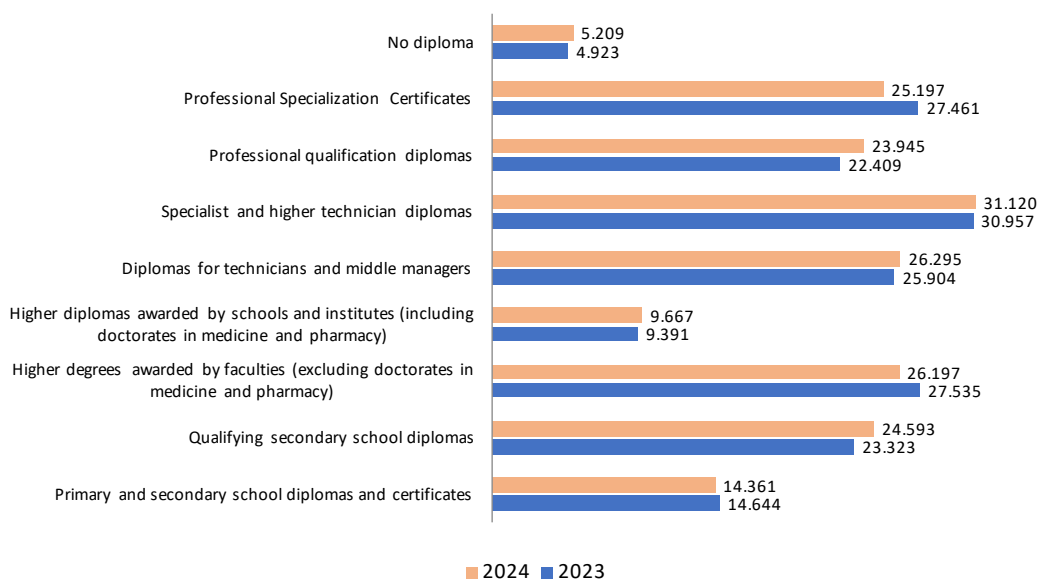


Source: HCP, Rabat. 2024

Figure 4 below shows two concomitant elements. In fact, two constants in the Moroccan labor market. These are the unemployment rates among "no diploma" holders and among holders of vocational training or higher education certificates or diplomas. In the former case, the unemployment rate, which can be described as full-employment, stands at just over 5%, while in the latter it averages over 25%, and reaches over 31% for specialized and higher technicians.

**Figure 4**

*Unemployment rate by degree between 2023 and 2024 (%)*



Source: HCP, Rabat. 2024

Such a configuration, while explaining the low level of labor productivity in the Moroccan economy and, incidentally, part of the slow growth in value-added generated by it, also means that the national education system is operating at a loss. This is because the education system produces unemployed people, either because the training it offers does not match the needs of the job market, or because the latter is reluctant to take up skilled jobs.<sup>2</sup>

This observation, fraught with consequences, leads us to the deficits in the Moroccan education system. Another social flaw in Morocco's public policies.

### ***Morocco's education and vocational training system, the country's other millstone around its neck***

The Moroccan government has made a considerable financial effort in the field of education. Until the end of the 1970s, the national education system generally fulfilled its missions. Despite the considerable deficits inherited from the colonial period - lack of financial and human resources; large numbers of young and not-so-young people left behind; linguistic problems, with a strong tug-of-war between the Spanish and French languages of the former colonists, and the local Arabic dialects and Amazigh (Berber) languages, etc. - and despite the strong demographic growth of the 1970s-1980s, it succeeded in widening Moroccans' access to education. It also provided the administration and the national economy with the managers needed to replace the foreign managers who left after independence in 1956. Moreover, for a time, education was a real channel for social mobility, opening up to the world, access to modernity and the production/strengthening of social ties" (Chakhrati & Amsidder, 2025).

However, from the early 1980s onwards, "the education system entered a long crisis, the most obvious symptoms of which are school wastage, the relapse of school leavers into illiteracy, the decline in civic sense and critical thinking, unemployment among university graduates, and the weakness of basic learning (reading, writing, arithmetic, languages, communication). Despite, and sometimes because of, a series of reforms, sometimes improvised and more often than not incomplete, the education system has become a heavy, unprofitable machine, producing graduates ill-prepared for the changes and demands of the modern economy and society. The system has ended up producing a multi-speed school, whose performance deteriorates the further you move away from the centers of major urban agglomerations" (Royaume du Maroc, 2005).

In fact, in addition to the observation made in the section above that, in the final analysis, "the less training you have in Morocco, or the less progress you make in training, the more likely you are to find a job". Two other observations are worth highlighting when discussing the failure of education policies in Morocco.

Thus, while the Moroccan government spends nearly 5% of the country's GDP (Ministry of Finance, 2024) on national education, i.e. more than the average for Arab countries or countries with similar economic development, only:

- The illiteracy rate is still high in the country. In 2023, one in three Moroccans over the age of 15 (around 34.2%) was illiterate, i.e. unable to read, write or do simple calculations, according to the Cour des Comptes annual report for 2023-2024. However, this rate represents a relatively significant - albeit very slow - reduction compared to 2004, when it stood at 47.7% (Tel Quel, 2024).

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<sup>2</sup> Due to the predominantly informal nature of the national production system, or the generally family/traditional way in which production units are organized within it, or both.

In addition, there's a strong imbalance here, with more emphasis on injustices against women.

As shown in the table below for the illiterate population aged 10 and over, the average illiteracy rate among women is almost double that of men. Even so, this rate has fallen sharply for both sexes since 1982.

**Table 2**

*Illiteracy rates by gender - trends between 1928 and 2024*

Years	Male	Female	Total
2024	17,20	32,40	24,80
2004	30,80	54,70	43,00
1994	41,00	67,00	55,00
1982	51,00	78,00	65,00

Source: HCP, Rabat. [https://www.hcp.ma/Taux-d-analphabetisme-de-la-population-agee-de-10-ans-et-plus-selon-le-sexe\\_a3323.html](https://www.hcp.ma/Taux-d-analphabetisme-de-la-population-agee-de-10-ans-et-plus-selon-le-sexe_a3323.html)

- Furthermore, in 2023, the HCP recorded that almost half (48.2%) of the working population in Morocco (and 71.6% of the working population in rural areas) had a level of education equal to or lower than that of basic schooling, i.e. a level devoid of any cognitive or professional aptitude.
- According to the HCP, one in four young Moroccans aged between 15 and 24 will be NEET (Not in Education, Employment or Training) in 2022, i.e. 1.5 million people. This figure underlines the inadequacy of public strategies and policies dedicated to the socio-economic integration of this particularly sensitive and vulnerable category. Such vulnerability is linked in particular to two determining factors, the first of which is school drop-out between primary and secondary school levels. In 2022, it was estimated that an average of over 331,000 pupils left school prematurely each year, without any diploma or educational qualifications, which represents a loss of both financial resources allocated to schools and human capital. The main reasons for this are failure at school, difficulties in accessing educational establishments (lack of roads, water and heating in schools, extreme poverty among parents, especially in rural areas, etc.), as well as a significant lack of vocational training opportunities. The second is when school-leavers enter the job market, where first-time job-seekers account for nearly 6 out of every 10 unemployed.

***The healthcare system: a qualitatively and quantitatively deficient system, reinforcing/prolonging regional imbalances***

The number of beneficiaries of the Compulsory Health Insurance (AMO) scheme, introduced in 2021, and of the National Social Security Fund (CNSS), has reached more than 24.7 million people, according to a communication made by the Moroccan government in February 2025. This number includes 3.1 million people in the public sector, as well as more than 11 million newly insured people who are unable to pay into the health insurance system, and whose contributions have been paid by the public authorities through an annual budget of 9.5 billion dirham, or almost 900 million euros (h24 info, 2025). Such an announcement expresses the social commitment of the Moroccan authorities. It is, however, weighed down by certain highly restrictive features of the Moroccan healthcare system.

Thus, in parallel with the low per capita national income and its highly unequal distribution between different regions and social categories - as mentioned above - it should be stressed that, until recently (i.e. the year 2021, when AMO was introduced), the burden of healthcare expenditure fell largely on households.



In this sense, according to a Ministry of Health report on the subject, it appears that households' direct contribution towards covering their healthcare costs amounted to 45.6% in 2018 (Ministry of Health, 2019). Adding the same households' health insurance contributions (14.3%), their share of healthcare expenditure rises to 59.7% of their disposable income.

Excluding social security contributions, the total individual expenditure on healthcare in Morocco in 2018 was 489 US dollars. By international comparison, this represented less than half the healthcare expenditure of a Lebanese person.

**Table 3**

*Comparison of individual expenditure on healthcare between Morocco and 4 countries with different levels of development*

Country	Individual healthcare expenditure (in US dollars)	Share of total individual expenditure
France	5.250	9,2%
United States of America	10.624	10,8%
Turkey	1.171	17,5%
Lebanon	1.080	33,2%
Morocco	489	45,2%

Source: WHO. Reprinted in "National health accounts". 2018. Ministry of Health, Rabat.

This financial situation is made even more restrictive to access to healthcare in Morocco by the low number of doctors per capita in the country. The country has just 8 doctors per 10,000 inhabitants, compared with a world average of 17.2 doctors per 10,000 inhabitants (OMS, 2022).

**Table 4**

*Regional distribution of Moroccan doctors, 2022*

Regions/Doctors	Public		Private		Total		
	Number	%	Number	%	Number	%	Cumulative
Casablanca-Settat	3.400	23.7	5.192	35,72	8.592	29,73	29,73
Rabat-Salé-Kénitra	1.900	13.23	2.990	20,57	4.890	16,92	46,65
Marrakech-Safi	2.174	15.14	1.459	10,03	3.633	12,57	59,22
Fez-Meknes	2.297	15.99	1.303	9,2	3.600	12,46	71,68
Tangier-Tetouan	1.582	11,02	1.270	8,73	2.852	9,87	81,55
<b>Total 5 regions</b>	<b>11.353</b>	<b>79,06</b>	<b>12.214</b>	<b>84,05</b>	<b>23.567</b>	<b>81,57</b>	<b>81,55</b>
<b>7 other regions</b>	<b>3.006</b>	<b>20,94</b>	<b>2.319</b>	<b>15,95</b>	<b>7.162</b>	<b>18,43</b>	<b>100</b>
<b>Total</b>	<b>14.359</b>	<b>100</b>	<b>14.533</b>	<b>100</b>	<b>28.892</b>	<b>100</b>	<b>100</b>

Source: Ministère de la Santé – Santé en chiffres. Rabat, 2022.

<https://www.sante.gov.ma/Documents/2024/02/Sante%20en%20chiffre%202022%20VF1.pdf>

For the rest, the table above shows that, more than the relatively small number of doctors available per capita, it is the highly unbalanced geographical distribution of these doctors across the country that makes healthcare services difficult to access for a large proportion of the population. Those living in rural areas, far from the main cities, are generally the poorest. Overall, Morocco is a medical desert, extending beyond 5 regions/urban centers where more than eight out of ten doctors are based nationwide.

This situation of regional under-medicalization is further exacerbated by the fact that almost ten thousand Moroccan doctors work outside the country. This has fuelled migratory

movements - including of skilled workers - making Morocco one of the most important emigration countries in the region. This phenomenon adds to the very unsocial nature of the country's public policies, as well as to the dependence of its economy, which continues to be financed to the tune of 8% by savings transfers from its citizens living abroad.

### ***Emigration from Morocco, another facet of exclusion and the failure of social policies***

From the early 1960s onwards, Morocco became a country of emigration, due to its historical ties with France and Spain, the two powers that occupied the country between 1912 and 1956. Secondly, because of the convergence between the great need for manpower expressed by certain European countries such as France (ILO, 1963) and Belgium (RTBF, 1964) - and the country's own economic and social policies. In the 1970s (Ministère du Plan, 1973), these policies had explicitly incorporated emigration as a means of limiting the pressure of job demand on the local labor market, and as a source of financing for the national economy.

Until the mid-1990s, there was no methodical monitoring of, and therefore no precise statistics on, emigration from Morocco to Europe. Until then Europe had been the main destination for Moroccan emigrants. However, according to estimates published by the OECD (OECD, 2017), the number of Moroccans born in Morocco and living abroad was around 650,000 in the 1960s, rising to around 800,000 in the following decade, before reaching just over 1.5 million in 2000 and 3 million in 2010, or almost 9% of the country's total population that year. These data reveal a very sharp acceleration in Moroccan migration from the beginning of the current century, with between 120,000 and 150,000 Moroccans leaving Morocco each year between 2000 and 2010.

For its part, the HCP, in charge of collecting statistics in Morocco, claims that there were 3.3 million Moroccans living abroad (Marocains résidant à l'étranger - MRE) in 2006, a figure that would have risen to 5.4 million by 2020, an increase of over 63% in the space of 14 years.<sup>3</sup>

**Table 5**

*Number of Moroccans living abroad, 1998-2006*

<b>Year</b>	<b>Number of Moroccans living outside Morocco (in millions)</b>
1998	1,66
2000	2,98
2002	2,55
2005	3,18
2006	3,30
2020	5,40

Source: HCP. Effectif des Marocains résidant à l'étranger.

[https://www.hcp.ma/Effectif-des-Marocains-residant-a-l-etranger-MRE\\_a705.html](https://www.hcp.ma/Effectif-des-Marocains-residant-a-l-etranger-MRE_a705.html)

These data, as presented above, show a very sharp acceleration in Moroccan migration over the last two decades, with, in particular, the number of residence permits (corresponding to regular migration) granted to Moroccan migrants in European Union countries varying between 120,000 and 150,000 annually, since the 2000s (Eurostat, 2019).

In a survey carried out between 2018 and 2019 by the HCP (HCP, 2020), it emerged that the continued departure in numbers of Moroccans abroad over the years is due to three

<sup>3</sup> Or to more than 5 million people in 2024, according to the King, in a speech on November 6, 2024. Maroc.ma <https://www.maroc.ma/fr/activites-royales/sm-le-roi-a-dresse-un-discours-la-nation-loccasion-du-49eme-anniversaire-de-la>

main reasons: 1) the search for employment and better working conditions; 2) studies and, 3) family reunification and marriage. According to the same survey, more than half of MREs (53.3%) left Morocco for economic reasons, and almost a quarter (23.4%) to pursue their studies abroad. The remainder left for social reasons (mainly family reunification and marriage) or political reasons (lack of political and/or religious freedoms, lack of respect for individual rights, etc.).

The numbers and other quotients quoted above speak for themselves when it comes to economic and social policies which, over 60 years ago, saw emigration as a temporary solution, but which ended up becoming a subject of conflict with Europe, particularly in terms of the "irregular migration" of Moroccans seeking a "better life elsewhere".

The latter remains relatively high, and even seems to have worsened with the health crisis of 2020, as shown in the table below, which shows that the number of Moroccan migrants attempting to leave Morocco irregularly increased by more than 3.5 times between 2016 and 2021.

**Table 6**

*Interceptions of Moroccan emigrants presumed in irregular situations, 2013 -2021*

Year	Interceptions of Moroccan emigrants presumed in irregular situations
2013	7.359
2014	11.586
2015	7.273
2016	7.064
2017	13.261
2018	18.190
2019	17.134
2020	20.243
2021	30.612

*Source:* Ministère de l'Intérieur, Rabat, Maroc.

### ***Access to water***

The ideologically and financially asocial nature of public policies in Morocco is particularly striking in the case of a basic service that is vital to the population: access to water and sanitation. In this sector, there is a complete gap between the rights proclaimed, both inside and outside the country, and what is actually applied.

Until the last decade (2010-2020), Morocco was one of only 13 countries worldwide (Water words, 2023) to have constitutionalized the right of access to water (see article 31 of the constitution, mentioned above). In the same vein, and both before and after the constitutionalization of access to water for all citizens, Moroccan lawmakers held, in the country's first water law, published in 1995, and then in a second, published in 2016, that "water is a public good that cannot be subject to private appropriation" (Ministry of Finance, 1995), "nor to transaction by sale and purchase" (Official Bulletin, 2016). Morocco also joined the community of nations when, on July 28, 2010, the United Nations General Assembly recognized "access to quality water and sanitation as a human right" (Nations Unies, 2010).

In practice, however, a completely different approach was followed, that of the State's offloading of this basic public service. In this context, the abandonment by the State of water, sanitation and electricity distribution services in Morocco took the legal form, from 1997 onwards, of "Delegated Management". Although there was no legal framework in place at the

time (CESE, 2015), this was to result in the gradual transfer to private capital - in this case, to two major French groups - of the distribution of the relevant services in three of Morocco's largest urban centers, Casablanca, Rabat-Salé and Tangier-Tetouan.

Thus, in 1997, Lyonnaise des Eaux took control of the public water company (Régie Autonome de Distribution - RAD) in Casablanca; the former RAD became Lydec. In 1998, the same operation was carried out in Rabat for the benefit of Spanish and Portuguese investors, who had never before been involved in the water sector, even in their own countries.

That same year (2002), Veolia Environnement-Maroc took over management of the two water utilities in the northern cities of Tangier and Tetouan. Thus, in the space of 6 years (1997-2002), public service delegation for water (and electricity) covered 50% of the volume of water distributed - and wastewater treatment - in Moroccan cities.

Introduced for essentially economic, financial and ideological reasons, delegated management was intended to "relieve the State" of the financial and "managerial" burden associated with urban water and electricity distribution, reduce the time it takes to connect "users/customers", and facilitate and reduce collection times.

Very quickly, however, the economic and "social" principles behind the decision to use the legal mechanism of delegated management - which in effect amounts to privatization of the service - came up against the poverty of the population, especially in the outlying districts of the urban centers concerned. And the principles of consent to pay, full cost recovery and "water pays for water" were applied to all subscribers. This application was made all the more painful for the population by the fact that, at the same time, the State introduced VAT on water and sanitation in 2006 (Ministry of Finance, 2006). The *opérations de branchements sociaux* (costing rates, technical measures, and regulations to ensure utility service connections for all) which were intended to facilitate access to the network for the poorest, failed to deliver the expected results. In the country's economic metropolis, Casablanca, for example, 10,000 new connections per year were announced annually, but the number of new connections actually made did not exceed 1,250 between 1997 and 2007.

It's as if the discourse around the right of access to water, water as a common good, and water as a non-market good, which can be "neither bought nor sold", is aimed at international public opinion. And it is invited only to better cover the liberal bias of public policies in Morocco, which are more focused on "covering costs" and the financial profitability of the actions undertaken than on their social effects.

And, in fact, these policies - with regard to distribution services as with any other basic service - take the exact opposite direction to the official proclamations of faith. The latter appear, in the final analysis, to be no more than a cover for the true ideological foundation of the Moroccan state. That of a liberal state acting in the social sectors, or qualified as such, only to better serve the interests of private capital.

In fact, if we omit this, we wouldn't understand why the management of water and liquid sanitation and the distribution of electricity have been delegated to private capital in some of the country's major conurbations, namely Casablanca-Mohammadia/Rabat-Salé/Tanger and Tétouan. Nor do we understand why freshwater springs - community resources for centuries - have been handed over to private individuals without further ado (in 2006/2007, in the case of Aïn Sultan, in the Fès region, and in 2010, in the case of Ben S'mime, in the Ifrane region. These two springs, whose water abstraction represents a veritable

spoliation of the populations who used to live on them, come on top of, for example, the more ancient transfers of the natural waters of Oulmès/Sidi Ali, in the Middle Atlas, Sidi Harazem or Aïn Fès, in the center of the country (Lahlou, 2024).

### Conclusions

Morocco - a country with 3,500 km of coastline among the world's richest in fish, the world's richest phosphate reserves, the fastest train on the African continent, inexhaustible solar energy potential, one of the largest ports in the Mediterranean and a motorway network that compares favourably with many European networks, etc.... - despite all this, occupies an unenviable position when it comes to the human development indicator presented as a benchmark for social development by the UNDP.

A review of the country's 7 key social and socio-economic sectors and their situation in 2025 provides ample evidence of this, while confirming the most pessimistic projections announced by the authors of the Fiftieth Anniversary Report of 2005, referred to several times in this text.

This report also stated that "The uncertain effectiveness of governance (could) be detrimental to the country's development if the shortcomings inherent in the public management system are not corrected: corruption, dysfunctional justice system, lack of program evaluation culture, compartmentalization and dispersion of sectoral solutions and ministerial departments, lack of planning and time management in public policies" (Royaume du Maroc, 2005).

"The scale of deficits could be exacerbated. A financial crisis or social crises would become likely. A financial crisis, which could take the form of a deterioration in the current account of the balance of payments or an accumulation of record budget deficits, in the absence of alternative budget revenues, would place Morocco under international conditions (adjustment programs). As for social crises, they would be triggered in particular by a succession of worsening droughts, persistent and worsening unemployment, deepening inequalities, a decline in freedoms and the rise of fundamentalism. The consequences for human development are far from positive" (Royaume du Maroc, 2005).

Now, 20 years later, and since before the Covid-19 pandemic added its devastating economic and social effects to those of the drought and other crises - double-digit inflation, disruption of commodity imports, rising prices for energy and certain basic materials, etc. it is evident that the "coherent choices" referred to in 2005 have not been made. Or they have been incoherent choices, in any case economically and socially inefficient. And even when some have been made, they have not been followed by effective policies or operational projects, or they have been sidetracked by poor political and administrative governance. In many cases, they have also been undermined by a lack of oversight on the part of the authorities responsible for implementing them, or by the persistence of contingent phenomena that continue to plague Moroccan society, notably corruption and/or nepotism.

Over the years, these trends became so obvious that the Head of State was compelled to voice it himself, announcing in a speech to parliament in 2017 the failure of the "Moroccan development model" followed until then. Thus, according to him, "the last few years have revealed the inability of our development model to satisfy the growing needs of some of our citizens, and to reduce social inequalities and spatial disparities" (Maroc Diplomatie, 2017).

The Human Development Index (HDI), a summary indicator that ranks countries worldwide according to their social performance in the broadest sense, shows that Morocco has been treading water, or nearly so, since 2005. In that year, its HDI was equal to 0.631, and in 2018 it was still only 0.676 - an increase, in 13 years, of 0.045 points - and in 2022 (UNDP, 2024), the same HDI was 0.698, ranking it 120<sup>th</sup> in the world (among 193 countries), behind Palestine (111<sup>th</sup>), over-populated Egypt (105<sup>th</sup>) or war-torn Arab countries such as Iraq, Libya or Lebanon, and many other Arab countries as poorly endowed with energy and natural resources as Jordan or Tunisia.

Such a position on the international social scene means that Morocco has not moved in the direction of the necessary changes demanded of it by some of its own human skills at the start of the current century. In 2005, these experts stated that "Morocco is at a crossroads. It is facing a historic situation of great choices and great goals, which boil down to two fundamental and contrasting options. On the one hand, the country can resolutely embark on a virtuous dynamic of renewal and development, seizing the opportunities open to it and making the reform process a permanent and structural one. On the other hand, resolving the knots of the future that stand in the way of development can be postponed indefinitely. These are the two paths that Morocco faces over the next two decades. One is regressive, lax and demobilizing, while the other is backed by a far more ambitious and proactive vision, commensurate with the strengths of the Moroccan people. The success of future generations and the consolidation of human development gains will necessarily require adherence to a proactive vision, based on overcoming the knots of the future, that of a desirable and possible Morocco" (Royaume du Maroc, 2005).

In fact, exactly 20 years (2005-2025) after such an observation/prophesy, the "regressive path", as predicted, seems indisputable. This is as true in terms of the purely economic framework, when it comes to the single variable relating to national income, as it is in terms of the social data that are the benchmark, such as employment and unemployment, education, migration and access to certain basic public services/goods such as health, water and sanitation.

At this level, it's clear that there's a huge gap in Morocco between the political rhetoric that puts the government's "social action" at the forefront of its priorities, and the realities on the ground, as well as those supported by some of these policies. A discrepancy that a new report - published in the spring of 2021 and referred to as the New Development Model (NMD) Report - has been unable to explain or justify. The report, for its part, postponed the deadline for overcoming the crisis to the 2030s. And that with a growth projection of 6.5% annually, between 2019 and 2035 (Kingdom of Morocco, 2021). That's almost 4 points more, on average per year, than between 2005 and 2019.

There are many factual and political reasons for all this, which are difficult to analyze here, but which can be summed up in *three major blocking factors*, in addition to the ambivalent role of the central administration and its territorial machinery.

As highlighted by the fiftieth anniversary report, "The administrative machine has shown little concern for the poor, even though it was the only actor in human development. While it has shown itself capable of building telecommunication networks, energy infrastructures, various industrial projects, dams, ports, freeways and airports, it has nonetheless suffered from a lack of listening, dialogue, proximity, delegation of responsibility and initiative". But this same machine has functioned under the supervision of the political system in place, and has acted in its own interest and security.

In this sense, the political institutions in place in Morocco, and the mode of governance that prevails there, have a lot to do with the findings of social deficits presented successively in this paper. These institutions and governance have not fundamentally changed since the 1960s. Even if they have modernized their means and structures, they have remained little inclined to scrutiny and questioning, even though they are at the origin and delivery of everything that is important in political, judicial, economic and social terms, etc., in the country.

Secondly, at the same time, the failure of the education system to integrate the entire school-age population, to retain it, and to train it on the basis of programs open to progress, particularly social progress, has contributed to the continued lack of emancipation of institutions. It has also allowed the continuation of blockages in terms of the nature of investment, labor productivity, the organization of production and the distribution of added value within the economy. As a result, today's economy is still on the "road to development", dependent on foreign countries, international markets and the level and annual distribution of rainfall.

This failure, combined with the persistent precariousness of a large part of the population, was at the root of violent religiosity and terrorist acts, during the years 2000 and 2010, the like of which Morocco has never experienced in its modern history (GREASE, 2018-2022).

Finally, in this synthesis, the place accorded to women in Moroccan society has made them both victims of social policies and agents of continuation of negative repercussions of these same policies and perpetrators of their negative effects. Moroccan women are the first to suffer the effects of all the social deficits mentioned in the various sections of this paper, including difficult access to school, employment and the healthcare system. Access is even more difficult in rural areas and far from major cities, where religious and social conservatism still prevails. It is also subject to an injustice that can be described as "endemic". That of access to wealth - and potentially to the means of investment - through the first form of its distribution, that of inheritance. Yet, until now, in a Morocco described as modern compared to other Arab-Muslim countries, no reform has dared to put an end to the absolute injustice of only entitling half as much property inheritance for a female heir as for a male heir. The "family code," in a reform project announced for the end of 2024 (Lemonde.fr, 2024), still only barely authorizes parents to make gifts during their lifetime to their daughters, even minors.

### **Acknowledgements**

I express gratitude to my friends at Global Migration Policy Associates, particularly to Patrick Taran and Olga Kadysheva, who encouraged me to write this article and supported me throughout its development, translation from the original French version and finalization, making this in many respects a collective text. I extend my sincere thanks and appreciation as well to the reviewers and editors.

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# **Innovación Educativa / Innovation in Education**



## Aprendizaje Basado en Proyectos, una práctica educativa innovadora en el Bachillerato Técnico

### Project-Based Learning, an innovative educational practice in the Technical Baccalaureate

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Enviado: 2024/07/09  
Aceptado: 2025/04/04  
Publicado: 2025/06/30

#### Resumen

La educación en el Bachillerato Técnico (BT) en instituciones públicas de Ecuador se fundamenta en el desarrollo de competencias a través de la adquisición de conocimientos teóricos y prácticos. Esto prepara a los estudiantes para su inserción en el ámbito laboral, emprender proyectos personales o dar continuidad a su formación superior. En este contexto, el objetivo de este artículo es aplicar el Aprendizaje Basado en Proyectos (ABP) como una práctica educativa innovadora en el proceso de enseñanza-aprendizaje de los estudiantes de tercero de Bachillerato Técnico de la especialidad de Electrónica de Consumo de la Unidad Educativa Guillermo Mensi y que contribuya al fortalecimiento de las competencias adquiridas por los estudiantes. La investigación se basó en un enfoque de investigación mixta, que combinó métodos cuantitativos y cualitativos para la recopilación y el análisis de los datos. La muestra incluyó a 38 estudiantes y 7 docentes, seleccionados mediante muestreo no probabilístico. Se evaluó el desempeño académico de los estudiantes y el grado de satisfacción de estudiantes y docentes, antes y después de la implementación del ABP. Los resultados revelaron un impacto positivo del ABP en los siguientes aspectos: rendimiento académico, metodología de enseñanza en el BT, desarrollo de competencias y recursos educativos. Finalmente, se concluye que la implementación del ABP como una práctica educativa innovadora en el BT influyó positivamente en el fortalecimiento de las competencias adquiridas por los estudiantes que cursaron el módulo de Equipos y Sistemas Microprocesados durante el periodo lectivo 2022 - 2023.

**Sumario:** Introducción, Metodología, Resultados, Discusión, Conclusiones.

**Como citar:** Pedrosa, A. & Loyola, E. (2025). Aprendizaje Basado en Proyectos, una práctica educativa innovadora en el Bachillerato Técnico. *Revista Tecnológica - Espol*, 37(1), 195-212.  
<https://rte.espol.edu.ec/index.php/tecnologica/article/view/1202>

**Palabras clave:** Educación Técnica, Formación Profesional, Metodología de Enseñanza, Desempeño Académico, Recursos Educativos, desarrollo de competencias, contenidos teóricos y prácticos.

### Abstract

Technical Baccalaureate (BT) education in public institutions in Ecuador is based on the development of competencies through the acquisition of theoretical and practical knowledge. This prepares students for their insertion in the labor market, to undertake personal projects, or to continue their higher education. In this context, the objective of this article is to apply Project Based Learning (PBL) as an innovative educational practice in the teaching-learning process of the third year students of the Technical Baccalaureate of the Consumer Electronics specialty of the Guillermo Mensi Educational Unit and that contributes to the strengthening of the competencies acquired by the students. This research is based on a mixed research approach, combining quantitative and qualitative methods for data collection and analysis. The sample included 38 students and 7 teachers, selected through non-probabilistic sampling. Academic performance, as well as student and teacher satisfaction, were evaluated before and after the implementation of PBL. The results revealed a positive impact of PBL in the following aspects: academic performance, teaching methodology in the BT, development of competencies, and educational resources. Finally, it is concluded that the implementation of PBL as an innovative educational practice in the BT positively influenced the strengthening of the competencies acquired by the students who participated in the Microprocessed Equipment and Systems module during the 2022 - 2023 school year.

**Keywords:** Technical education, Professional Training, Teaching Methodology, Academic Performance, Educational Resources, development of competencies, theoretical and practical content.

### Introducción

Esta investigación surge de la necesidad de superar las barreras que enfrentan los estudiantes y docentes en el contexto del Bachillerato Técnico (BT) en Ecuador, con un enfoque particular en la Unidad Educativa Guillermo Mensi, en la ciudad de Cuenca. Entre estas barreras destacan las limitaciones en infraestructura, las restricciones económicas y el desinterés estudiantil por los contenidos teóricos, los mismos que son asimilados mínimamente en comparación con los contenidos prácticos. Estas problemáticas se han visto acentuadas tras la pandemia, dado que la interrupción abrupta de las actividades en los laboratorios restringió el proceso de enseñanza-aprendizaje a la transmisión de conocimientos exclusivamente teóricos. Como consecuencia, se han evidenciado deficiencias en el desarrollo de competencias técnicas en el estudiantado, situación documentada en las actas de las reuniones del área de Electrónica de Consumo.

Estas problemáticas subrayan la importancia de explorar metodologías innovadoras, como el Aprendizaje Basado en Proyectos (ABP), el cual ha demostrado su efectividad para incrementar la motivación estudiantil, favorecer un aprendizaje significativo y establecer una conexión entre los contenidos teóricos y su aplicación práctica (Martínez, 2023). El sistema educativo del BT Fiscal en Ecuador se sustenta en la estructura curricular establecida por el Ministerio de Educación, con un enfoque orientado al desarrollo de competencias para los estudiantes (Ministerio de Educación, 2023).

En este contexto, la presente investigación se enfoca en evaluar el impacto del ABP como una práctica educativa innovadora en la formación técnica de los estudiantes de tercero

de BT en la Figura Profesional (FIP) de Electrónica de Consumo, específicamente aquellos que cursaron el módulo de Equipos y Sistemas Microprocesados durante el periodo lectivo 2022-2023. Los hallazgos obtenidos permitirán aportar soluciones aplicables a contextos educativos similares.

El Bachillerato Técnico constituye una modalidad educativa que faculta a los estudiantes a robustecer su inserción en el ámbito laboral, emprender iniciativas de carácter social o económico, así como dar continuidad a su desarrollo técnico y tecnológico en educación superior (Ministerio de Educación, 2023). Su fundamento reside en un enfoque de aprendizaje teórico y práctico, sustentado en una metodología propia basada en el Diseño Curricular; no obstante, estudios recientes destacan la necesidad de revisar y actualizar estos enfoques para garantizar que la formación técnica responda a los cambios acelerados en el mercado laboral y la tecnología (Vera et al., 2020). En este contexto, el docente desempeña un papel crucial al definir el método y los procedimientos para el desarrollo de las competencias que engloban un conjunto de saberes, aptitudes, destrezas y disposiciones que habilitan el desempeño profesional de acuerdo con las demandas de la producción y el empleo (Asamblea Nacional de Ecuador, 2011).

Vera et al. (2020) señalan que los educadores de instituciones técnicas evidencian la importancia de implementar metodologías que faciliten la adquisición de habilidades orientadas a fomentar un espíritu emprendedor e innovador en el entorno educativo. El ABP ha sido identificado como una estrategia clave para abordar esta necesidad, ya que permite que los estudiantes trabajen en proyectos que simulan situaciones del mundo real, facilitando la transferencia del conocimiento a un entorno laboral o profesional (Bolick et al., 2024), además, según los líderes educativos, se reconoce la importancia de diseñar estrategias educativas que estén orientadas a la realidad sociocultural de su zona y que repercutan positivamente en la comunidad. Este enfoque podría tener un doble beneficio: motivar a los estudiantes y fomentar su participación activa (Vera et al., 2020).

La formación técnica se presenta como un elemento indispensable en las estrategias gubernamentales a nivel regional en Ecuador, enfocándose en impulsar el progreso económico y garantizar la igualdad social. Esta perspectiva ha adquirido notoriedad gracias a su contribución a la mejora de las oportunidades de empleo y la preparación de individuos para ejercer un impacto positivo en la eficiencia, excelencia y aptitud competitiva en los procesos de producción y el sector empresarial (Tomaselli, 2018). En este sentido, la implementación de metodologías activas como el ABP no solo mejora el aprendizaje, sino que también contribuye a cerrar la brecha entre la educación y las necesidades del sector productivo (Bornacelly, 2013).

D'Ascaino (2022), enfatiza la relevancia de la educación técnica como un pilar esencial para afrontar las exigencias tecnológicas, económicas y sociales que caracterizan la época contemporánea. Esto se refleja en su posición destacada dentro del proceso de transformación y desarrollo de Argentina, ya que la formación continua del personal es imprescindible para un sector laboral en constante modernización. En México, el Colegio Nacional de Educación Profesional Técnica ha mantenido su compromiso por más de cuatro décadas como una institución dedicada a la educación técnica. En este tiempo, ha realizado valiosas aportaciones y experimentadas transformaciones orientadas al perfeccionamiento del plan de estudios y enfoques pedagógicos de la educación técnica en la nación. Esto permite a los estudiantes adquirir o mejorar sus competencias en diversos campos laborales (Bernal, 2020).

En la actualidad el ABP constituye un enfoque educativo de gran relevancia, por su metodología orientada a la innovación del proceso de enseñanza-aprendizaje y que se ha extendido en todos los establecimientos educativos del mundo, cuya metodología educativa se centra en los estudiantes motivándolos a asumir un involucramiento activo en su proceso de formación. Este enfoque organiza y estructura las actividades de manera que los estudiantes trabajen colaborativamente en grupos y apliquen lo aprendido durante las clases para el beneficio de toda la comunidad. (Ministerio de Educación, 2019). El ABP se caracteriza por las facilidades que ofrece en la asimilación efectiva de los contenidos teóricos, en contraste con otros métodos tradicionales como la clase magistral y el estudio memorístico; los estudiantes participan activamente en los procesos de aprendizaje, asumiendo una mayor responsabilidad y autonomía, que se evidencia con un cambio significativo en su proceso de enseñanza-aprendizaje (Navarro et al., 2019).

Según Thomas (2015) el ABP es una metodología activa en la cual los estudiantes alcanzan un conocimiento profundo y perdurable mediante la realización de investigaciones, la atención de problemas y la realización de proyectos prácticos para solventar necesidades del mundo real. Este enfoque fomenta el desarrollo del pensamiento crítico, la capacidad de resolución de problemas y la cooperación entre los estudiantes, quienes pueden participar en un proyecto de duración variable, que puede extenderse desde una semana hasta varios meses, dependiendo de su nivel de complejidad (Bytyqi, 2021). Así también, los principales actores son los estudiantes y los educadores. Los estudiantes participan activamente en la identificación del problema, la investigación, la planificación, la ejecución del proyecto y la presentación de sus hallazgos. Los docentes actúan como guías y facilitadores, brindando orientación y apoyo durante todo el proceso (Blumenfeld et al., 2011; Thomas, 2015).

Asimismo, la planificación del ABP puede variar en función de los objetivos educativos, el nivel de los estudiantes, los recursos disponibles y otros factores contextuales. Aunque el ABP sigue una estructura general que implica la identificación de un problema o pregunta, la investigación, la colaboración y la presentación de resultados, la planificación e implementación pueden variar en cada caso (Barron y Darling, 2008; Botella y Ramos, 2019; Thomas, 2000). En este sentido Aragay y Martínez (2020), AulaPlaneta, (2015) y SomProjecte, (2020) proponen las siguientes etapas para la planificación de un ABP:

1. Elección del tema y formulación de la pregunta guía.- Se debe seleccionar un tema relacionado con los contenidos curriculares a impartir, que sea significativo y despierte el interés de los estudiantes. Puede estar relacionado con la solución de problemas técnicos, el diseño de proyectos o la aplicación de habilidades prácticas.
2. Formación de equipos y roles.- Se debe organizar grupos de estudiantes preferiblemente de tres o máximo cuatro, con perfiles diversos, para que cada integrante pueda desempeñar una función específica.
3. Definir el producto o desafío final.- Se define el producto que los equipos deberán alcanzar a base de la o las competencias a ser desarrolladas. Algunas opciones son las siguientes: presentaciones, prototipos, informes, exhibiciones, posibles soluciones a un problema, propuestas, entre otros.
4. Planificación del proyecto.- Consiste en elaborar un plan detallado que incluya los objetivos, los recursos necesarios, los plazos, las tareas y las responsabilidades de los estudiantes y el docente a lo largo del proceso.
5. Investigación y adquisición de conocimientos.- Radica en que los estudiantes se sumerjan en un proceso de investigación activa y autónoma para obtener los conocimientos necesarios que les permitan abordar el proyecto de manera informada.

6. Diseño y desarrollo.- Los estudiantes trabajan de manera colaborativa para diseñar y desarrollar el producto o solución como respuesta a la pregunta guía planteada en el proyecto.
7. Elaboración del producto final.- Es el momento en el que los estudiantes ponen en práctica lo aprendido y trabajan de manera activa para llevar a cabo su producto final.
8. Presentación del proyecto.- Los estudiantes exponen los resultados de su trabajo a una audiencia relevante. Esta presentación puede tomar diferentes formas, dependiendo del contexto y los objetivos del proyecto.
9. Respuesta colectiva a la pregunta inicial. Los equipos de trabajo reflexionan sobre los resultados y plantean una resolución conjunta para la interrogante, problema o incógnita con la que comenzó el proyecto.
10. Evaluación y Autoevaluación.- Es fundamental realizar una evaluación y autoevaluación de los resultados obtenidos para verificar si se han alcanzado los objetivos, reflexionar sobre el aprendizaje y mejorar futuros proyectos.

La organización del ABP ha facilitado su utilización en diferentes campos relacionados a la educación, por ejemplo, Vargas (2021), lo utilizó para la enseñanza de la estadística descriptiva, Rodríguez (2022), para cambiar el desempeño del alumnado en la clase de música, Salido (2020, p. 137), lo aplicó en la formación inicial del profesorado de arte de Educación Primaria, Pérez (2023), lo implementó para enseñar los contenidos básicos de la Física y Química en el bachillerato, Ayerbe y Perales (2020, p. 181), lo aplicaron para mejorar la conciencia ambiental en los estudiantes de secundaria, entre otros temas. Sin duda el ABP ha promovido la creatividad y el pensamiento innovador en los estudiantes, al involucrarlos en la resolución de problemas que los invita a aplicar sus conocimientos en contextos auténticos, lo cual despierta su curiosidad y los impulsa a buscar soluciones innovadoras (Soriano y Jiménez, 2023); sin embargo, no se ha evaluado el ABP como una práctica educativa innovadora en la enseñanza del Bachillerato Técnico.

Esta investigación analiza cómo influyó la aplicación del ABP como una práctica educativa innovadora en el proceso de aprendizaje de los estudiantes de tercero de BT de la FIP de Electrónica de Consumo de la Unidad Educativa Guillermo Mensi. En este contexto, se realizó una revisión exhaustiva de los fundamentos teóricos que sustentan el ABP, con el propósito de desarrollar una guía de trabajo basada en esta metodología. La guía se elaboró para ser utilizada por los docentes y estudiantes en el entorno de los laboratorios.

De igual manera, se aplicó una encuesta a estudiantes y docentes con el propósito de evaluar su nivel de satisfacción respecto a la metodología utilizada y su impacto efectivo en la adquisición de conocimientos por parte de los estudiantes. Este proceso se llevó a cabo en dos momentos diferentes: al finalizar el primer quimestre, sin la utilización del ABP, y al concluir el segundo quimestre, una vez que el ABP había sido incorporado en el proceso de enseñanza. Así también, se analizó el rendimiento académico de los estudiantes a partir de sus calificaciones obtenidas durante el primer quimestre sin la aplicación del ABP, y en el segundo quimestre, con la integración del ABP en su proceso de aprendizaje.

Finalmente, los resultados obtenidos al finalizar el primer quimestre revelaron una significativa insatisfacción por parte de los estudiantes respecto a la metodología empleada, así como un interés limitado por parte de los docentes en el ABP; no obstante, al término del segundo quimestre se concluye que la implementación del ABP, en el proceso de enseñanza-aprendizaje de los estudiantes de tercero de BT de la FIP de Electrónica de Consumo, estableció cambios positivos tanto en la actitud de los estudiantes como de los docentes. Se superó el

enfoque tradicionalista donde el docente es considerado el único responsable de la custodia y transmisión de conocimientos. Los estudiantes experimentaron un aumento en su motivación, se promovió el trabajo colaborativo, la participación activa durante las clases y una mejor predisposición para la asimilación de los contenidos teóricos y prácticos.

### Metodología

La finalidad de esta investigación es aplicar el Aprendizaje Basado en Proyectos como una práctica educativa innovadora en el proceso de enseñanza-aprendizaje de los estudiantes de tercero de Bachillerato Técnico de la especialidad de Electrónica de Consumo de la Unidad Educativa Guillermo Mensi y que contribuya al fortalecimiento de las competencias adquiridas por los estudiantes. En este contexto se establecieron tres objetivos específicos para abordar el presente estudio:

1. Identificar las estrategias de enseñanza-aprendizaje mediante el estudio de los contenidos teóricos para proponer una guía de trabajo basada en el ABP.
2. Implementar el Aprendizaje Basado en Proyectos en el proceso de enseñanza-aprendizaje para desarrollar las competencias de los estudiantes de tercero de Bachillerato Técnico de la especialidad de Electrónica de Consumo.
3. Validar los resultados obtenidos mediante un análisis cuantitativo y cualitativo para medir la percepción de los estudiantes.

El desarrollo de esta investigación asumió un enfoque mixto, que consiste en un proceso de recaudo y análisis de información de tipo cuantitativo mediante un diseño experimental (Hernandez y Mendoza, 2018) y cualitativo basado en un diseño de investigación acción (Latorre, 2005; Sanahuja et al., 2020), reflejados en la información obtenida y procesada en la fase de diagnóstico inicial sin ABP y la fase final con ABP, conformado por datos numéricos relacionados al rendimiento académico de los estudiantes y los resultados obtenidos de la encuesta aplicada a docentes y estudiantes del BT.

La investigación tubo un alcance descriptivo, que permitió indagar la incidencia (Hernandez y Mendoza, 2018) de la metodología del APB en el proceso de enseñanza-aprendizaje de los estudiantes, el mismo que está orientado al desarrollo de competencias mediante la consolidación de los conocimientos teóricos y prácticos.

a. El abordaje del primer objetivo se direccionó a través del método analítico deductivo y el sintético. La estrategia descompone y relaciona el tema en elementos más simples y luego los sintetiza para una comprensión profunda. Se emplearon técnicas como la revisión documental, la revisión bibliográfica y la revisión de webgráficas para analizar y sintetizar información de documentos existentes relacionados con el ABP. El propósito fue elaborar una Guía de Trabajo fundamentada en el ABP para su utilización por parte de docentes y estudiantes en los laboratorios de la especialidad de Electrónica de Consumo.

b. En el marco del segundo objetivo se utilizó el método sistémico, que es una estrategia educativa que enfoca el aprendizaje en sistemas interconectados, promoviendo la comprensión holística. En la recopilación de la información se aplicó la técnica de análisis de contenidos con la finalidad de examinar en detalle los cuadros de notas de los estudiantes al concluir tanto el primer como segundo quimestre del año lectivo 2022 - 2023. Así también, se empleó la técnica de la encuesta, aplicada a docentes y estudiantes con el propósito de evaluar los resultados de aprendizaje de los estudiantes antes y después de la implementación del ABP en el proceso de enseñanza-aprendizaje. Este instrumento está conformado por 6 ítems en la escala de Likert, que va desde Muy alto (5), Alto (4), Mediano (3), Bajo (2) y hasta Muy bajo (1),



además dos ítems que son de opción múltiple y una pregunta abierta. Estos ítems se organizaron en tres temáticas:

1. Metodología de enseñanza en el BT: ítems 1, 2 y 7.
2. Desarrollo de competencias: ítems 5 y 6.
3. Recursos educativos: ítems 3, 4 y 9.

La evaluación de la metodología de enseñanza en el BT es esencial para comprender la transición hacia el ABP y su impacto en la experiencia de aprendizaje. La temática del desarrollo de competencias aborda directamente los objetivos formativos del BT, al evaluar cómo el ABP contribuye al desarrollo de los conocimientos teóricos y prácticos. Finalmente, los recursos educativos reflejan la importancia de las herramientas tradicionales y digitales en el ABP, proporcionando percepciones sobre su integración y aceptación. Estas temáticas se seleccionaron estratégicamente para obtener una comprensión holística de cómo el ABP influye en la metodología, competencias y recursos educativos en el contexto específico de BT.

c. Finalmente, para el tercer objetivo se utilizó el método de triangulación, que es una estrategia de investigación que combina múltiples fuentes de datos y enfoques para mejorar la validez y la confiabilidad de los hallazgos. Los datos se recolectaron en dos momentos diferentes del proceso investigativo, en el primero, se analizaron los resultados sin la utilización del ABP, mientras que, en el segundo, se evaluaron los resultados después de la implementación del ABP. Se empleó la técnica de análisis comparativo para estudiar la incidencia del ABP en el proceso de enseñanza-aprendizaje de los estudiantes de tercero de BT de la (FIP) de Electrónica de Consumo de la Unidad Educativa Guillermo Mensi.

### **Muestra**

La población de estudio estuvo conformada por 173 estudiantes y 22 docentes que pertenecen al BT en la FIP de Electrónica de Consumo. La muestra se determinó utilizando la técnica de muestreo no probabilístico, conformada por 38 estudiantes de los terceros de BT y 7 docentes que dan cátedra a estos paralelos.

### **Resultados**

Los resultados principales obtenidos en esta investigación, ratifican que el ABP evidencia una tendencia de un cambio positivo en la disposición de los estudiantes, tras la implantación del ABP como una práctica educativa innovadora en el proceso de enseñanza-aprendizaje de los contenidos teóricos y prácticos con la finalidad de fomentar el desarrollo de competencias en los estudiantes de tercero de BT de la FIP de Electrónica de Consumo de la Unidad Educativa Guillermo Mensi.

### **Resultados de las encuestas aplicadas a los estudiantes y docentes**

A continuación, se presentan los resultados más relevantes obtenidos al implementar el ABP en el proceso de enseñanza-aprendizaje de los estudiantes de BT, los mismos que, para un mejor entendimiento han sido agrupados en tres temáticas: 1. Metodología de enseñanza en el BT, 2. Desarrollo de competencias y 3. Recursos educativos.

#### ***Temática 1: Metodología de enseñanza en el Bachillerato Técnico***

Esta temática mide la importancia de utilizar el ABP como una metodología activa en el proceso de enseñanza-aprendizaje de los estudiantes. En la Tabla 1, la pregunta: ¿La forma de enseñar del profesor facilita su aprendizaje? El 68,4% de los estudiantes al concluir el primer quimestre manifiestan estar medianamente satisfechos con la forma de enseñar del docente, mientras que, al finalizar el segundo quimestre el 65,8% (Valores 4 y 5) están satisfechos. En

la pregunta “¿El profesor le informa sobre lo que usted desarrollará en la clase?”, el 44,7% de los estudiantes al término del primer quimestre manifiestan estar medianamente satisfechos con la información proporcionada por el profesor, mientras que, al finalizar el segundo quimestre el 73,7% (Valores 4 y 5) están satisfechos. En cuanto a la pregunta de si le gustaría utilizar el ABP para su aprendizaje, el 60,5% (valores 4 y 5) de los estudiantes, al término del primer quimestre, manifiestan que les gustaría aprender utilizando el ABP, mientras que al finalizar el segundo quimestre el 81,6% (Valores 4 y 5) ratifican su preferencia por el ABP como método de aprendizaje.

**Tabla 1**

*Nivel de satisfacción de los estudiantes con la metodología utilizada por el docente*

ÍTEM	NIVEL DE SATISFACCIÓN (%)									
	SIN ABP					CON ABP				
	1	2	3	4	5	1	2	3	4	5
1. ¿La forma de enseñar del profesor facilita su aprendizaje?	2,6	0,0	68,4	26,3	2,6	-	-	34,2	47,4	18,4
2. ¿El profesor le informa sobre lo que usted desarrollará en la clase?	-	7,9	44,7	42,1	5,3	-	-	26,3	39,5	34,2
3. Le gustaría utilizar el Aprendizaje Basado en Proyectos para su aprendizaje.	2,6	2,6	34,2	42,1	18,4	-	-	18,4	47,4	34,2

*Nota:* 1-Muy bajo, 2-Bajo, 3-Mediano, 4-Alto, 5-Muy Alto.

Así también, desde la perspectiva del docente se evalúa la importancia de utilizar el ABP en el proceso de enseñanza-aprendizaje de los estudiantes. En la Tabla 2, la pregunta referente a los tipos de metodologías utilizadas por el docente durante sus horas de clase, el 85,7% de los docentes encuestados, al finalizar el segundo quimestre y tras la implementación del ABP, expresan su preferencia por el ABP como metodología de enseñanza, en comparación con las metodologías previamente empleadas, que incluía el Aula Invertida y el Aprendizaje Basado en Competencias durante el primer quimestre.

**Tabla 2**

*Metodologías utilizadas por el docente*

Ítem: De los siguientes tipos de metodologías subraye dos que usted utilice frecuentemente durante sus horas de clase:																		
SIN ABP									CON ABP									
G	AI	AC	ABD	ABC	PBA	ABP	MC	O	A	AI	AC	ABD	ABC	PBA	ABP	MC	O	
-	57,1	-	-	57,1	28,6	14,3	42,9	-	-	-	14,3	-	28,6	14,3	85,7	42,9	-	

*Nota:* G-Gamificación, AI-Aula invertida, AC-Aprendizaje cooperativo, ABD-Aprendizaje basado en destrezas, ABC-Aprendizaje basado en competencias, PBA-Aprendizaje basado en problemas, ABP-Aprendizaje basado en proyectos, MC-Metodología constructivista, O-Otro.

De igual manera, la pregunta “¿Considera usted que la metodología utilizada facilita el proceso de enseñanza-aprendizaje de los estudiantes?” establece que el 85,8% (valores 4 y 5) de los docentes encuestados, al término del primer quimestre, están satisfechos con la metodología empleada en la enseñanza de los estudiantes; sin embargo, al finalizar el segundo quimestre el 100% (Valores 4 y 5) manifiesta satisfacción con la utilización del ABP como

método de enseñanza. En la interrogante acerca de si el docente socializa a los estudiantes la planificación y metodología que se seguirá durante las horas de clase, se determina que el 14,3% de los docentes, al concluir el primer quimestre, informan a los estudiantes sobre cómo se trabajará en clase; no obstante, al término del segundo quimestre, el 100% comunica a los estudiantes la planificación y metodología. Así también, la respuesta a la pregunta sobre si el docente estaría de acuerdo en incorporar el ABP en su proceso de enseñanza-aprendizaje, revela que al 85,7% de profesores, al finalizar el primer quimestre, les interesaría implementar el ABP; sin embargo, al concluir el segundo quimestre, el 100% (Valores 4 y 5) implementa el ABP en su proceso de enseñanza (Véase Tabla 3).

**Tabla 3**

*Nivel de satisfacción del docente al trabajar con el ABP*

ÍTEM	NIVEL DE SATISFACCIÓN (%)									
	SIN ABP					CON ABP				
	1	2	3	4	5	1	2	3	4	5
1. ¿Considera usted que la metodología utilizada facilita el proceso de enseñanza-aprendizaje de los estudiantes?	-	-	14,3	42,9	42,9	-	-	-	28,6	71,4
2. Socializa a los estudiantes la planificación y metodología que se seguirá durante las horas de clase.	-	-	14,3	71,4	14,3	-	-	-	28,6	71,4
3. Estaría de acuerdo en incorporar el Aprendizaje Basado en Proyectos en sus procesos de enseñanza-aprendizaje.	-	-	14,3	28,6	57,1	-	-	-	14,3	85,7

*Nota:* 1-Muy bajo, 2-Bajo, 3-Mediano, 4-Alto, 5-Muy Alto.

En términos generales, la implementación del ABP como metodología de enseñanza en el BT, ha fortalecido la comunicación entre el docente y los estudiantes. Un porcentaje significativo de alumnos destaca su preferencia por el ABP como metodología de enseñanza, mientras que en los docentes es evidente un creciente interés por el ABP, lo que los motiva a incorporar esta metodología en el proceso de enseñanza-aprendizaje de los estudiantes.

### **Temática2: Desarrollo de competencias**

Esta temática permite medir la importancia del ABP como una práctica educativa en el desarrollo de las competencias de los estudiantes. En cuanto a la pregunta de si las clases teóricas facilitan el aprendizaje, el 57,8% (Valores 1, 2 y 3) de los estudiantes, al finalizar el primer quimestre, no están satisfechos con las clases teóricas, mientras que, al finalizar el segundo quimestre el 65,8% (Valores 4 y 5) están satisfechos. Respecto a la interrogante de si las clases prácticas facilitan el aprendizaje, al finalizar el primer y segundo quimestre se evidencia que el nivel de satisfacción de los estudiantes tiene un incremento del 78,9% al 86,8% (Valores 4 y 5) (Véase Tabla 4).

**Tabla 4**

*Nivel de satisfacción de los estudiantes al desarrollar los contenidos teóricos y prácticos*

ÍTEM	NIVEL DE SATISFACCIÓN (%)									
	SIN ABP					CON ABP				
	1	2	3	4	5	1	2	3	4	5
1. Las clases teóricas facilitan su aprendizaje.	2,6	18,4	36,8	42,1	-	-	-	34,2	47,4	18,4
2. Las clases prácticas facilitan su aprendizaje.	-	-	21,1	44,7	34,2	-	-	13,2	34,2	52,6

*Nota:* 1-Muy bajo, 2-Bajo, 3-Mediano, 4-Alto, 5-Muy Alto.

Desde la perspectiva del docente, también se evalúa la relevancia del ABP en el proceso de enseñanza, para fomentar el desarrollo de las competencias de los estudiantes. En este sentido, en cuanto a la pregunta de si la metodología utilizada permite que los estudiantes alcancen un nivel de conocimiento teórico, el 42,9% de los docentes consideran que los estudiantes han alcanzado medianamente los conocimientos al finalizar el primer quimestre; sin embargo, es relevante destacar que al concluir el segundo quimestre el 100% (Valores 4 y 5) de los docentes afirman que los estudiantes han alcanzado un nivel de conocimiento teórico satisfactorio. Con respecto a la interrogante de si la metodología utilizada permite que los estudiantes alcancen un nivel de conocimiento práctico, el 28,6% de los docentes sostienen que los estudiantes han alcanzado medianamente los conocimientos en el primer quimestre, mientras que, al concluir el segundo quimestre el 85,8% (Valores 4 y 5) considera que los estudiantes han alcanzado un nivel de conocimiento práctico satisfactorio (Véase Tabla 5).

**Tabla 5**

*Percepción del docente sobre los conocimientos teóricos y prácticos desarrollados por los estudiantes*

ÍTEM	NIVEL DE SATISFACCIÓN (%)									
	SIN ABP					CON ABP				
	1	2	3	4	5	1	2	3	4	5
1. A base de la metodología utilizada considera usted que los estudiantes han alcanzado un nivel de conocimiento teórico.	-	-	42,9	57,1	-	-	-	-	57,1	42,9
2. A base de la metodología utilizada considera usted que los estudiantes han alcanzado un nivel de conocimiento práctico.	-	-	28,6	71,4	-	-	-	14,3	42,9	42,9

*Nota:* 1-Muy bajo, 2-Bajo, 3-Mediano, 4-Alto, 5-Muy Alto.

Tanto los docentes como los estudiantes en un mayor porcentaje concuerdan en que la aplicación del ABP influye positivamente en el desarrollo de competencias, permitiendo a los estudiantes asimilar de manera más efectiva tanto los conocimientos teóricos como prácticos.

### **Temática 3: Recursos educativos**

Esta temática proporciona una visión sobre la utilización de recursos educativos durante las clases con la finalidad de incentivar el desarrollo de las competencias en los estudiantes. En este sentido, los estudiantes enfatizan en que los recursos tecnológicos más empleados por los docentes en el primer quimestre incluyen el computador, el proyector y los programas de simulación. Al finalizar el segundo quimestre, se observa un mayor énfasis en el uso de estos mismos recursos tecnológicos, resaltando un destacado aumento en la utilización de Internet, alcanzando un 47,4% (Véase Tabla 6).

**Tabla 6**

*Recursos tecnológicos utilizados para desarrollar las competencias en los estudiantes*

ÍTEM: Durante la clase ¿qué recursos tecnológicos utiliza frecuentemente el profesor? Marque el o los recursos que usted ha evidenciado.											
SIN ABP						CON ABP					
C	P	T	Ps	I	O	C	P	T	PS	I	O
<b>86,8%</b>	89,5%	-	60,5%	26,3%	-	97,4%	92,1%	-	86,8%	47,4%	5,3%

*Nota:* C-Computador, P-Proyector, T-Tablet, Ps-Programas de simulación, I-Internet, O-Otros.

En cuanto al uso de herramientas digitales en la web, los estudiantes encuestados sostienen que durante el primer quimestre no se identificó el uso de tales herramientas; no obstante, al finalizar el segundo quimestre, los estudiantes señalan que los docentes han incorporado herramientas como Genially y Padlet en las sesiones de clase (Véase Tabla 7).

**Tabla 7**

*Herramientas digitales utilizadas para desarrollar las competencias en los estudiantes*

**ÍTEM:** Durante la clase que herramienta digital en la web utiliza frecuentemente el profesor. Marque el o los recursos que usted ha evidenciado.

G	SIN ABP					CON ABP					
	Ca	Cd	P	S	O	G	Ca	Cd	P	S	O
2,6%	2,6%	-	-	-	65,8%	28,9%	-	-	18,4%	2,6%	86,8%

*Nota:* G-Genially, Ca-Canva, Cd-Classdojo, P-Padlet, S-Symbaloo, O-Otros.

Asimismo, se aplicó una pregunta abierta con el fin de obtener la percepción de los estudiantes y recopilar posibles sugerencias para elevar la calidad de la práctica educativa. Para analizar las sugerencias de mejora, se categorizaron las respuestas de los encuestados en cuatro grupos y se registró su frecuencia. Al finalizar el primer quimestre, de los estudiantes encuestados, el 15,8% expresaron la necesidad de mejorar el espacio y los recursos del laboratorio, el 13,2% sugirió proporcionar más tiempo para las actividades, y el 52,6% planteó que se debe mejorar la metodología de enseñanza. Sin embargo, al concluir el segundo quimestre y tras la implementación del ABP, se observa una significativa disminución en los porcentajes. Esto sugiere que los estudiantes han optimizado el uso de los espacios y recursos en el laboratorio, han mejorado su organización del tiempo para completar sus actividades y están más satisfechos con la metodología utilizada, además, han destacado la relevancia del uso de Internet en un 15,8% (Véase Tabla 8).

**Tabla 8**

*Sugerencias de mejora desde la percepción de los estudiantes*

**ÍTEM:** ¿Desde su experiencia que considera que se debe mejorar en las clases?

CATEGORÍAS	SIN ABP		CON ABP	
	Nº de encuestados	Porcentaje (%)	Nº de encuestados	Porcentaje (%)
Mejorar el espacio y recursos del laboratorio.	6	15,8	3	7,9
Proporcionar más tiempo para las actividades.	5	13,2	3	7,9
Mejorar la metodología de enseñanza.	20	52,6	13	34,2
Internet.	0	0,0	6	15,8

Así también, desde la perspectiva del docente se analiza la importancia de los recursos educativos en el proceso de enseñanza-aprendizaje de los estudiantes. En lo referente a la consulta de si el docente utiliza recursos tecnológicos para planificar las actividades que

trabajará con los estudiantes, se evidencia que la totalidad de los docentes encuestados confirman el uso de recursos tecnológicos, tanto en el primer como en el segundo quimestre, para la planificación de sus actividades con los estudiantes. En la consulta de si el docente utiliza herramientas digitales en la web para planificar las actividades que trabajará con los estudiantes, se observa que la preferencia de los docentes hacia el uso de las herramientas digitales en la web, ha aumentado significativamente en un 14,3% después de la implementación del ABP (Véase Tabla 9).

**Tabla 9**

*Recursos educativos utilizados por el docente en la planificación de actividades*

ÍTEM	SIN ABP		CON ABP	
	SI	NO	SI	NO
1. Para planificar las actividades que trabajará con los estudiantes. ¿Utiliza recursos tecnológicos?	100%	-	100%	-
2. Para planificar las actividades que trabajará con los estudiantes. ¿Utiliza herramientas digitales en la web?	57,1%	42,9%	71,4%	28,6%

De igual forma, se incluye una pregunta abierta con el propósito de obtener la percepción de los docentes y recopilar posibles sugerencias para mejorar la calidad de la práctica educativa. Para analizar las sugerencias de mejora, se categorizaron las respuestas de los encuestados en dos grupos y se registró su frecuencia. Al finalizar el primer quimestre, se evidencia que el 42,9% de los docentes encuestados manifiestan la necesidad de mejorar el espacio y los recursos de los laboratorios, mientras que el 57,1% sugirió que se debe incentivar la motivación y compromiso de los estudiantes; no obstante, al concluir el segundo quimestre y una vez implementado el ABP los docentes no consideran que los espacios y recursos de los laboratorios sean un limitante; por el contrario, la totalidad de los docentes coinciden en la importancia de fomentar la motivación y compromiso del alumnado durante la clase (Véase Tabla 10).

La totalidad de los docentes utilizan recursos tecnológicos y un porcentaje significativo de ellos ha incorporado las herramientas digitales de la web en sus planificaciones. Este enfoque ha tenido un impacto positivo en el proceso de aprendizaje de los estudiantes, además, el ABP ha generado efectos positivos al inculcar en los estudiantes la noción de que la carencia de recursos no es un limitante para su aprendizaje, sino más bien una oportunidad para mejorarlo.

**Tabla 10**

*Sugerencias de mejora desde la perspectiva del docente*

ÍTEM: ¿Desde su experiencia, qué considera que se debe mejorar en las clases para que los estudiantes tengan una participación activa?				
CATEGORÍAS	SIN ABP		CON ABP	
	Nº de encuestados	Porcentaje (%)	Nº de encuestados	Porcentaje (%)
Mejorar el espacio y recursos del laboratorio.	3	42,9	-	-
Incentivar la motivación y compromiso de los estudiantes.	4	57,1	7	100

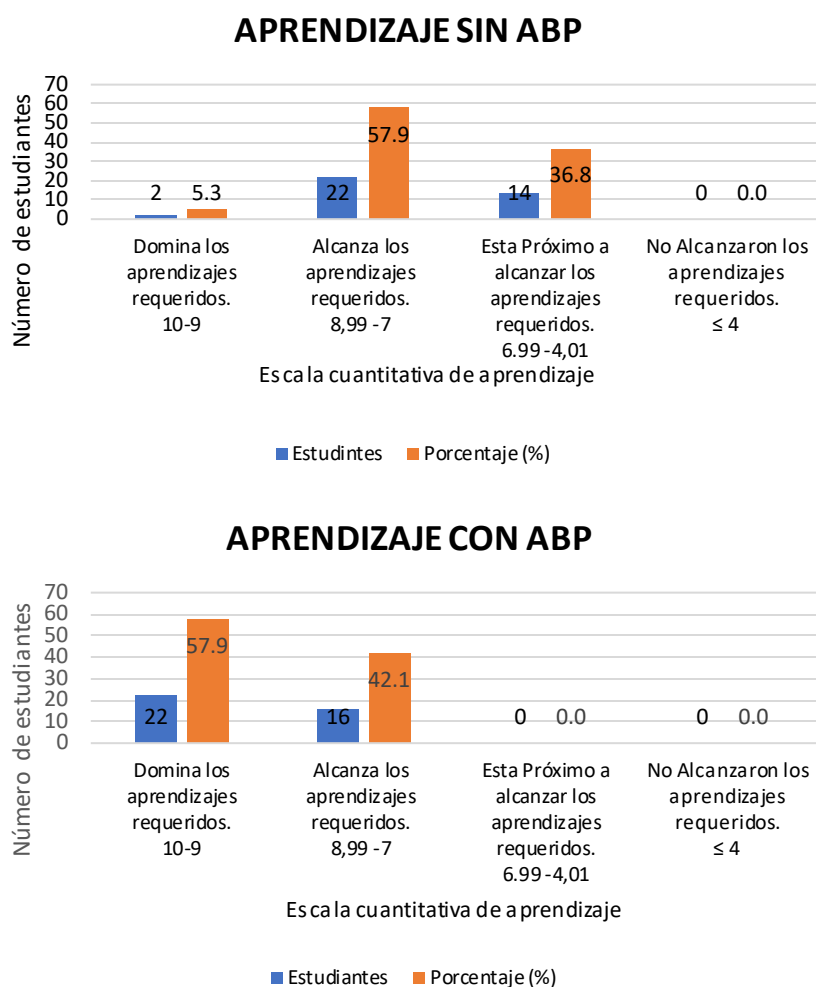
### Cuadro de rendimiento académico de los estudiantes.

La evaluación del rendimiento académico se entiende como el nivel de éxito que el estudiante alcanzó en sus estudios y actividades educativas al cursar el módulo de Equipos y Sistemas Microprocesados. Este indicador se deriva del cálculo del promedio general, que se obtiene al promediar las calificaciones asignadas a los proyectos realizados por los estudiantes durante un periodo específico. Dichas calificaciones se basan en escalas de valoración que reflejan el “cumplimiento de los objetivos de aprendizaje establecidos en el currículo y los estándares de aprendizaje”(Asamblea Nacional de Ecuador, 2023).

Como punto de partida, es importante destacar que al finalizar el primer quimestre, antes de la implementación del ABP, el rendimiento académico de las y los estudiantes se distribuye principalmente en las escalas de “Está próximo a alcanzar los aprendizajes requeridos” con un 36.8%, “Alcanza los aprendizajes requeridos” con un 57,9%, y “Domina los aprendizajes requeridos” con un mínimo porcentaje del 5,3%; no obstante, al concluir el segundo quimestre, una vez que se ha implementado al ABP en el proceso de enseñanza-aprendizaje de los estudiantes se observa un aumento significativo en las escalas de: “Alcanza los aprendizajes requeridos” con un 42,1% y “Domina los aprendizajes requeridos” con un 57,9%. Es relevante señalar que, en ambos casos, la escala en la que los estudiantes “No alcanza los aprendizajes requeridos” se mantiene en un 0% (Véase Figura 1).

**Figura 1**

*Rendimiento académico de los estudiantes*



## Discusión

La investigación revela que los estudiantes han experimentado cambios significativos en su actitud y desempeño académico tras la implementación del ABP como una práctica educativa innovadora en el BT, enfocada en la asimilación de los contenidos tanto teóricos como prácticos, facilitando el desarrollo de sus competencias. Estos hallazgos coinciden con otras investigaciones, entre ellas la de Thomas (2015), que destaca los beneficios de la utilización del ABP en la mejora del aprendizaje y desarrollo de competencias, pero existen otras variables que inciden en el proceso y que son comparables en contextos educativos diferentes. Estos resultados pueden ser extrapolables a otros contextos educativos similares, permitiendo que futuras investigaciones repliquen la metodología en distintos entornos académicos y comparen su eficacia.

En lo referente a la metodología de aprendizaje en el Bachillerato Técnico, el ABP en esta investigación incide de manera positiva desde la percepción de los estudiantes. Antes de la implementación del ABP, algunos estudiantes expresaron un nivel de satisfacción moderada con la metodología utilizada por los docentes; sin embargo, al finalizar el segundo quimestre, periodo en el cual se aplicó el ABP este nivel moderado de satisfacción fue incrementado, ratificando la pertinencia de esta alternativa educativa.

Desde la perspectiva de los docentes, también se observa un cambio positivo. Inicialmente, algunos docentes utilizaban como metodología el Aula Invertida y el Aprendizaje Basado en Competencias. Sin embargo, al finalizar el segundo quimestre, la mayoría de los docentes prefirieron el ABP. Esto sugiere que los profesores han experimentado una transición hacia el ABP y están satisfechos con los resultados que se obtienen con los estudiantes. Este cambio está relacionado con la efectividad del ABP en el desarrollo de competencias, lo que respalda la noción de que esta metodología mejora la práctica educativa en el contexto técnico, realidad reflejada en la investigación de (Thomas, 2000).

En lo que respecta al desarrollo de competencias, en un principio algunos estudiantes no estaban satisfechos con las clases teóricas y prácticas, sin embargo, al término del segundo quimestre, una vez implementado el ABP se evidencia un incremento representativo en la satisfacción estudiantil. Esto indica que el ABP resultó efectivo en el desarrollo de las competencias para el aprendizaje en el ámbito de la formación técnica (Bes et al., 2023).

Desde el punto de vista de los docentes, se observa una mejora significativa en su percepción sobre el nivel de conocimiento de los estudiantes. Al principio, algunos docentes consideraron que los estudiantes solo habían alcanzado un conocimiento mediano, pero al final del año académico, todos afirmaron que los estudiantes habían alcanzado un nivel satisfactorio de conocimientos teóricos y prácticos. Esto sugiere que el ABP puede mejorar la adquisición de conocimientos y competencias (Bes et al., 2023; Lozano et al., 2022); sin embargo, es relevante realizar investigaciones futuras sobre el impacto a largo plazo del ABP en el desarrollo de competencias profesionales de los estudiantes.

En cuanto a los recursos educativos, los resultados revelan que los estudiantes notaron el uso de recursos tecnológicos, como computadoras, proyectores y programas de simulación durante las clases, además, algunos estudiantes informaron el uso de otras herramientas digitales como Genially y Padlet por parte de los docentes. Esto sugiere que el ABP puede estar promoviendo el uso de tecnología en el aula, lo que es relevante en la formación técnica. El resultado es coherente con la tendencia actual de incorporar la tecnología en el aula para enriquecer la enseñanza y el aprendizaje (Pavel et al., 2015).



Con base en los fundamentos teóricos que sustentan el enfoque del ABP, se formuló una Guía de Trabajo destinada a ser empleada en el entorno de los laboratorios asociados a la FIP de Electrónica de Consumo, en el contexto del BT. El diseño de este formato está organizado en una estructura compuesta por cinco etapas, las cuales son implementadas de manera colaborativa por el estudiante y el docente facilitador. Cabe destacar que esta guía fue objeto de un proceso de socialización, y posterior aprobación, durante las reuniones llevadas a cabo en el marco del área de Electrónica de Consumo; asimismo, se empleó como instrumento para evaluar el desempeño académico de los estudiantes. Futuras investigaciones podrían evaluar la efectividad de esta guía en otros entornos educativos, así como su adaptabilidad en otras FIP del BT.

En términos de rendimiento académico, los resultados reflejan una mejora significativa tras la implementación del ABP, evidenciada en la calificación cuantitativa luego del proceso de evaluación correspondiente. En cuanto al nivel de aprendizaje después de la implementación del ABP, se incrementó significativamente evidenciando que el alumnado ha mejorado el dominio de los contenidos, según la escala de valoración establecida en el Reglamento General de la Ley Orgánica de Educación Intercultural vigente.

### Conclusiones

La metodología del ABP fortalece el aprendizaje profundo y significativo por parte de los estudiantes, estimulando sus competencias y el nivel de satisfacción en su proceso de aprendizaje, realidad que se evidencia en los docentes que también expresan una mayor satisfacción al incorporar en su rol la metodología del ABP. Estos hallazgos pueden ser considerados como un modelo para mejorar la enseñanza en otras instituciones técnicas y tecnológicas.

Se constata que la implementación del ABP como metodología de enseñanza en el BT incide de manera efectiva en el desarrollo de las competencias de los estudiantes. Esto se evidencia al finalizar el año lectivo con un incremento significativo en el nivel de satisfacción del alumnado, tanto en las clases teóricas como prácticas; es decir, el ABP contribuye de manera sustancial a una experiencia de aprendizaje percibida por el estudiante más eficaz; asimismo, los docentes perciben que los estudiantes alcanzan niveles de conocimiento más satisfactorios de contenidos que sean de carácter teórico como práctico. Esto sugiere que la aplicación del ABP puede ser igualmente efectiva en otros contextos de educación técnica y profesional.

En cuanto a la utilización de recursos educativos, los resultados evidencian que los docentes han integrado de manera positiva recursos tecnológicos y herramientas digitales *online* en sus prácticas pedagógicas, esto ha generado un impacto favorable en los estudiantes. Se ha observado un incremento en la utilización de computadoras, proyectores, programas de simulación y otros recursos digitales en línea durante el segundo quimestre. Estos resultados sugieren seguir explorando el papel de las tecnologías emergentes en el ABP, como el uso de realidad virtual y simulaciones interactivas.

Respecto a las sugerencias de mejora se resalta el hecho de que algunos estudiantes enfatizan la importancia del uso del Internet y se propone la continuidad del uso del ABP como enfoque pedagógico. En este contexto, se recomienda una mayor integración de estrategias híbridas que combinen el ABP con metodologías digitales, lo que permitiría adaptar el modelo a distintos niveles y especialidades dentro del BT. Esta sugerencia es respaldada por los docentes, quienes enfatizan que el ABP permite que los estudiantes se sientan motivados y comprometidos durante la clase.

De igual manera, los resultados revelan que los estudiantes mejoraron de forma positiva el desempeño académico, valorado conforme la escala de la LOEI. Inicialmente, los logros de los estudiantes se situaban en las categorías "Alcanza los aprendizajes requeridos" y "Está próximo a alcanzar los aprendizajes requeridos"; no obstante, al finalizar el segundo quimestre, los niveles de logro se elevan a "Alcanza los aprendizajes requeridos" y "Domina los aprendizajes requeridos". Este hallazgo sugiere que el ABP puede mejorar el rendimiento académico en un corto plazo.

Finalmente, los resultados obtenidos afirman que los estudiantes han experimentado cambios significativos en su actitud, la metodología de enseñanza, el desarrollo de competencias, el uso de recursos educativos y su desempeño académico después de la implementación del ABP como una práctica educativa innovadora en el BT, con impacto positivo en el fortalecimiento de las competencias declaradas en módulo de Equipos y Sistemas Microprocesados. Se recomienda que futuras investigaciones analicen la sostenibilidad del ABP a largo plazo, así como su impacto en la inserción laboral de los egresados del BT.

### Reconocimientos

Los autores declaran la contribución y participación equitativa de roles de autoría para esta publicación.

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## Gamificación en el aprendizaje de las matemáticas

### Gamification in Mathematics Learning

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Enviado: 2024/09/30  
Aceptado: 2025/04/08  
Publicado: 2025/06/30

#### Resumen

La falta de estrategias innovadoras a la hora de enseñar genera problemas en el aprendizaje de matemática, considerada esencial para el desarrollo del pensamiento lógico y crítico de las personas; no obstante, actualmente su enseñanza ha enfrentado grandes desafíos que van desde la motivación por aprender hasta la inclusión de la gamificación en el proceso educativo. El propósito de la investigación fue determinar el aporte de las estrategias de gamificación en el aprendizaje de operaciones de suma y resta de fracciones en los estudiantes de séptimo grado de Educación General Básica. La investigación tuvo un enfoque cuantitativo de diseño pre experimental, se trabajó con un solo grupo experimental de 31 estudiantes, con modalidad bibliográfica y de campo. Para la recolección de información se aplicó un test donde se evaluaron aspectos referentes a la teoría y práctica contextualizada de suma y resta de fracciones. Los resultados mostraron que en el pretest las calificaciones dieron una media de 6.69, colocando a los estudiantes en la escala de está próximo a alcanzar los aprendizajes requeridos, según el Reglamento de la Ley Orgánica de Educación. Después de la intervención

**Sumario:** Introducción, Materiales y Métodos, Resultados y Discusión, Conclusiones.

**Como citar:** Rivera, J., Morocho-Lara, D., Quimbita, P. & Bustos, Y. (2025). Gamificación en el aprendizaje de las matemáticas. *Revista Tecnológica - Espol*, 37(1), 213-226.  
<https://rte.espol.edu.ec/index.php/tecnologica/article/view/1257>

de las estrategias de gamificación, las calificaciones del postest arrojaron una media de 8.85, ubicándolos en la escala de alcanza los aprendizajes requeridos, evidenciando la efectividad de la aplicación. Finalmente, se concluye que las estrategias de gamificación ayudan a los estudiantes a comprender conceptos de fracciones y, por consiguiente, un incremento en su desempeño académico.

**Palabras clave:** Aprendizaje, Enseñanza, Estrategias, Fracciones, Gamificación, Innovación, Juego, Matemática, Motivación.

### Abstract

The lack of innovative teaching strategies causes problems in learning mathematics, which is considered essential for developing logical and critical thinking in individuals. The way mathematics is taught today faces significant challenges, ranging from motivational issues to to the potential inclusion of gamification in the educational process. The purpose of the research was to determine the impact of gamification strategies in learning addition and subtraction operations with fractions among seventh-grade students in Basic General Education. The study followed a quantitative approach with a pre-experimental design, working with a single experimental group of 31 students, employing both bibliographic and field methods. For data collection, a test was administered to assess aspects related to the theory and contextualized practice of adding and subtracting fractions. The results showed that in the pre-test, the scores had an average of 6.69, placing students in the “close to achieving the required learning” category, according to the Regulations of the Organic Law of Education. After the implementation of gamification strategies, the post-test scores showed an average of 8.85, placing them in the “achieves the required learning” category, demonstrating the effectiveness of the intervention. The study concluded that gamification strategies help students understand fraction concepts and learn mathematics, leading to improved academic performance.

**Keywords:** Learning, Teaching, Strategies, Fractions, Gamification, Innovation, Game, Mathematics, Motivation.

### Introducción

Después de la pandemia se ha presenciado la nueva realidad del sistema educativo adaptándonos a un tipo de educación virtual, los docentes buscan diversas formas de inspirar y mantener a los estudiantes interesados en aprender con la finalidad de desarrollar no solo habilidades intelectuales sino también actitudinales que permitan la realización de las actividades cotidianas. El aprendizaje de la matemática también ha contribuido a lo largo de la historia, pues no solo es importante para la vida académica, sino que desempeña un papel protagónico en situaciones de la vida cotidiana. Estas habilidades se pueden desarrollar con la ayuda de la tecnología que ha sido una aliada fundamental para fortalecer el proceso educativo mediante la gamificación, donde los alumnos progresan por diversas rutas de aprendizaje personalizado, y completan misiones y juegos dentro de varias secciones a más de realizar ejercicios asignados para el grupo (Matific, 2024).

Por tal motivo, el presente trabajo de investigación determinó el aporte de las estrategias de gamificación en el aprendizaje de operaciones de suma y resta de fracciones en los estudiantes de séptimo grado de Educación General Básica. La investigación, tuvo un diseño pre experimental, con enfoque cuantitativo, bajo una modalidad de campo y bibliográfica, fue de nivel aplicado, se intervino en la población de estudio para transformar su realidad, se aplicó un pre-test y post-test para analizar la información expresada mediante gráficos y tablas.

## Estrategias de Gamificación

Gamificación es un término que se ha adoptado de la lengua inglesa y su raíz procede de la palabra *game* que significa juego y también se lo denominada ludificación por aprovechar las herramientas y recursos que brinda el juego para optimizar el rendimiento y resultados. La gamificación es una estrategia educativa que utiliza los elementos de los juegos en el proceso de enseñanza con el propósito de incentivar al estudiante a aprender, haciendo que sea más activo y motivador, a la vez que facilita el desarrollo de habilidades y destrezas útiles para la vida (Boussad, 2023).

Por su parte, Arias y Aguilar (2023) mencionan que la gamificación se considera una estrategia que incorpora elementos propios de los juegos en contextos que no están diseñados para ser recreativos, es decir, en ambientes de trabajo que carecen de interactividad, participación o entretenimiento. En el ámbito educativo se aplica con el objetivo de despertar la motivación en los estudiantes para provocar la participación activa que permita mejorar y construir su aprendizaje. Al implementarla, se destacan elementos como recompensas, desafíos, colaboración y competencia, lo que despierta en los estudiantes curiosidad y entusiasmo por aprender de manera interactiva, significativa y motivadora.

Por otra parte, Jiménez et al. (2019) mencionan que la gamificación no utiliza en esencia, como apoyo, las tecnologías, ya que se pueden efectuar actividades sin ellas, en las diversas asignaturas que desarrollan las instituciones; además, señalan que la gamificación promueve el desarrollo de competencias cívicas y sociales, así también, facilitan el proceso de enseñanza-aprendizaje, lo que impulsa a los centros educativos a capacitar a sus docentes y a proporcionar las herramientas y recursos adecuados para ponerlos en práctica en las aulas de clase.

## Características

La gamificación, al ser una estrategia fundamentada en el juego, presenta cuatro características:

- Normas: Detallan las condiciones o reglas que deben seguir los participantes para alcanzar el objetivo del juego, con el objetivo de desarrollar capacidades y pensamientos estratégicos.
- Objetivos: Son aquellos resultados de éxito que los participantes quieren obtener al participar en la actividad.
- Feedback: Se determina por medio de calificación o puntos que adquieren los participantes al atravesar los niveles para conocer cuan cerca o lejos están de cumplir el objetivo.
- Participación voluntaria: Freire J, (2022), asegura que la experiencia sea agradable y significativa, ya que conocen las normas, objetivos y feedback que se establecieron al inicio de las actividades.

## Elementos

Es importante tener en cuenta varios aspectos para diseñar actividades gamificadas que beneficien al protagonista del proceso educativo, el estudiante. García et al. (2020) mencionan que la gamificación se cimienta en tres pilares fundamentales: dinámicas, mecánicas y componentes. Estos pilares, al combinarse, hacen posible la creación de experiencias de aprendizaje motivadoras, atractivas y lo más importante efectivas en la adquisición de habilidades y conceptos. De esta manera, se mejora su participación, involucrándolo activamente como el actor principal en las diversas actividades que se lleven a cabo.

## Dinámicas

Este primer pilar, según Zambrano et al. (2020), se relaciona con los sistemas, patrones o contextos que desarrollan los juegos generando en el jugador emociones y deseos por involucrarse y continuar, pues de lo contrario se tornaría rutinario y perdería el interés por jugar. Algunas de las dinámicas son las siguientes:

- **Recompensas:** Beneficios que consigue el jugador al finalizar la actividad, haciendo que repita varias veces esta conducta, se conoce como un sistema de puntos. Es importante establecer distintas recompensas tomando en cuenta la dificultad de la actividad planteada.
- **Estatus:** Diferentes niveles o clasificaciones que tiene el juego, ya que motiva al jugador a alcanzar una posición superior con el que se siente respetado y reconocido por los demás jugadores.
- **Logros:** Alcanzar algo que tiene cierto nivel de dificultad después de varios esfuerzos, generando satisfacción personal por hacerlo.
- **Competición:** Conseguir recompensas de acuerdo con su rendimiento en comparación con sus demás compañeros.
- **Expresión:** Crear un avatar que refleje las características de los jugadores.

## Mecánicas

Se refiere a los elementos, reglas o técnicas que utiliza la gamificación para motivar al participante y que este alcance la meta u objetivo. García et al. (2020). Algunas de ellas son las siguientes:

- **Puntos:** Ganar puntos permite al participante esforzarse en la ejecución de las actividades para recibir premios.
- **Niveles:** Es la progresión que va adquiriendo el jugador conforme juega, se caracteriza por aumentar la dificultad a medida que va avanzando.
- **Premios:** Reconocimientos que recibe el jugador por avanzar, algunos de estos son diplomas, trofeos o medallas; mostrando que su trabajo es reconocido.
- **Misiones:** Actividades a largo plazo que realizan los participantes de forma grupal o individual, aquí se puede dividir las distintas recompensas durante la trayectoria de estas misiones.

## Componentes

Finalmente, para García y Alejaldre (2018), el pilar de componentes se define como recursos diseñados para las actividades concretas, que se aplican dentro de una actividad gamificada con el fin de mejorar la experiencia del usuario. Entre ellos están:

- **Avatares:** Representaciones visuales o jugadores virtuales que cada jugador personaliza de acuerdo a sus preferencias o complejidad de nivel, brinda una identidad al usuario que permite el reconocimiento de otros jugadores.
- **Colecciones:** Conjunto de elementos que se van acumulando mediante el desarrollo del juego para intercambiarlos por diversos beneficios.
- **Combate:** Competencia que se realiza entre los participantes para alcanzar el mismo objetivo, con la finalidad de ganar al oponente.

Las estrategias de gamificación (Tabla 1) al utilizar elementos del juego responde a las exigencias que demanda la era digital, es así que los docentes pueden adaptar esta herramienta en la planificación del proceso de enseñanza-aprendizaje tomando en cuenta el contexto en el



que trabajan y las particularidades de los estudiantes para motivar a una participación activa tanto individual como grupal; además, atrae a los estudiantes hacia los diversos contenidos que se desarrollan, logrando aprendizajes significativos que puedan emplear en las distintas situaciones cotidianas y la adquisición de habilidades que permitan hacer frente a los desafíos actuales.

**Tabla 1**

*Recursos de gamificación*

Recurso	Logro
Matific	Desarrolla el pensamiento crítico y disminuye la ansiedad matemática.
Liveworksheet	Crea y comparte hojas de trabajo interactivo.
Kahoot	Instrumento lúdico de evaluación, acumulan puntos si la respuesta es correcta.
Wordwall	Emplea plantillas predefinidas que incluyen juegos clásicos como aplastar topos, emparejar, ruleta, encontrar palabras, memoria, cartas, cuestionarios, anagramas, etc.
Cokitos	Sitio web donde se agrupan juegos educativos para facilitar el acceso en un solo lugar.

### Aprendizaje de la matemática

La relevancia de las matemáticas en la vida diaria de las personas es incuestionable, ya que brindan conocimientos aplicables en diferentes situaciones a lo largo de la vida, desde el manejo del tiempo hasta la gestión de los recursos financieros; por lo tanto, el proceso de aprender matemáticas se describe como la obtención de nuevas habilidades y conocimientos relacionados con números, geometría, magnitudes y otros conceptos matemáticos, lo que habilita a las personas para solucionar problemas utilizando el lenguaje y los conceptos apropiados (Gavilanes, 2021).

Las fases del aprendizaje matemático descritas por Lazo (2018) se conectan directamente con la gamificación, pues esta estrategia permite fortalecer cada una de estas etapas mediante el uso de dinámicas lúdicas, recompensas y motivación extrínseca e intrínseca. A continuación, se explica la relación de cada fase con la gamificación:

- Fase intuitiva o concreta: La gamificación permite que los estudiantes interactúen con conceptos matemáticos en contextos reales mediante juegos de simulación, realidad aumentada o aplicaciones interactivas. Por ejemplo, estudios como el de Pérez (2022) han demostrado que el uso de plataformas gamificadas mejora la comprensión inicial de los estudiantes en matemáticas al proporcionar experiencias inmersivas y atractivas.
- Fase gráfica o sensorial: En esta etapa, la gamificación puede reforzar la representación visual de los conceptos matemáticos mediante juegos digitales que incorporan elementos gráficos dinámicos, como tableros interactivos o desafíos visuales. Según investigaciones como la de Martín (2019), la gamificación mejora la retención de la información al involucrar a los estudiantes en tareas que requieren manipulación gráfica y resolución visual.
- Fase conceptual o simbólica: Durante esta fase, los estudiantes traducen sus conocimientos en lenguaje matemático. La gamificación contribuye con desafíos y recompensas por resolver problemas en plataformas como Kahoot! o Mathletics. Un estudio de Estrade (2023) sugiere que las estrategias gamificadas incrementan la motivación y la precisión en la resolución de problemas matemáticos.
- Fase complementaria: La gamificación impulsa la consolidación de conocimientos a través de misiones, retos y recompensas por la práctica continua. En este sentido, la investigación de Bolívar (2021) destaca que el uso de mecánicas de juego en la educación matemática fomenta un aprendizaje autónomo y sostenible en el tiempo.

### Valor agregado de este estudio

Este estudio aporta al campo de la educación matemática al aplicar la gamificación en un contexto específico. A diferencia de investigaciones previas que se han centrado en la educación superior, aquí se considera un grupo con características particulares, demostrando cómo la gamificación no solo facilita la comprensión de conceptos matemáticos, sino que también motiva a poblaciones que han tenido dificultades previas en su formación académica.

### Aprendizaje de operaciones de suma y resta de fracciones

En el currículo ecuatoriano, actualizado en 2016, la enseñanza de las matemáticas busca fomentar en los estudiantes un pensamiento crítico y reflexivo para razonar, comunicar y aplicar sus ideas a las problemáticas reales de su entorno. Se destaca que, desde el subnivel medio y superior, los contenidos tratados y los procesos se vuelven sistemáticamente más complejos, ya que emplean conceptos, proposiciones y demostraciones para inducir al estudiante a pensar críticamente y poder responder a las demandas de la sociedad.

Así mismo, garantiza que los estudiantes tengan una base fundamentada de los cuatro bloques curriculares, permitiendo su desarrollo integral, ya que de forma directa e indirecta la matemática se relaciona con la vida cotidiana, por lo que contribuye al perfil de salida del bachillerato ecuatoriano (Ministerio de Educación, 2016).

Los estudiantes que cursan el subnivel medio de Educación General Básica, de acuerdo con el Currículo Educativo Ecuatoriano, alcanzan el siguiente objetivo que corresponde al bloque curricular 1 sobre álgebra y funciones. “O.M.3.2. Participar en equipos de trabajo, en la solución de problemas de la vida cotidiana, empleando como estrategias los algoritmos de las operaciones con números naturales, decimales y fracciones, la tecnología y los conceptos de proporcionalidad” (Ministerio de Educación, 2016, p. 709).

Con este objetivo se busca desarrollar en los estudiantes habilidades de razonamiento matemático, con el que manejen números fraccionarios para resolver problemas cotidianos por medio de la colaboración y el trabajo, usando la tecnología y las distintas herramientas de gamificación que tienen a su alcance. Por ello, los estudiantes dominarán las siguientes destrezas relacionadas con suma y resta de fracciones:

- M.3.1.16. Identificar números primos y números compuestos por su definición, aplicando criterios de divisibilidad.
- M.3.1.17. Encontrar el máximo común divisor y el mínimo común múltiplo de un conjunto de números naturales.
- M.3.1.39. Calcular sumas y restas con fracciones obteniendo el denominador común.
- M.3.1.42. Resolver y plantear problemas de sumas, restas, multiplicaciones y divisiones con fracciones, e interpretar la solución dentro del contexto del problema. (Ministerio de Educación, 2016, pp. 711-712).

### Materiales y Métodos

El trabajo de investigación se desarrolló con un diseño pre-experimental, se contó con un grupo experimental de 31 estudiantes de séptimo grado de Educación General Básica. Este diseño permite al investigador intervenir y aplicar distintos instrumentos que posibilitan recolectar información sobre la variable dependiente antes (pre-test) y después de la aplicación (post-test) con un solo grupo (Ramos, 2021).

El enfoque cuantitativo se relaciona con datos numéricos, ya que se acumula información numérica mediante conceptos y variables medibles durante la investigación, para analizarlas haciendo uso de diversas herramientas matemáticas, informáticas y estadísticas (Neill y Cortez, 2018). Para este estudio se aplicó una prueba diagnóstica con el fin de conocer el grado de aprendizaje de los estudiantes de séptimo grado, además, se implementaron estrategias de gamificación en diversos períodos y una prueba final para cuantificar el nivel de conocimientos sobre suma y resta de fracciones. Los datos obtenidos fueron expresados mediante gráficos y tablas.

Finalmente, se trabajó con modalidad bibliográfica en la búsqueda, recopilación y organización de la información obtenida de diversas fuentes sobre las variables en cuestión (Andrade, 2019). Se accedió a bibliotecas virtuales, revistas digitales y libros para buscar información en diferentes textos académicos que facilitaron la construcción del marco teórico que sustentan la investigación; y también con una modalidad de campo pues se evaluó a los estudiantes de séptimo grado de EGB en su aula de clase. Según Jiménez y Suárez (2021), esta modalidad hace referencia a que los datos se recopilan de forma directa en la realidad que ocurren los hechos con los sujetos investigados.

### **Población o muestra**

La población de la investigación hace referencia al conjunto de casos que cumplen con ciertos criterios predeterminados que se desea medir (Arias et al., 2016). Esta investigación se desarrolló con una población de 31 estudiantes de séptimo grado pertenecientes a una institución particular pedagógica bilingüe, situada en el cantón Ambato, parroquia Atahualpa. Cuenta con modalidad presencial de jornada única matutina y nivel educativo de Inicial, Educación Básica y Bachillerato. Al tratarse de una población pequeña no se determinó una muestra para la investigación.

### **Recolección de la información**

En la presente investigación se utilizó como técnica la prueba y su instrumento, el cuestionario, que constó de 7 ítems, y que evaluó conocimientos sobre la variable dependiente (suma y resta de fracciones) para identificar el grado de aprendizaje de las operaciones de suma y resta de fracciones. La prueba de conocimientos se aplicó en dos etapas: la diagnóstica denominada pre-test y después de la intervención o aplicación de estrategias de gamificación una prueba objetiva denominada pos-test. Los instrumentos fueron validados por dos docentes de la Universidad Técnica de Ambato mediante una rúbrica para corroborar su confiabilidad y validez.

### **Procesamiento de la información y análisis estadístico**

Los resultados obtenidos en la prueba diagnóstica (pre-test) se procesaron mediante la herramienta estadística IBM SPSS, utilizando la estadística descriptiva se obtuvieron tablas y gráficos estadísticos. A partir de los resultados logrados en la prueba diagnóstica se emplearon estrategias de gamificación para el aprendizaje de las operaciones de suma y resta de fracciones a la población. En la fase final se aplicó una prueba objetiva (post-test). Para la prueba de hipótesis se usó la T-student para muestras relacionadas con el fin de determinar si hay diferencia entre las medias de las pruebas.

## **Resultados y Discusión**

### **Resultados**

Para identificar el grado de aprendizaje de las operaciones de suma y resta de fracciones se empleó una prueba diagnóstica (pre-test) a los 31 estudiantes de séptimo grado de Educación General Básica de una Unidad Pedagógica Bilingüe. Después de la aplicación de estrategias de

gamificación se aplicó una prueba objetiva post-test para evaluar el grado de aprendizaje de las operaciones de suma y resta de fracciones. La prueba comprendió 7 preguntas para la parte teórica, y práctica de suma y resta de fracciones, se consideró la escala de calificaciones del Reglamento General de la Ley Orgánica de Educación Intercultural (RLOEI).

**Tabla 2**

*Escala de calificaciones*

<b>Escala cualitativa</b>	<b>Escala cuantitativa</b>
Domina los aprendizajes	9.00 – 10.00
Alcanza los aprendizajes	7.00 – 8.99
Está próximo a alcanzar los aprendizajes	4.01 – 6.99
No alcanza los aprendizajes	≤ 4

Los resultados obtenidos de la aplicación del pre-test a los estudiantes del grupo experimental, quienes corresponden al sistema de calificación antes mencionado, mostraron puntos fuertes y puntos por mejorar sobre suma y resta de fracciones, utilizados como referencia para la posterior aplicación de estrategias de gamificación. En la Tabla 2 se comparan las calificaciones obtenidas en las dos etapas.

**Tabla 3**

*Comparación del pretest y postest*

	<b>Pre test</b>	<b>Pos test</b>
<b>N</b>	31	31
<b>Media</b>	6.6935	8.5806
<b>Mediana</b>	7.0000	8.5000
<b>Desv. típ.</b>	1.21400	.88362
<b>Rango</b>	4.00	3.50
<b>Mínimo</b>	4.50	6.50
<b>Máximo</b>	8.50	10.00

En la Tabla 3 se evidencian el pre-test que parte desde el valor mínimo de 4.5 y su valor máximo de 8.5; cuyas calificaciones dan una media de (6.69), situando los estudiantes en la escala de está próximo a alcanzar los aprendizajes requeridos. Por su parte, en el post-test se tuvo un valor mínimo de 6.5 y un valor máximo de 10, la media fue de 8.85, ubicándolos en la escala de alcanza los aprendizajes requeridos.

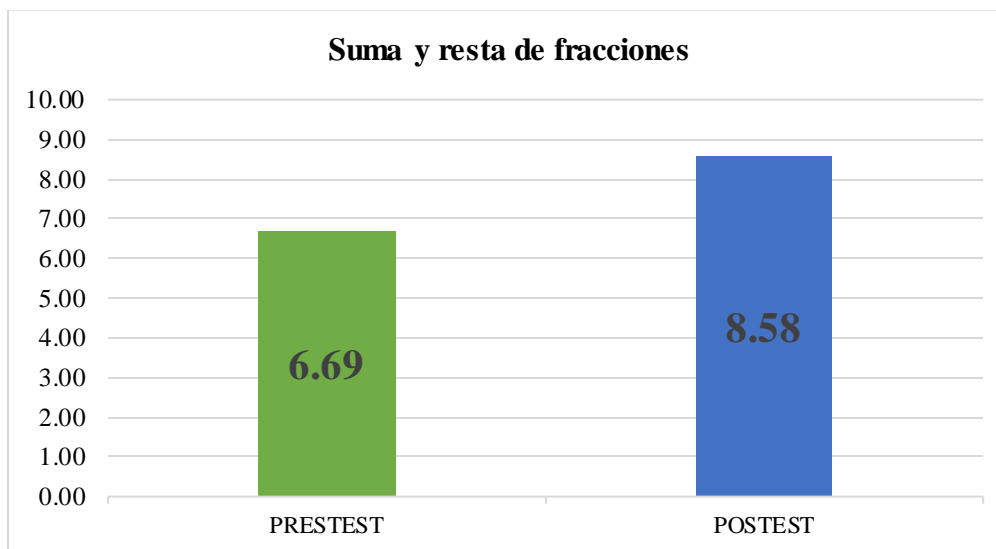
De acuerdo a la comparación de sus medias, 6,69 y 8,58 (Figura 1) se obtuvo la diferencia de 1,89 puntos que hace notable la efectividad de la aplicación de diversas estrategias de gamificación como Cokitos, Kahoot, Liverworsheet, etc. Estas estrategias permitieron que los estudiantes comprendieran y aplicaran mejor los conceptos y procesos de suma y resta de fracciones, pues se usaron ejercicios contextualizados, que acorde a la escala de calificaciones del RLOEI se ubican en el intervalo de alcanzan los aprendizajes.

La implementación de estrategias de gamificación en el aprendizaje de operaciones de suma y resta de fracciones se realizó a lo largo de 6 sesiones de 80 minutos cada una, mediante la plataforma Canva. En la primera presentación se abordó la temática de suma y resta de fracciones homogéneas y ejercicios, la segunda presentación sobre suma y resta de fracciones heterogéneas, y a su vez ejercicios de práctica. Las presentaciones estuvieron organizadas de

forma que durante todas las etapas de la clase interactúen con las herramientas de gamificación como: Matific, Cokitos, wordwall, Liverksheet, Kahoot y Cerebriti. Todas estas herramientas reforzaron el aprendizaje sobre la temática tratada y motivaron a los estudiantes por su interactividad, flexibilidad y accesibilidad desde cualquier espacio. Es importante destacar que la institución contaba con el equipamiento necesario que hizo posible su implementación.

**Figura 1**

*Comparación de pretest y postest*



### Comprobación de la hipótesis

#### *Prueba de normalidad*

Para comprobar la hipótesis del trabajo de investigación se aplicó la prueba de normalidad de Shapiro Wilk que permite trabajar con una población menor a 50 individuos. Para su decisión de rechazo o aceptación de la hipótesis nula se compara el valor de alfa ( $\alpha = 0,05$ ) con el valor estadístico de Shapiro Wilk. En caso de que el valor de Shapiro sea menor al valor de Alfa se rechaza la hipótesis nula que menciona que los datos siguen una distribución normal.

Planteamiento de las hipótesis:

H0: La variable presenta una distribución normal.

H1: La variable presenta una distribución no normal.

Toma de decisión:

H0 =  $P \geq 0,05$

H1 =  $P < 0,05$

**Tabla 4**

*Prueba de normalidad*

	Shapiro-Wilk		
	Estadístico	gl	Sig.
Pre test	.938	31	.071
Pos test	.953	31	.190

Los resultados obtenidos (Tabla 4) por medio de la aplicación de la prueba de Shapiro-Wilk (puesto que la muestra fue inferior a 50) y dado que el valor de P o significancia fue 0,071 para el pre test y 0.190 para el post-test (mayor que  $\alpha = 0,05$ ) se concluyó que los datos estuvieron normalmente distribuidos y, en consecuencia, para la prueba de hipótesis se pudo utilizar el estadígrafo T de student.

### **Método estadístico**

Para dar cumplimiento al objetivo enfocado en determinar la utilización de estrategias de gamificación, se analizaron los datos de forma estadística por medio de la prueba estadística T Student para muestras relacionadas (pareadas). Esta prueba permitió establecer la diferencia significativa entre un pretest y post-test, ya que comparó los datos cuantitativos que arrojaron. Para su desarrollo se tomaron en cuenta los resultados antes y después de la intervención.

### **Paso 1: Planteamiento de hipótesis**

#### **Modo lógico**

Hipótesis nula ( $H_0$ ): Las estrategias de gamificación NO aportan en el aprendizaje de operaciones de suma y resta de fracciones.

Hipótesis alterna ( $H_1$ ): Las estrategias de gamificación aportan en el aprendizaje de operaciones de suma y resta de fracciones.

#### **Modo estadístico**

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

### **Paso 2: Nivel de significación**

Nivel de significancia 5% ( $\alpha = 0,05$ ) y nivel de confianza del 95% (0,95)

Regla de oro: Cuando el valor de la significancia bilateral o P es menor que  $\alpha = 0,05$  se rechaza la hipótesis nula y se acepta la hipótesis alterna: caso contrario, si el valor de la significancia bilateral es mayor que  $\alpha = 0,05$  se acepta la hipótesis nula.

### **Paso 3: Estadígrafo de prueba**

T de Student para una sola muestra

$$t = \frac{\bar{X}D}{\frac{SD}{\sqrt{n-1}}}$$

Donde:

$(\bar{X})D$  = Media de las diferencias

SD = Desviación típica de las diferencias

N = tamaño muestral

### **Paso 4: Cálculo de T en SPSS y gráfico de distribución de la probabilidad**

**Tabla 5**

*Estadísticas de muestras emparejadas*

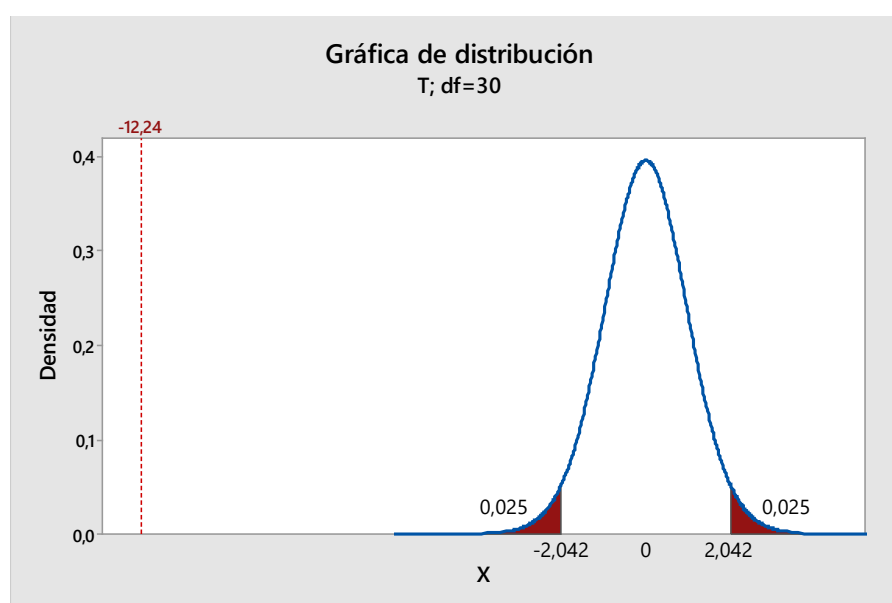
		Media	N	Desv. Desviación	Desv. Error
				promedio	
<b>Par 1</b>	Calificaciones en el pretest	6,6935	31	1,21400	,21804
	Calificaciones en el postest	8,5806	31	,88362	,15870

Tabla 6

*Prueba t para muestras emparejadas*

	Diferencias emparejadas					t	Sig. gl(bilateral)	
	Media	Desv. Desviación	Desv. Error promedio	95% de intervalo de confianza de la diferencia				
				Inferior	Superior			
Par 1	Calificaciones en el pretest - Calificaciones en el posttest	-1,88710	,85839	,15417	-2,20196	-1,57224	-12,240 30	,000

Figura 2

*Distribución de probabilidad***Paso 6 Decisión final**

Puesto que el valor de la significancia bilateral  $P = 0,000$  es menor que  $\alpha = 0,05$ , de acuerdo con la Regla de Oro, se rechaza la hipótesis nula y se acepta la hipótesis alterna que expresa que las estrategias de gamificación aportaron en el aprendizaje de operaciones de suma y resta de fracciones, lo que se evidenció en las puntuaciones obtenidas por los estudiantes en el pretest ( $\mu = 6,69$ ) y en el posttest ( $\mu = 8,58$ ).

**Discusión de resultados**

Los resultados generados en la presente investigación evidencian que las estrategias de gamificación, al ser aplicadas en las aulas, aprovechando los recursos que la institución dispone, fortalece el aprendizaje significativo de contenidos y el desarrollo de habilidades matemáticas, mostrando un incremento de 1.89 puntos en la media del post-test comparada con la media del pretest realizado. Estos resultados concuerdan con lo que menciona Quizhpi (2018), que al aplicar la gamificación como estrategia de aprendizaje el promedio de los evaluados incrementó, en este caso en 1,47 puntos, demostrando que su utilización dentro del proceso de aprendizaje en cualquier momento es altamente efectiva para mejorar el rendimiento académico y el compromiso de los estudiantes por realizar las actividades propuestas.

Además, las herramientas de gamificación tienen un enfoque constructivista, ya que se evidenció que motiva al estudiante, permitiéndole crear y construir su conocimiento de acuerdo a sus intereses, pues desarrolla no solo conocimientos sino también habilidades que utilizarán en situaciones reales del día a día. El terminar un reto y alcanzar otro nivel, generó que el estudiante autorregule su aprendizaje con la finalidad de superar una dificultad en las distintas etapas que propone la gamificación. Los datos obtenidos en este estudio concuerdan con Ordóñez (2022) al considerar que en la vida del ser humano es fundamental la matemática y, sobre todo, las operaciones aritméticas de fracciones, por lo que la aplicación de la gamificación ayuda a los estudiantes a construir aprendizajes significativos, incrementando su motivación, con la consiguiente mejora de sus resultados académicos.

También, se logró evidenciar que el juego, al ser innato en los seres humanos y adaptarlos con diversos contenidos de clase, permite desarrollar habilidades digitales que se requiere en la sociedad actual con participación activa y sobre todo mejora en el rendimiento académico. Por su parte, Rúa Sánchez (2023) coincide con este criterio en su investigación al determinar que después de atravesar la pandemia del COVID-19 las estrategias de gamificación en la educación virtual han desarrollado un aprendizaje guiado para las actividades asignadas, pues con el mecanismo de recompensa se logra centrar la atención del estudiante y mejorar sus habilidades digitales.

Por otro lado, la matemática ha sido vista como un proceso complejo, ya que para su enseñanza se utilizan métodos tradicionales, mostrando conceptos matemáticos abstractos con enfoque memorístico; sin embargo, al utilizar la gamificación se evidencia que el promedio de los estudiantes mejora de forma significativa, pues al ir de la mano de la tecnología se generan contextos de aprendizaje más interactivos por medio de plataformas, simuladores, sitios web, entre otros. El docente innova y el estudiante construye su propio conocimiento. Este resultado concuerda con lo que plantea Díaz (2018), quien muestra que el rendimiento académico del grupo experimental mejoró utilizando el simulador Phet para el desarrollo del proceso de enseñanza de fracciones equivalentes. El uso de simuladores despierta el interés y la motivación en los estudiantes, provocando que trabajen de manera más dinámica en temáticas relacionadas con la tecnología e informática.

### **Conclusiones**

Los estudiantes logran comprender conceptos matemáticos, además, desarrollan habilidades tecnológicas que les ayudan hacer frente a la sociedad digitalizada, por lo que se concluye que las estrategias de gamificación aportan en el aprendizaje de operaciones de suma y resta de fracciones.

Una vez implementadas las estrategias de gamificación se evaluó el grado de aprendizaje de las operaciones de suma y resta de fracciones obteniendo una media de 8.58 puntos sobre 10, de acuerdo a la escala de calificaciones, lo que permite concluir que los estudiantes alcanzan los aprendizajes requeridos, evidenciando que existe una mejora significativa en sus destrezas.

### **Limitaciones**

La mayor dificultad fue el tiempo, ya que, aunque la gamificación atrajo a los estudiantes, el avance del currículo del Ministerio de Educación exigía ritmo. Hubiera sido ideal contar con más sesiones para reforzar conceptos sin sacrificar la profundidad del aprendizaje.



### Aclaración / Nota del autor

Parte del contenido y análisis presentado en este artículo se basa en la investigación y resultados obtenidos durante la realización de la tesis de posgrado en la Facultad de Ciencias Humanas y de la Educación para optar al título de cuarto nivel de magíster en Educación mención Enseñanza de la Matemática con el tema "Estrategias de gamificación en el aprendizaje de operaciones de suma y resta de fracciones en los estudiantes de séptimo grado de Educación General Básica" y presentada en 01 de septiembre de 2024 en la de la Universidad Técnica de Ambato.

### Reconocimientos

Se expresa un profundo agradecimiento a la Universidad Técnica de Ambato, al proyecto de investigación: "Diseño y evaluación de un sistema didáctico basado en inteligencia artificial para el aprendizaje significativo en la educación superior", SFFCHE14, aprobado según resolución Nro. UTA-CONIN-2023-0332-R, al cual este tema de investigación está vinculado.

Los autores declaran la contribución y participación equitativa de roles de autoría para esta publicación.

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## Prácticas efectivas en la enseñanza de lengua y literatura para estudiantes de 9 a 12 años

## Effective Practices in the Teaching of Language and Literature for Students Aged 9 to 12

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Enviado: 2025/04/04  
Aceptado: 2025/06/09  
Publicado: 2025/06/30

### Resumen

La enseñanza de Lengua y Literatura es esencial en la formación de estudiantes de educación básica media, especialmente durante la adolescencia temprana (de 9 a 12 años), una etapa clave para el desarrollo de habilidades comunicativas y literarias. Sin embargo, la diversidad en los niveles de desempeño estudiantil exige identificar prácticas pedagógicas que respondan de forma efectiva a las necesidades de aprendizaje. El objetivo principal de este estudio fue analizar el impacto de distintas estrategias de enseñanza aplicadas por docentes de Lengua y Literatura en la comprensión lectora y expresión escrita de los estudiantes. Se empleó una metodología cuantitativa de diseño descriptivo, mediante una encuesta estructurada aplicada a treinta docentes de una institución educativa fiscal. Los resultados evidenciaron que el uso de lectura en voz alta, escritura creativa, herramientas digitales y actividades interculturales potenciaron la motivación y el pensamiento crítico de los estudiantes. Asimismo, se identificaron diferencias en el desarrollo de habilidades entre estudiantes de distintos contextos socioeconómicos, lo que resalta la importancia de enfoques pedagógicos inclusivos. Esta investigación concluye que una combinación de estrategias participativas, el uso pertinente de tecnología y el fomento de la reflexión crítica a través de la literatura permiten mejorar significativamente el aprendizaje en esta área. El estudio ofrece recomendaciones prácticas que pueden contribuir a fortalecer la enseñanza de Lengua y Literatura, promoviendo una educación más equitativa, significativa y contextualizada.

**Sumario:** Introducción, Metodología, Resultados y Discusión, Conclusiones.

**Como citar:** Encalada, B., Encalada, E. & Gonzaga, S. (2025). Prácticas efectivas en la enseñanza de lengua y literatura para estudiantes de 9 a 12 años. *Revista Tecnológica - Espol*, 37(1), 227-245.  
<https://rte.espol.edu.ec/index.php/tecnologica/article/view/1304>

**Palabras clave:** enseñanza; lengua; literatura; adolescencia; habilidades comunicativas.

### Abstract

The teaching of Language and Literature is essential in the education of upper elementary students, particularly during early adolescence (ages 9 to 12), a key stage for the development of communication and literary skills. However, the diversity in students' performance levels requires the identification of pedagogical practices that effectively address learning needs. The main objective of this study was to analyze the impact of different teaching strategies used by Language and Literature teachers on students' reading comprehension and written expression. A quantitative methodology with a descriptive design was employed through a structured survey applied to thirty teachers at a public educational institution. The results showed that the use of read-alouds, creative writing, digital tools, and intercultural activities significantly enhanced students' motivation and critical thinking. Additionally, differences in skill development were identified among students from various socioeconomic backgrounds, highlighting the importance of inclusive pedagogical approaches. This study concludes that a combination of participatory strategies, the appropriate use of technology, and the encouragement of critical reflection through literature can significantly improve learning in this area. The research offers practical recommendations that can help strengthen the teaching of Language and Literature, promoting more equitable, meaningful, and contextualized education.

**Keywords:** Teaching; Language; Literature; Adolescence; Communication skills.

### Introducción

La enseñanza de lengua y literatura desempeña un papel crucial en el desarrollo integral de los estudiantes durante la educación básica media, especialmente en los primeros años de la adolescencia. Durante esta etapa, los jóvenes atraviesan importantes transformaciones cognitivas, emocionales y sociales que influyen directamente en su manera de comunicarse, reflexionar y construir su identidad personal (UNESCO, 2021).

Dominar las habilidades comunicativas —como la lectura crítica, la escritura expresiva y el diálogo argumentativo— no solo favorece el rendimiento académico, sino que también facilita la expresión emocional, la participación social y la comprensión del entorno (Rosenblatt, 2020). Según estudios recientes en neuroeducación, esta etapa del desarrollo se caracteriza por una mayor capacidad de razonamiento abstracto y una apertura al pensamiento introspectivo, lo que refuerza la necesidad de prácticas pedagógicas adaptadas a estas capacidades emergentes (García y Rodríguez, 2022).

El lenguaje y la literatura ofrecen herramientas fundamentales para canalizar estos procesos de cambio; sin embargo, existe una alta variabilidad entre los estudiantes de 9 a 12 años en cuanto a habilidades lectoras y expresivas, lo que refleja tanto diferencias en el desarrollo cognitivo como en las metodologías docentes aplicadas. Tal como indican Díaz y Larraín (2021), la enseñanza eficaz en esta etapa requiere una atención diferenciada que articule la dimensión afectiva y cognitiva del aprendizaje.

Este panorama plantea la necesidad urgente de investigar qué prácticas pedagógicas realmente potencian el desarrollo de competencias comunicativas en estos niveles. Como señalan Bravo y Riveros (2022), las estrategias efectivas deben ir más allá de la instrucción

tradicional y promover aprendizajes contextualizados, activos y significativos. En esta línea, el presente estudio se propone identificar prácticas efectivas en la enseñanza de lengua y literatura, analizando su impacto en el desarrollo de la comprensión lectora y la producción escrita.

El compromiso de esta investigación se alinea con las exigencias contemporáneas de una educación inclusiva, crítica y culturalmente relevante. En coherencia con los principios del currículo ecuatoriano (Ministerio de Educación, 2021), la enseñanza de la lengua debe fomentar la expresión creativa, la valoración de la diversidad textual y el pensamiento reflexivo, en contextos donde todos los estudiantes puedan participar activamente del proceso educativo.

Este estudio, desarrollado en la Escuela de Educación Básica Fiscal Manuel Gómez Abad, pretende ofrecer insumos prácticos y teóricos para la mejora de la enseñanza del lenguaje, desde un enfoque situado y basado en evidencias. A través del análisis de estrategias pedagógicas aplicadas por docentes en esta institución, buscamos aportar al debate educativo con propuestas que promuevan una formación lingüística integral.

De este modo, se espera que el aprendizaje del lenguaje y la literatura no solo responda a los estándares académicos, sino que también sea una herramienta de transformación personal y social. La meta es generar espacios de aprendizaje relevantes para los adolescentes, considerando sus contextos, intereses y formas de aprender (Camacho y Salazar, 2020). El estudio permitirá identificar buenas prácticas replicables, y orientará futuras acciones docentes en función del desarrollo efectivo de las habilidades lingüísticas y literarias en esta etapa tan determinante de la vida escolar.

En suma, este trabajo busca contribuir tanto a la mejora institucional como a la literatura académica sobre prácticas pedagógicas, documentando experiencias significativas que fortalezcan el aprendizaje del lenguaje en la educación básica media.

### **Definición del problema**

En el contexto educativo actual, el desarrollo de competencias lingüísticas —como la lectura comprensiva, la expresión escrita y el pensamiento crítico— representa un desafío clave en la formación integral de los estudiantes de educación básica media, particularmente en el grupo etario de 9 a 12 años. Esta etapa, correspondiente a la adolescencia temprana, implica cambios significativos en las dimensiones cognitiva, emocional y social del estudiante, lo que influye directamente en su forma de aprender y comunicarse (García & Rodríguez, 2022); sin embargo, diversas evaluaciones institucionales y regionales evidencian que una parte considerable del estudiantado presenta dificultades sostenidas para comprender textos, organizar ideas por escrito y expresarse con claridad. Esta situación refleja una desconexión entre las prácticas pedagógicas implementadas en el aula y las necesidades reales de los estudiantes en cuanto al desarrollo de habilidades comunicativas (Díaz & Larraín, 2021).

Pese a los esfuerzos por incorporar metodologías activas y estrategias diversificadas, persisten brechas notorias en el rendimiento escolar en Lengua y Literatura. Esto sugiere que no todas las prácticas empleadas en el aula logran potenciar el aprendizaje significativo en estos ámbitos, especialmente en contextos marcados por desigualdades sociales, económicas y culturales.

A esta problemática se suma la falta de sistematización y evaluación de las estrategias docentes aplicadas en el área. Muchos enfoques didácticos se implementan sin evidencia clara

de su efectividad, lo que limita su replicabilidad y dificulta su mejora continua (Bravo & Riveros, 2022).

En este sentido, surge la necesidad urgente de identificar qué prácticas pedagógicas realmente favorecen el desarrollo de habilidades lingüísticas en estudiantes de 9 a 12 años, considerando tanto los aspectos cognitivos del aprendizaje como los factores contextuales que afectan su desempeño. Este estudio busca aportar evidencia empírica sobre estrategias que no solo mejoren la comprensión lectora y la expresión escrita, sino que además sean sensibles a la diversidad del alumnado, promoviendo una enseñanza equitativa y centrada en el estudiante (UNESCO, 2021).

## **Objetivos**

### ***Objetivo General***

Analizar las prácticas pedagógicas implementadas en la enseñanza de Lengua y Literatura a estudiantes de 9 a 12 años en educación básica media, con el fin de identificar aquellas estrategias que resultan efectivas para el desarrollo de habilidades comunicativas, comprensivas y expresivas, en contextos diversos.

### ***Objetivos específicos***

Identificar y sistematizar estrategias didácticas utilizadas por docentes de Lengua y Literatura en los grados correspondientes a estudiantes de 9 a 12 años.

Evaluar el impacto de dichas estrategias en el desempeño de los estudiantes en comprensión lectora y expresión escrita, a partir de evidencias empíricas.

Analizar posibles diferencias en el desarrollo de habilidades lingüísticas según el contexto socioeconómico de los estudiantes, y proponer enfoques pedagógicos inclusivos.

Explorar las percepciones de docentes y estudiantes sobre el valor formativo de la enseñanza de la Lengua y la Literatura en su trayectoria académica y personal.

Examinar el uso de herramientas tecnológicas aplicadas a la enseñanza de Lengua y Literatura, y su relación con el interés y rendimiento académico de los estudiantes.

## **Justificación**

La presente investigación cobra relevancia en un momento clave del desarrollo educativo, donde los estudiantes de entre 9 y 12 años atraviesan una etapa de transición cognitiva, emocional y social que define su relación con el aprendizaje. Comprender cómo inciden las prácticas pedagógicas en la enseñanza de Lengua y Literatura en esta etapa es fundamental para diseñar experiencias de aprendizaje significativas y equitativas.

Este estudio busca aportar evidencia sobre las estrategias docentes que favorecen el desarrollo de habilidades comunicativas esenciales, tales como la comprensión lectora, la argumentación oral y la expresión escrita. Dichas habilidades no solo impactan el rendimiento académico en esta área específica, sino que también influyen en el desarrollo del pensamiento crítico, la construcción de identidad y la interacción social de los estudiantes.

La información obtenida servirá de base para fortalecer los procesos curriculares y didácticos dentro de la educación básica media, permitiendo a docentes y directivos adaptar sus metodologías a las necesidades reales de sus estudiantes. Al identificar qué prácticas

resultan más efectivas, será posible promover una enseñanza más inclusiva, contextualizada y sensible a la diversidad del aula, facilitando así la equidad en el acceso al aprendizaje.

Como lo destacan Darling-Hammond et al. (2020), “una educación de calidad requiere estrategias pedagógicas que partan de la comprensión del contexto del estudiante y respondan activamente a sus condiciones culturales, lingüísticas y sociales” (p. 112). Bajo esta perspectiva, este análisis contribuye al desarrollo de propuestas didácticas que garanticen no solo el éxito académico, sino la formación integral del estudiante como sujeto activo en su entorno.

En suma, esta investigación pretende ser un insumo valioso para la mejora de la práctica educativa en Lengua y Literatura, impulsando políticas escolares y decisiones pedagógicas más informadas, sostenibles y comprometidas con el desarrollo humano.

## **Marco teórico**

### ***Fundamentos del aprendizaje lingüístico en la adolescencia temprana***

La adolescencia temprana, entre los 9 y 12 años, representa un periodo de transición crucial en el desarrollo cognitivo, lingüístico y socioemocional de los estudiantes. Durante esta etapa, los jóvenes adquieren habilidades más complejas de pensamiento abstracto, autorreflexión y razonamiento lógico, lo que exige enfoques pedagógicos que estimulen la lectura crítica, la comunicación efectiva y la producción textual significativa (UNESCO, 2021).

Desde un enfoque socio constructivista, Vygotsky (2020 [reed.]) plantea que el lenguaje es una herramienta de mediación central en el desarrollo del pensamiento y la conciencia, por lo que enseñar Lengua y Literatura debe ir más allá del dominio formal del idioma: debe propiciar interacciones significativas y situadas. Este principio ha sido retomado en investigaciones contemporáneas que insisten en adaptar las prácticas pedagógicas a las particularidades cognitivas y culturales de los estudiantes (González & Silva, 2021).

### ***Tipologías de prácticas pedagógicas efectivas en Lengua y Literatura***

En el ámbito de la educación lingüística, las prácticas efectivas son aquellas estrategias de enseñanza que han demostrado mejorar las competencias comunicativas de los estudiantes de manera consistente, según el contexto en que se aplican (Díaz & Larraín, 2021). Estas prácticas pueden clasificarse en diversas tipologías, dependiendo de su enfoque, mediación o propósito.

**Prácticas centradas en el estudiante.-** Incluyen lectura compartida, clubes de lectura, talleres de escritura creativa, debates orales y aprendizaje basado en proyectos. Estas actividades favorecen la participación activa y el pensamiento crítico (Camacho & Salazar, 2020).

**Prácticas explícitas y formales.-** Se refieren a la enseñanza sistemática de gramática, ortografía y estructuras textuales. Aunque tradicionalmente criticadas, su aplicación contextualizada ha demostrado ser beneficiosa en combinación con métodos activos (Bravo & Riveros, 2022).

**Prácticas mediadas por tecnología.-** Incluyen el uso de plataformas digitales, blogs, podcasts, y narrativas transmedia. Estas herramientas promueven la motivación del estudiante al integrar lenguajes múltiples y entornos interactivos (Muñoz & León, 2022).

Prácticas inclusivas y situadas.- Parten del reconocimiento de la diversidad sociocultural del aula e integran textos de diferentes orígenes, lenguas y culturas. También fomentan el uso de la lengua materna como punto de partida para el aprendizaje de estructuras académicas (Rodríguez y Ortega, 2021).

Esta clasificación no es excluyente, sino que apunta a mostrar la variedad de caminos didácticos posibles para el desarrollo del lenguaje en la escuela.

### ***Relación entre prácticas pedagógicas y rendimiento académico***

La efectividad de las prácticas pedagógicas puede medirse en función del impacto que tienen sobre los aprendizajes de los estudiantes, particularmente en áreas como la comprensión lectora, la producción escrita y la participación comunicativa. Diversas investigaciones han señalado que aquellas estrategias que combinan claridad estructural, participación activa y vinculación con el contexto del alumno suelen generar mejores resultados académicos y una mayor motivación (Torres & López, 2020; Darling-Hammond et al., 2020).

A partir de esto, se plantea como hipótesis de base que las prácticas pedagógicas que promueven el aprendizaje activo, el trabajo colaborativo y el uso de tecnología contextualizada tienen un efecto positivo en el rendimiento de los estudiantes de Lengua y Literatura, especialmente en comprensión lectora y expresión escrita.

Este supuesto será contrastado en el estudio empírico, considerando tanto las percepciones docentes como los datos obtenidos en los cuestionarios. Como sugieren Morales & Pérez (2022), evaluar la práctica educativa no solo permite comprender lo que se hace en el aula, sino también mejorar las condiciones de enseñanza para generar aprendizajes más profundos y duraderos.

### **Metodología**

Este estudio adopta un enfoque cuantitativo de tipo descriptivo, con el propósito de identificar las prácticas pedagógicas más frecuentes y percibidas como efectivas por los docentes de Lengua y Literatura en el nivel de educación básica media, específicamente con estudiantes de entre 9 y 12 años. Este enfoque permite analizar patrones, tendencias y relaciones entre variables observables mediante datos empíricos estructurados (Hernández, Fernández y Baptista, 2021).

El diseño de investigación fue no experimental y de corte transversal, ya que se recolectaron los datos en un único momento sin manipular variables, lo que resulta apropiado para estudios exploratorios sobre prácticas educativas. El instrumento principal utilizado fue un cuestionario estructurado con ítems de escala tipo Likert de cinco puntos, orientado a valorar la frecuencia y percepción de efectividad de diversas estrategias didácticas.

La población del estudio estuvo conformada por docentes de Lengua y Literatura de la Escuela de Educación Básica Fiscal Manuel Gómez Abad. El muestreo fue no probabilístico por conveniencia, considerando a los docentes activos del área con al menos un año de experiencia en la enseñanza a estudiantes del rango etario mencionado. Participaron en total 30 docentes, quienes colaboraron de manera voluntaria y anónima.

El cuestionario fue diseñado a partir de una revisión bibliográfica sobre prácticas pedagógicas en el área de lengua y literatura, y validado por juicio de expertos para asegurar su pertinencia y claridad. La recolección de datos se realizó de manera presencial, en sesiones



previamente acordadas con los docentes participantes, garantizando el cumplimiento de principios éticos como el consentimiento informado y la confidencialidad.

Los datos obtenidos fueron procesados mediante técnicas de estadística descriptiva: frecuencias absolutas y relativas, medidas de tendencia central y análisis cruzado de variables. Estos resultados permitieron identificar las estrategias más utilizadas, las percepciones de efectividad y su relación con factores contextuales como la formación docente o el nivel socioeconómico del alumnado.

Como señalan Muñoz y López (2023), la investigación educativa debe incluir procedimientos sistemáticos que permitan traducir la experiencia docente en datos que orienten la toma de decisiones pedagógicas. En concordancia con ello, esta metodología busca ofrecer una base empírica sólida para comprender cómo se enseña lengua y literatura en el aula y qué prácticas pueden replicarse o ajustarse para promover mejores aprendizajes.

### **Diseño de la encuesta**

Para recoger información sobre las prácticas pedagógicas aplicadas en la enseñanza de Lengua y Literatura, se elaboró un cuestionario estructurado compuesto por preguntas cerradas. Estas preguntas abordaron dimensiones clave del proceso de enseñanza-aprendizaje, tales como dificultades en la enseñanza de literatura clásica, enfoques en la enseñanza de la gramática y la sintaxis, géneros literarios preferidos por los estudiantes, inclusión de literatura multicultural, uso de escritura argumentativa, incorporación de tecnologías educativas, y el rol de actividades extracurriculares en el fortalecimiento de habilidades comunicativas.

Cada ítem presentó opciones múltiples con una escala de valoración porcentual, lo que permitió identificar tendencias cuantificables en las respuestas de los docentes. Este tipo de formato, además de facilitar la codificación y el análisis estadístico, reduce la subjetividad en la interpretación de resultados (Domínguez & Andrade, 2021).

### **Selección de Participantes**

El estudio utilizó un muestreo no probabilístico por conveniencia, centrado en los docentes de Lengua y Literatura de la Escuela de Educación Básica Fiscal Manuel Gómez Abad. La participación fue voluntaria y anónima, y se incluyeron aquellos docentes con al menos un año de experiencia en el área. Se logró la participación de 30 docentes, lo cual representa un porcentaje significativo del equipo docente de la institución, y ofrece una muestra válida para la exploración de las percepciones sobre las prácticas pedagógicas implementadas.

Tal como señalan Torres y López (2020), este tipo de muestreo es útil en investigaciones exploratorias que buscan analizar fenómenos contextualizados con participantes clave.

### **Recolección de Datos**

La aplicación del cuestionario se llevó a cabo mediante un formulario en línea, alojado en una plataforma digital institucional, lo que facilitó el acceso remoto de los participantes y optimizó los tiempos de respuesta. El instrumento estuvo disponible durante un periodo de dos semanas, asegurando que cada docente pudiera completarlo según su disponibilidad.

El uso de herramientas tecnológicas en la recolección de datos no solo agiliza el proceso, sino que incrementa la precisión y seguridad de los registros, como señalan recientes investigaciones en metodologías digitales aplicadas a la educación (Camargo y Rodríguez, 2022).

## Análisis de Datos

Los datos recopilados fueron tratados mediante técnicas de estadística descriptiva. Se calcularon frecuencias absolutas y relativas, así como medidas de tendencia central que permitieron identificar patrones y preferencias en las respuestas. Esta forma de análisis facilita una interpretación clara de las percepciones docentes, lo que resulta especialmente útil para generar recomendaciones prácticas basadas en evidencias.

El enfoque cuantitativo utilizado favorece la objetividad en la evaluación de tendencias y comportamientos comunes dentro del contexto institucional (Morales y Pérez, 2021).

## Limitaciones del estudio de investigación

Una de las principales limitaciones de esta investigación radica en el tipo de muestreo no probabilístico utilizado, el cual restringe la posibilidad de generalizar los hallazgos a otras instituciones o regiones del país; asimismo, al centrarse en una sola institución, los resultados pueden estar condicionados por particularidades propias de su contexto, lo que limita la amplitud del análisis; además, si bien la muestra de 30 docentes es representativa a nivel local, no necesariamente refleja la diversidad de realidades educativas presentes en otras zonas geográficas o con diferentes condiciones socioculturales.

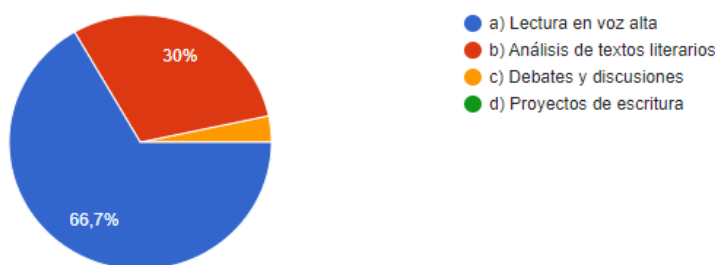
**Tabla 1**

*Distribución porcentual de los principales desafíos docentes al enseñar literatura clásica en educación básica media*

Opción	Número de respuesta	%
a) Lectura en voz alta	20	66.70
b) Análisis de textos literarios	9	30.00
c) Debates y discusiones	1	03.30
d) Proyectos de escritura	0	00.00
Total	30	100.00

**Figura 1**

*Desafíos identificados por docentes en la enseñanza de literatura clásica en educación básica media*



Los principales retos percibidos por los docentes al impartir contenidos de literatura clásica en estudiantes de entre 9 y 12 años. La lectura en voz alta fue mencionada por el 66,7% como el desafío más frecuente, seguida del análisis de textos literarios (30%). Un 3,3% identificó los debates y discusiones como un reto, mientras que los proyectos de escritura no fueron señalados como dificultad.

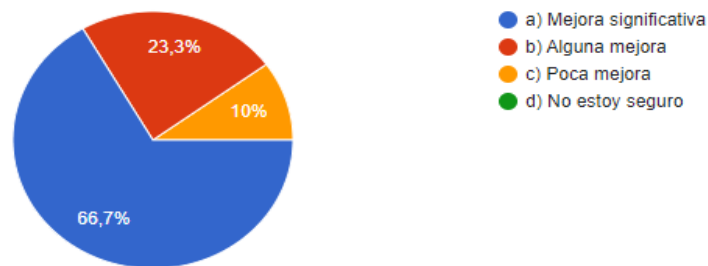
**Tabla 2**

*Valoración del impacto de la enseñanza gramatical en la mejora de la escritura estudiantil*

Opción	Numero de Respuesta	%
a) Mejora significativa	20	66.70%
b) Alguna mejora	07	23.30%
c) Poca mejora	03	10.00%
d) No estoy seguro	00	00.00%
Total	30	100.00

**Figura 2**

*Percepción docente sobre el impacto de la enseñanza de gramática y sintaxis en la escritura estudiantil*



La percepción de los docentes sobre el efecto que tiene la enseñanza de gramática y sintaxis en la calidad de la escritura de los estudiantes de educación básica media. El 66,7% considera que su impacto es significativamente positivo, mientras que un 23,3% percibe alguna mejora. Un 10% indica que la mejora es mínima, y ningún docente manifestó incertidumbre al respecto. Estos datos reflejan la importancia de integrar la gramática funcional como eje transversal en la producción escrita.

**Tabla 3**

*Preferencias literarias estudiantiles, según la percepción docente*

Opción	Número de respuesta	%
a) Novelas de aventuras	17	56.70
b) Poesía	04	13.30
c) Ciencia ficción	09	30.00
d) Literatura histórica	00	00.00
Total	30	100.00

**Figura 3**

*Géneros literarios percibidos como más atractivos por los estudiantes de educación básica media*



Las preferencias literarias que según los docentes encuestados, resultan más atractivas para estudiantes entre 9 y 12 años. El 56,7% de los docentes indicó que las novelas de aventuras son el género más motivador en el aula, seguido por la ciencia ficción con un 30%. Un 13,3% mencionó la poesía como opción preferida, mientras que la literatura histórica no fue señalada por los participantes. Estos datos orientan la selección de textos en el currículo para fomentar el interés lector.

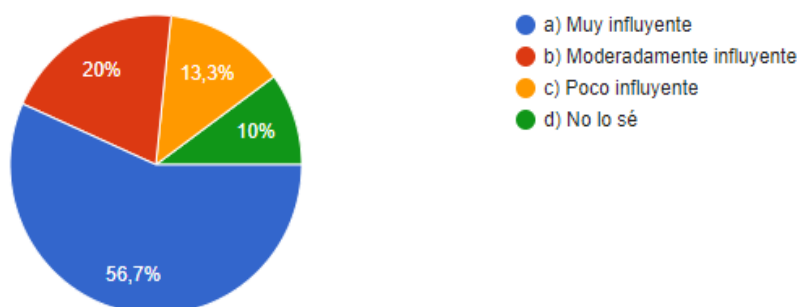
**Tabla 4**

*Percepción docente sobre la influencia de la lectura de textos culturales en la comprensión intercultural*

Opción	Número de respuesta	%
a) Muy influyente	17	56.70
b) Moderadamente influyente	06	20.00
c) Poco influyente	04	13.30
d) No lo sé	03	10.00
Total	30	100.00

**Figura 4**

*Influencia percibida de la lectura de textos culturales diversos en la comprensión intercultural de los estudiantes*



Las percepciones de los docentes sobre el efecto que tiene la lectura de textos provenientes de distintas culturas en el desarrollo de la comprensión intercultural en estudiantes de educación básica media. El 56,7% considera que esta práctica es muy influyente, mientras que un 20% la percibe como moderadamente influyente. Un 13,3% la considera poco influyente y un 10% manifiesta no tener una opinión clara. Estos resultados destacan la relevancia de incorporar literatura multicultural en el aula para fomentar el respeto, la empatía y la diversidad cultural.

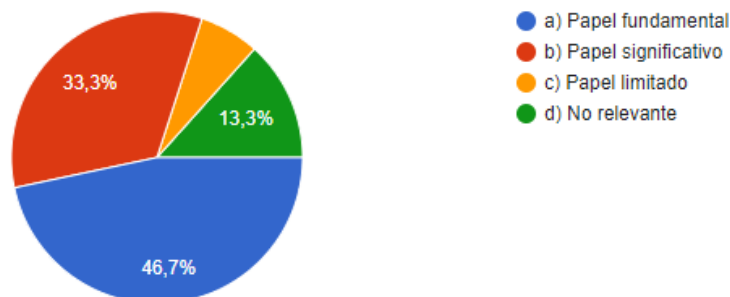
**Tabla 5**

*Valoración docente del impacto de la escritura argumentativa en el pensamiento crítico estudiantil*

Opción	Numero de Respuesta	%
a) Papel fundamental	14	46.70
b) Papel significativo	10	33.30
c) Papel limitado	02	06.70
d) No relevante	04	13.30
Total	30	100.00

**Figura 5**

*Percepción docente sobre el papel de la escritura argumentativa en el desarrollo del pensamiento crítico*



Los docentes valoran la escritura argumentativa como herramienta pedagógica para fomentar el pensamiento crítico en estudiantes de educación básica media. El 46,7% la considera un recurso con un papel fundamental, mientras que el 33,3% señala que cumple una función significativa. Un 6,7% opina que su papel es limitado, y el 13,3% considera que no es relevante. Estos resultados subrayan la importancia de incluir prácticas de escritura argumentativa de manera sistemática para fortalecer las capacidades de análisis, reflexión y expresión de los estudiantes.

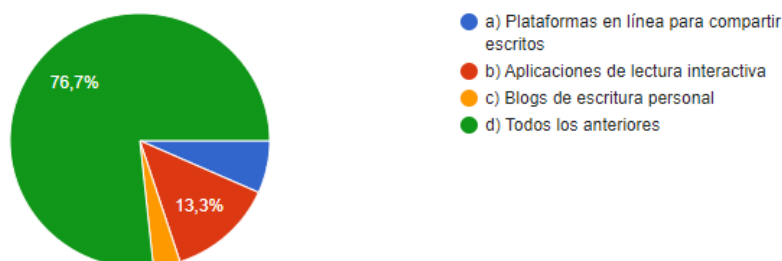
**Tabla 6**

*Preferencia docente sobre herramientas tecnológicas aplicadas a la lectura y escritura*

Opción	Número de respuesta	%
a) Plataformas en línea para compartir escritos	02	2.67
b) Aplicaciones de lectura interactiva	04	13.30
c) Blogs de escritura personal	01	03.03
d) Todos los anteriores	23	76.70
Total	30	100.00

**Figura 6**

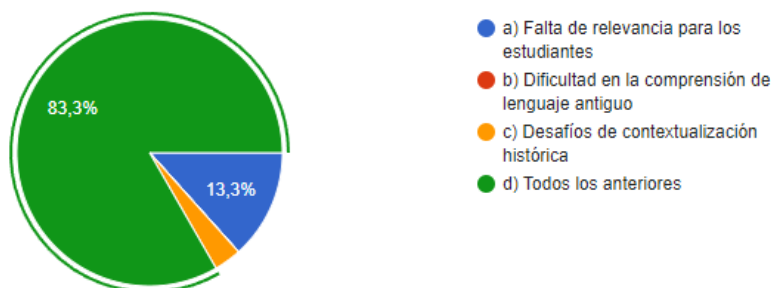
*Recursos tecnológicos utilizados para fomentar el interés por la lectura y la escritura, según la percepción docente*



La percepción de los docentes sobre las herramientas tecnológicas más efectivas para incentivar el interés estudiantil en la lectura y la escritura. El 76,7% de los encuestados considera que una combinación de plataformas en línea, aplicaciones de lectura interactiva y blogs personales resulta ser la estrategia más efectiva. Un 13,3% opta únicamente por las aplicaciones de lectura, mientras que un 6,7% señala los blogs personales, y un 3,3% las plataformas en línea. Estos resultados sugieren que la integración de múltiples formatos digitales puede ser clave para estimular la producción y comprensión textual en estudiantes de educación básica media.

**Tabla 7***Obstáculos en la enseñanza de literatura clásica según la percepción docente*

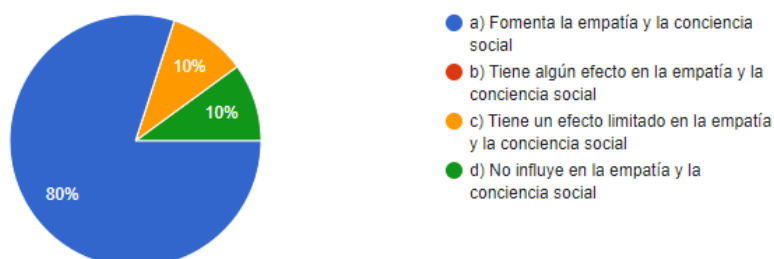
Opción	Número de respuesta	%
a) Falta de relevancia para los estudiantes	04	13.30
b) Dificultad en la comprensión de lenguaje antiguo	00	0.00
c) Desafíos de contextualización histórica	01	03.40
d) Todos los anteriores	25	83.30
Total	30	100.00

**Figura 7***Principales desafíos identificados en la enseñanza de literatura clásica según docentes de educación básica media*

Las percepciones docentes sobre los obstáculos más frecuentes al enseñar literatura clásica en estudiantes de entre 9 y 12 años. El 83,3% de los encuestados considera que la enseñanza enfrenta múltiples retos simultáneos, incluyendo la falta de relevancia percibida por los estudiantes, la dificultad en la comprensión del lenguaje antiguo y los desafíos para contextualizar históricamente las obras. El 13,3% señaló únicamente la falta de relevancia como el principal problema. Estos datos evidencian la necesidad de enfoques pedagógicos que vinculen la literatura clásica con contextos actuales y accesibles para los estudiantes.

**Tabla 8***Influencia percibida de la literatura en el desarrollo de la empatía y la conciencia social*

Opción	Numero de Respuesta	%
a) Fomenta la empatía y la conciencia social	24	80.00
b) Tiene algún efecto en la empatía y la conciencia social	00	0.00
c) Tiene un efecto limitado en la empatía y la conciencia social	03	10.00
d) No influye en la empatía y la conciencia social	03	10.00
Total	30	100.00

**Figura 8***Percepción docente sobre la influencia de la literatura en el desarrollo de la empatía y la conciencia social en estudiantes*

La opinión de los docentes respecto al impacto de la enseñanza de la literatura en el fomento de la empatía y la conciencia social entre los estudiantes de educación básica media. El 80% considera que esta área del conocimiento tiene una fuerte influencia en el desarrollo emocional y social del alumnado. Un 10% afirma que tiene algún efecto positivo, mientras que otro 10% opina que no influye en absoluto. Estos resultados respaldan la inclusión de textos literarios que promuevan valores humanos, la comprensión de otras realidades y el desarrollo de habilidades socioemocionales.

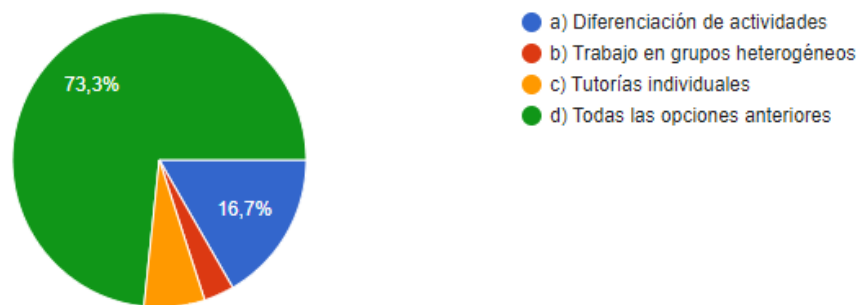
**Tabla 9**

*Influencia percibida de la literatura en el desarrollo de la empatía y la conciencia social*

Opción	Número de respuesta	%
a) Diferenciación de actividades	05	16.70
b) Trabajo en grupos heterogéneos	01	3.30
c) Tutorías individuales	02	6.70
d) Todas las opciones anteriores	22	73.30
Total	30	100.00

**Figura 9**

*Percepción docente sobre la influencia de la literatura en el desarrollo de la empatía y la conciencia social en estudiantes*



La opinión de los docentes respecto al impacto de la enseñanza de la literatura en el fomento de la empatía y la conciencia social entre los estudiantes de educación básica media. El 80% considera que este área del conocimiento tiene una fuerte influencia en el desarrollo emocional y social del alumnado. Un 10% afirma que tiene algún efecto positivo, mientras que otro 10% opina que no influye en absoluto. Estos resultados respaldan la inclusión de textos literarios que promuevan valores humanos, la comprensión de otras realidades y el desarrollo de habilidades socioemocionales.

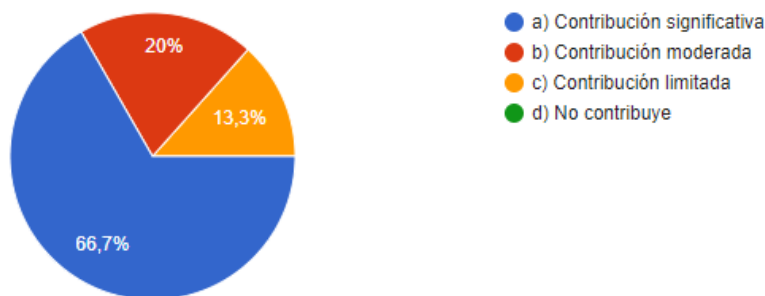
**Tabla 10**

*Valoración docente sobre el impacto de actividades extracurriculares en el desarrollo integral del estudiante*

Opción	Número de respuesta	%
a) Contribución significativa	20	66.70
b) Contribución moderada	06	20.00
c) Contribución limitada	04	13.30
d) No contribuye	00	00.00
Total	30	100.00

**Figura 10**

*Contribución percibida de las actividades extracurriculares de lengua y literatura al desarrollo integral estudiantil*



La percepción de los docentes sobre el grado en que las actividades extracurriculares relacionadas con la lengua y la literatura aportan al desarrollo integral de los estudiantes de educación básica media. Un 66,7% considera que estas actividades tienen una contribución significativa, mientras que un 20% las valora como de contribución moderada. El 13,3% cree que su aporte es limitado, y ningún encuestado indicó que no contribuyen en absoluto. Estos resultados destacan la importancia de promover iniciativas extracurriculares como clubes de lectura, concursos literarios y talleres de escritura creativa como espacios complementarios de aprendizaje.

### **Resultados y Discusión**

La encuesta aplicada a los docentes de la Escuela de Educación Básica Fiscal Manuel Gómez Abad revela aspectos clave sobre las percepciones y desafíos en la enseñanza de Lengua y Literatura en estudiantes de entre 9 y 12 años. A continuación, se presentan los hallazgos principales, organizados por eje temático.

#### **Dificultades en la lectura y análisis literario**

Un 66,7% de los docentes reporta que la lectura en voz alta representa un desafío para los estudiantes, lo que puede reflejar dificultades en la fluidez y comprensión lectora, especialmente cuando se abordan textos clásicos; asimismo, un 30% de los encuestados indicó que el análisis literario también resulta complejo para sus alumnos. Estos resultados sugieren la necesidad de aplicar estrategias didácticas que descompongan textos literarios complejos en elementos más accesibles.

Estudios recientes destacan que la mediación docente, a través del uso de guías de lectura estructuradas, preguntas orientadoras y recursos audiovisuales, favorece significativamente la comprensión de textos literarios complejos en estudiantes de educación básica (González & Viera, 2022). Por ello, resulta fundamental diseñar apoyos pedagógicos que se ajusten a las habilidades lectoras específicas del grupo etario, facilitando así un acercamiento progresivo y significativo a obras literarias exigentes.

#### **Impacto de la enseñanza de gramática y sintaxis**

El 66,7% de los docentes coincide en que el trabajo sistemático con gramática y sintaxis ha favorecido la mejora en la calidad de la escritura de los estudiantes. Este hallazgo refuerza la importancia de integrar la instrucción gramatical con actividades significativas de producción textual.



Según López y Serrano (2021), “la enseñanza explícita de la gramática, contextualizada en tareas comunicativas, fortalece la coherencia y cohesión en la escritura estudiantil” (p. 104). Esto sugiere que combinar enfoques formales con tareas prácticas resulta altamente beneficioso.

### **Preferencias de géneros literarios**

Los géneros más atractivos para los estudiantes, según los docentes encuestados, son la novela de aventuras (56,7%) y la ciencia ficción (30%). Estas preferencias reflejan un interés por textos que estimulan la imaginación y permiten a los estudiantes explorar realidades alternativas.

La inclusión de estos géneros en el currículo puede aumentar la motivación hacia la lectura. Según Herrera & Domínguez (2020), “la literatura juvenil que apela a lo fantástico y la exploración de lo desconocido genera mayor conexión emocional y cognitiva con el lector adolescente” (p. 83).

### **Lectura intercultural y diversidad literaria**

Más del 56% de los docentes considera que la lectura de textos provenientes de diversas culturas fortalece la comprensión intercultural de los estudiantes. Esto evidencia la importancia de un enfoque literario inclusivo y plural.

Investigaciones como la de Alvarado & Carrasco (2022) demuestran que “la literatura multicultural promueve la empatía y el respeto por la diversidad al ampliar el marco interpretativo de los estudiantes” (p. 57). Incluir autores y contextos variados en el aula favorece una educación más equitativa.

### **Escritura argumentativa y pensamiento crítico**

El 46,7% de los encuestados afirma que la escritura argumentativa contribuye directamente al desarrollo del pensamiento crítico. Esta práctica permite a los estudiantes organizar sus ideas, formular juicios y defender puntos de vista con fundamento lógico.

Autores como Martínez & Rivas (2023) destacan que “la producción de textos argumentativos fortalece la autonomía intelectual, al exigir reflexión, evidencia y estructuración clara de ideas” (p. 62). Por ello, debería considerarse como un eje central en el currículo.

### **Uso de tecnología en la enseñanza**

Un 76,7% de los docentes indica que el uso de plataformas digitales, blogs y aplicaciones educativas incrementa el interés del alumnado por la lectura y la escritura. Este resultado destaca la necesidad de integrar tecnologías de forma pedagógicamente significativa.

Según Rivera & Quintero (2022), “el uso de herramientas digitales en la enseñanza de la lengua posibilita entornos más interactivos, personalizados y motivadores para los estudiantes” (p. 118).

### **Desafíos en la enseñanza de literatura clásica**

El 83,3% de los docentes identifica obstáculos en la enseñanza de literatura clásica, relacionados con el lenguaje arcaico, el contexto histórico distante y la falta de conexión con los intereses actuales de los estudiantes. Esto subraya la urgencia de rediseñar las estrategias didácticas para abordar estos textos de manera más contextualizada.

En esta línea, Salcedo & Nieto (2021) afirman que “la relectura crítica y creativa de textos clásicos, apoyada en recursos visuales y vínculos con problemáticas actuales, mejora significativamente su recepción por parte del alumnado” (p. 74).

### **Literatura y desarrollo socioemocional**

Más del 80% de los docentes reconoce que la literatura contribuye al desarrollo de la empatía y la conciencia social. Este resultado reafirma el papel humanizador de la lectura literaria, especialmente durante la adolescencia.

Como sostienen Castro & Méndez (2020), “los textos literarios permiten a los estudiantes experimentar perspectivas distintas, lo que potencia su capacidad de comprender y valorar al otro” (p. 90).

### **Estrategias para abordar la diversidad en el aula**

El 73,3% de los encuestados señala que las metodologías más efectivas para atender la diversidad incluyen la diferenciación de actividades, el trabajo colaborativo y las tutorías individualizadas. Estas estrategias permiten adaptar la enseñanza al ritmo y estilo de aprendizaje de cada estudiante.

Tomlinson et al. (2022) sostienen que “la diferenciación instruccional crea oportunidades equitativas de aprendizaje, al ofrecer múltiples vías de acceso a los contenidos” (p. 49), lo que la convierte en una práctica imprescindible.

### **Rol de las actividades extracurriculares**

El 66,7% de los docentes destaca que las actividades extracurriculares vinculadas con la lectura y la escritura enriquecen el proceso de aprendizaje y fortalecen el desarrollo integral del estudiantado.

Estudios recientes han demostrado que los clubes de lectura, los concursos literarios y las salidas culturales fomentan la apropiación de las habilidades comunicativas en contextos reales y significativos (Fernández & Orozco, 2021).

## **Conclusiones**

Los resultados de esta investigación evidencian que la enseñanza de Lengua y Literatura en la adolescencia temprana debe responder a la diversidad cognitiva, social y emocional del alumnado, especialmente entre los 9 y 12 años. Esto requiere la implementación de estrategias pedagógicas variadas, adaptativas y culturalmente relevantes que fortalezcan las habilidades comunicativas, el pensamiento crítico y el desarrollo emocional de los estudiantes.

Uno de los principales desafíos identificados es la enseñanza de la literatura clásica, tanto por su densidad lingüística como por la distancia cultural que presenta. Más del 80% de los docentes encuestados reportan dificultades en este aspecto. La investigación respalda la necesidad de integrar técnicas didácticas como la lectura guiada, el análisis colaborativo y el uso de materiales audiovisuales contextualizados para facilitar la comprensión de textos complejos (Salcedo & Nieto, 2021). La relectura crítica, desde un enfoque contemporáneo, es clave para conectar estas obras con la realidad del estudiante; asimismo, se confirma que la enseñanza explícita de gramática y sintaxis, cuando es integrada de forma funcional en tareas de escritura, tiene un impacto positivo en la producción textual. Los docentes coincidieron en que esta instrucción refuerza la coherencia, la claridad y la corrección en la expresión escrita, alineándose con investigaciones recientes que promueven la gramática en contexto (López & Serrano, 2021).

La preferencia estudiantil por géneros, como la ciencia ficción y la novela de aventuras, sugiere que la motivación lectora puede potenciarse a través de textos que estimulen la imaginación y promuevan la identificación emocional. Esto invita a revisar el currículo para incorporar lecturas que mantengan el interés sin perder el valor literario y formativo. Según Herrera & Domínguez (2020), el compromiso lector se incrementa cuando se integran narrativas con temáticas cercanas a la realidad de los estudiantes.

La escritura argumentativa emerge como una estrategia eficaz para fomentar el pensamiento crítico y la organización lógica de ideas. Esta habilidad, esencial para el desarrollo académico y la ciudadanía activa, debería integrarse desde los primeros niveles de la educación media, tal como lo señalan Martínez & Rivas (2023).

En cuanto a las tecnologías digitales, se destaca su potencial para enriquecer la enseñanza de la lengua, siempre que su uso esté mediado pedagógicamente. Plataformas interactivas, blogs, y editores colaborativos pueden transformar la forma en que los estudiantes producen y consumen textos, incentivando una participación más activa y personalizada (Rivera & Quintero, 2022).

El estudio también evidencia que la lectura de textos de distintas culturas y contextos favorece el desarrollo de la empatía, el pensamiento plural y la conciencia social. La literatura multicultural y las actividades extracurriculares vinculadas con el lenguaje ofrecen oportunidades concretas para desarrollar habilidades sociales, ética y emocionalmente significativas. Como lo afirman Castro & Méndez (2020), estas experiencias favorecen la construcción de una identidad más abierta, crítica y comprometida con el entorno.

Finalmente, la diferenciación pedagógica y el enfoque inclusivo fueron señalados como herramientas efectivas para atender a la heterogeneidad de niveles en el aula. El diseño de actividades flexibles, tutorías personalizadas y espacios colaborativos resultan fundamentales para asegurar que todos los estudiantes puedan avanzar en su proceso de aprendizaje.

En conjunto, esta investigación contribuye al fortalecimiento del enfoque pedagógico en lengua y literatura desde una perspectiva integral, al proponer un modelo que combine prácticas didácticas basadas en evidencia, sensibilidad social y adaptación tecnológica. Más allá del rendimiento académico, estas estrategias apuntan a la formación de sujetos críticos, creativos y socialmente responsables.

En este sentido, la enseñanza de la lengua y la literatura no solo debe concebirse como una asignatura curricular, sino como un eje transversal para el desarrollo humano y la transformación social.

### **Limitaciones y futuras líneas de investigación**

Si bien este estudio ofrece una visión amplia sobre las percepciones docentes respecto a prácticas pedagógicas en lengua y literatura, presenta ciertas limitaciones. La investigación se centró en una sola institución educativa y utilizó un muestreo no probabilístico, lo que restringe la generalización de los resultados a otros contextos; además, no se recopilaron datos cuantitativos directos sobre el rendimiento académico de los estudiantes (por ejemplo, calificaciones estandarizadas o pruebas internas), lo que limita el análisis de correlaciones entre prácticas docentes y resultados concretos.

Futuras investigaciones podrían abordar estas limitaciones ampliando la muestra a diversas instituciones y regiones, así como incorporando métricas objetivas de aprendizaje.

También se sugiere el desarrollo de estudios mixtos que combinen encuestas con observación en aula, entrevistas a estudiantes y análisis documental para una comprensión más profunda y triangulada del fenómeno educativo.

### Reconocimientos

Los autores declaran la contribución y participación equitativa de roles de autoría para esta publicación.

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**Sección Abierta Multidisciplinaria: Ciencia para el Desarrollo**  
**Open Multidisciplinary Section: Science for Development**

# **Tecnología y Gestión Aplicada / Applied Technology and Management**



## Revisión sistemática de literatura sobre mecanismos de recolección de energía utilizados en dispositivos de monitorización de signos vitales

### Systematic Literature Review on Energy Harvesting Mechanisms Used in Vital Signs Monitoring

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Enviado: 2024/07/26  
Aceptado: 2025/04/08  
Publicado: 2025/06/30

#### Resumen

Los dispositivos de monitorización de signos vitales desempeñan un papel importante en el ámbito médico al permitir el seguimiento continuo de los pacientes. No obstante, estos equipos actualmente dependen de baterías o suministro eléctrico para su funcionamiento, pudiendo presentar limitaciones e inconvenientes como la pérdida de datos y la interrupción de la vigilancia constante. A pesar de ello, la creciente implementación de mecanismos autónomos de recolección de energía podría reemplazar los métodos convencionales de alimentación. Esta revisión sistemática de literatura se llevó a cabo con el objetivo de identificar los mecanismos de captación de energía más apropiados para dispositivos de seguimiento de constantes vitales en seres vivos. El análisis incluyó tanto fuentes ambientales como aquellas producidas por el cuerpo humano. Se proporcionó también información sobre los signos vitales más comúnmente monitorizados, así como la ubicación del dispositivo en el cuerpo. También se especificó la producción energética generada por las tecnologías consideradas en las publicaciones analizadas. Los mecanismos más utilizados fueron el triboeléctrico y piezoeléctrico, mientras que la radiofrecuencia y triboeléctrico obtuvieron una mayor producción energética. Cabe recalcar que los mecanismos evaluados son aplicables tanto en personas como otros seres vivos pues se comparten ciertas similitudes con los animales domésticos.

**Sumario:** Introducción, Materiales y Métodos, Resultados y Discusión, Conclusiones.

**Como citar:** Peñafiel-Arteaga, N. & Navia, M. (2025). Revisión sistemática de literatura sobre mecanismos de recolección de energía utilizados en dispositivos de monitorización de signos vitales. *Revista Tecnológica - Espol*, 37(1), 247-263. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1224>

**Palabras clave:** Recolección de energía, dispositivos inalámbricos, triboeléctrico, piezoeléctrico, radiofrecuencia.

### Abstract

Vital signs monitoring devices play a crucial role in the medical field by enabling continuous patient tracking. However, these devices rely on batteries or an electrical power supply, which can present limitations and inconveniences such as data loss and interruptions in continuous monitoring. Nevertheless, the increasing implementation of autonomous energy harvesting mechanisms may replace conventional power sources. This systematic literature review was conducted to identify the most appropriate energy harvesting mechanisms for vital signs monitoring devices in living organisms. The analysis included both environmental sources and those generated by the human body. Information was also provided on the most commonly monitored vital signs and the device's location on the body. Additionally, the energy output generated by the technologies considered in the analyzed publications was specified. The most used mechanisms were triboelectric and piezoelectric, while radiofrequency and triboelectric methods achieved higher energy production. It is worth noting that the evaluated mechanisms apply to both humans and other living beings, as they share certain similarities with domestic animals.

**Keywords:** Energy harvesting, wireless devices, triboelectric, piezoelectric, radiofrequency.

### Introducción

La automatización de dispositivos impulsada por los avances tecnológicos continuos ha significado una notable mejora en eficiencia y agilidad en diversos procesos de productividad en innumerables ámbitos. A pesar de estos progresos, persiste un problema importante en el campo de la energía. Los aparatos electrónicos, ya sea aquellos conectados a la corriente eléctrica como los que siguen dependiendo de baterías, siguen enfrentándose a importantes retos relacionados con su alimentación, ya que aún se encuentran en proceso de mejora.

El incremento en la vida útil de las baterías, con modelos que actualmente pueden durar hasta 7 años, demuestra logros significativos, aunque el tiempo de funcionamiento todavía depende de la capacidad energética que consumen los sistemas (Blažević et al., 2022). Sin embargo, el uso constante de baterías presenta problemas de sostenibilidad debido a los componentes corrosivos que impactan negativamente al medio ambiente; además, esta situación afecta la eficiencia de dispositivos que manejan aplicaciones críticas, especialmente en el campo médico como el monitoreo de la salud.

Por tanto, el seguimiento de la salud mediante dispositivos electrónicos es fundamental para la gestión de la atención médica. No obstante, el cambio periódico de las baterías produce la pérdida temporal del control, comprometiendo la continuidad, eficiencia del monitoreo y las mediciones durante el lapso requerido para el reemplazo, perjudicando, particularmente, la supervisión de la salud en áreas de difícil acceso (Pozo et al., 2018).

Los dispositivos que monitorean los signos vitales representan una línea significativa entre el estado del paciente y la atención médica inmediata, ya que se pueden obtener datos al monitorear la temperatura corporal, presión arterial, saturación de oxígeno y otros parámetros médicos. De esta manera las alertas generadas por los dispositivos inalámbricos ante cambios en la condición de los pacientes pueden reflejarse en aplicaciones de monitorización, convirtiendo la información obtenida en un recurso valioso para la prevención de enfermedades



(Hezekiah et al., 2023). Sin embargo, es necesario priorizar que la tecnología aplicada en la persona no interfiera en sus actividades diarias (Manzano & Bejarano, 2021).

Ahora, imaginar un sistema de seguimiento de salud que nunca requiera una batería para mantener una vigilancia permanente e ininterrumpida sobre los pacientes, podría ser posible a través de la recolección de energía ambiental. Esta tecnología revolucionará la atención médica inmediata y remota.

Por tal motivo, propuestas innovadoras y autónomas como la recolección de energía o “Energy Harvesting” (EH, por sus siglas en inglés), surgen para abordar los desafíos de sostenibilidad y eficiencia en el monitoreo de salud. Este enfoque no solo reduce la dependencia de las baterías, sino que también promueve la conservación del medio ambiente al captar energía disponible del entorno o del cuerpo y convertirla en energía eléctrica, misma que sería utilizada como fuente de alimentación para dispositivos inalámbricos de bajo consumo. Es importante conocer la cantidad de energía consumida por el circuito para garantizar que la energía acumulada y almacenada sea superior (Shuvo et al., 2022; Isiyoto et al., 2022)

Además, se visualiza que EH desempeñará un papel fundamental en los sistemas de IoT en la era 5G, debido a su facilidad de autoalimentación al experimentar deficiencia energética. Es por esto que se ha incrementado la necesidad de estudiar y desarrollar la implementación de recolección de energía en dispositivos portátiles (Heidari et al., 2021).

En el presente trabajo se llevará a cabo una revisión sistemática de literatura sobre estudios relevantes de “Energy Harvesting” aplicados a dispositivos de monitorización de signos vitales utilizando información de diferentes bases de datos científicas. La finalidad es comprender los disímiles tipos de fuentes energéticas utilizadas en la recolección de energía e identificar las propuestas que mayormente son aplicadas en dispositivos de monitorización de signos vitales en seres vivos. El aporte principal de este trabajo es un análisis actualizado de los mecanismos de EH aplicados en este ámbito, pero además se ha considerado la monitorización en cualquier ser vivo, ya que la mayoría de revisiones se basan exclusivamente en seres humanos.

La estructura de este artículo implica varias secciones. Se da inicio con la descripción de antecedentes relevantes acerca de los mecanismos de recolección de energía y sus aplicaciones en diversas áreas; a continuación, se desarrolla el apartado de métodos y herramientas, donde se detalla la metodología y recursos aplicados en el proceso investigativo; posteriormente, se presentan los resultados obtenidos y una breve discusión; en la última sección se exponen las conclusiones del trabajo.

### **Estado del arte**

La monitorización de signos vitales es un aspecto primordial en la atención médica, ya que provee información crucial para el seguimiento y tratamiento de pacientes, que incluso influye en el diagnóstico de posibles enfermedades.

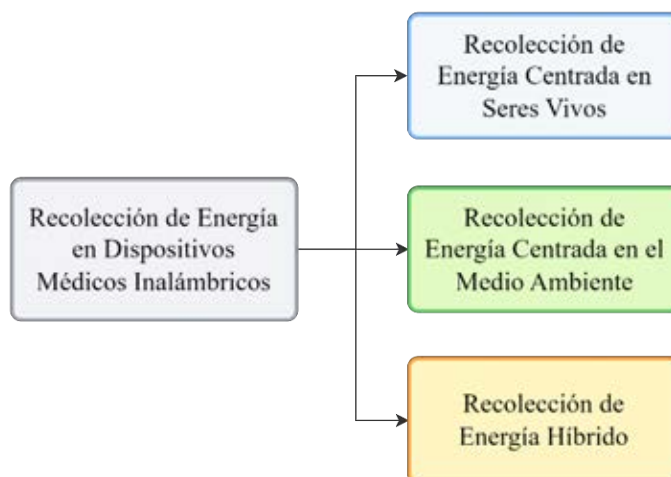
Por dichas razones, crear dispositivos portátiles de bajo costo, precisos y fáciles de usar se intensifica, y el desarrollo de brazaletes para la monitorización de signos vitales parece ser una opción viable. Hadiyoso et al. (2021) demuestran que estos dispositivos podrían realizar lecturas de presión arterial, frecuencia cardíaca, saturación de oxígeno, hasta electrocardiogramas. En su propuesta presentan en la pantalla del brazalete los datos recopilados y para facilitar el seguimiento inalámbrico emplean un módulo Bluetooth.

Siguiendo la idea de reemplazar las baterías para el funcionamiento de dispositivos autónomos, han surgido diversos estudios y progresivamente se explora sobre la recolección de energía y sus métodos para aplicarlos en dispositivos portátiles inalámbricos, tal como concluye la investigación presentada por Ali et al. (2023)

En cuanto al área médica, se disponen de diversos estudios con estas técnicas aplicadas en dispositivos de monitorización de signos vitales. Varios autores dan a conocer diferentes implantes y dispositivos médicos que emplean EH para su operatividad, a pesar que no indican el mecanismo de recolección de energía predominante en el ámbito médico, respecto al monitoreo de signos vitales (Shuvo et al., 2022b); adicionalmente, el trabajo citado proporciona una clasificación de métodos de recolección de energía en dispositivos médicos, ya sean implantables o inalámbricos. La Figura 1 es una adaptación representativa de dicho esquema, pero enfocada con el tema de estudio propuesto.

**Figura 1**

*Adaptación de clasificación de técnicas de EH en dispositivos médicos implantables y portátiles*



En relación con la Figura 1, el trabajo realizado por Mahmood et al. (2023), con el tema de recolección de energía basada en aplicaciones biomédicas, es una revisión que indica técnicas de captación energética provenientes de fuentes medioambientales y del cuerpo humano. Su propósito es aplicarla en dispositivos que podrían ser usados tanto en entornos interiores como exteriores; además, define los mecanismos de la siguiente manera:

- **Triboeléctrica:** la electricidad se obtiene a partir del efecto triboeléctrico. Los materiales se cargan eléctricamente a través de la fricción. Se colocan electrodos en cada material, y el efecto de electrificación se combina con la inducción electrostática para obtener energía reutilizable. Para la recolección de energía en dispositivos portátiles se utilizan principalmente nanogeneradores triboeléctricos.
- **Fotovoltaica:** este tipo de energía se basa en la conversión de la luz solar en electricidad mediante células solares que funcionan con materiales semiconductores, generando un flujo de electrones.
- **Termodinámica:** se aprovecha la diferencia de temperatura entre dos cuerpos para generar electricidad. Puede ocurrir de forma natural, a partir del calor corporal humano que proporciona una cantidad adecuada de energía para alimentar sensores implantados, o de otra manera, utilizando generadores termoeléctricos fabricados con metales o polímeros.

- Piezoeléctrico: adquiere energía de los movimientos mecánicos como vibraciones o impactos. Los materiales piezoeléctricos pueden convertir la energía mecánica directamente en electricidad sin necesidad de un proceso intermedio. Al experimentar tensión mecánica se genera un campo eléctrico, y la energía captada se usa para alimentar dispositivos de bajo consumo.
- Eólica: es obtenida a partir del viento, que es la fuente de energía renovable. Se utilizan aerogeneradores, dispositivos con aspas que giran por la misma acción del viento, transformando la energía cinética en electricidad. Las turbinas eólicas son de distintos tamaños y formas según la potencia requerida.
- Radiofrecuencia: recolecta ondas electromagnéticas emitidas por antenas de radio u otros medios y luego las convierte en energía, mediante circuitos rectificadores y antenas especializadas para alimentar dispositivos. Estas ondas pueden penetrar tejidos blandos, siendo factibles utilizarlas en dispositivos médicos.

A continuación, se describen ejemplos de dispositivos de monitorización de signos vitales que implementan EH:

En un estudio se utilizó un nanogenerador piezoeléctrico que recolectó energía a partir de la respiración y los latidos del corazón de una rata, lo que permitió medir la frecuencia respiratoria (Li et al., 2010); asimismo, en otro trabajo, se diseñó un sistema para recolectar energía de los latidos cardíacos porcinos, debido a su anatomía similar a la de los seres humanos, y se obtuvo información de la frecuencia cardíaca (Kim et al., 2017); también se investigó la relación de la frecuencia cardíaca y la generación de energía a través del balanceo de los brazos al aplicar películas especializadas (Z. Lin et al., 2017).

En otro enfoque, diversos autores desarrollaron un sistema portátil sin batería que mide las frecuencias respiratoria y cardíaca, y el movimiento del torso de una persona. En el sistema incorporaron un panel solar flexible que alimenta la placa del circuito en una camisa para facilitar las actividades de la persona. Comparaciones entre las mediciones obtenidas por el circuito y los instrumentos médicos convencionales corroboraron la confiabilidad de los datos (Dionisi et al., 2016).

Los investigadores Isioto et al. (2022) consideran al cuerpo humano como fuente de energía que suministra alimentación energética a sistemas independientes. La recolección de energía se lleva a cabo durante las actividades cotidianas que se realizan, como el movimiento generado por los brazos, las pisadas u otras acciones; no obstante, cuando el movimiento es originado por la respiración y los latidos del corazón, se requiere el uso de películas especializadas para captar la energía (W. Lin et al., 2023).

La importancia de la recolección de energía en contextos de monitoreo relacionados con aspectos de los seres vivos ha sido y seguirá siendo objeto de investigación en constante desarrollo.

### **Materiales y Métodos**

En esta investigación se aplicó la metodología PRISMA (*Preferred Reporting Items for Systematic Review and Meta-Analysis*) (Page et al., 2021). Se emplearon las tres fases de PRISMA propuestas por los autores Kitchenham & Charters (2007) para la ejecución de una revisión sistemática de literatura (*System Literature Review*, SLR):

- Fase 1 Planificación: se enfocó en el planteamiento de las preguntas de investigación que se abordaron en la investigación y también en el desarrollo del protocolo que se llevó a cabo.
- Fase 2 Ejecución de la revisión: se identificaron y seleccionaron los estudios rigurosamente. Luego se evaluó la calidad, extrayendo los datos pertinentes de los documentos aceptados.
- Fase 3 Informe de la revisión: se especificaron los resultados obtenidos a lo largo del proceso investigativo en un documento detallado.

### **Preguntas de investigación**

La pregunta de investigación principal (*Research Question*, RQ) que surge para guiar este estudio fue la siguiente: ¿De qué forma se pueden determinar los mecanismos de recolección de energía más utilizados en dispositivos de monitorización de signos vitales en seres vivos?

El objetivo de esta SLR fue proporcionar una respuesta a la pregunta propuesta, centrándose en identificar y analizar las técnicas de *energy harvesting* que han generado mayor impacto en los últimos años en los dispositivos de monitoreo de signos vitales en seres vivos.

Cabe recalcar que la evaluación de los estudios se realizó en inglés, considerando que la comunidad científica lo utiliza como idioma estándar y, por lo tanto, existe una mayor gama de recursos actualizados y de calidad.

A su vez, se definieron los términos clave en este idioma, los que fueron asignados apropiadamente en los criterios de PICOC (población, intervención, comparación, resultados y contexto) para estructurar las preguntas investigativas que ayudaron con la respuesta de la interrogante principal. Las palabras clave establecidas para este propósito fueron:

- Población (P): energy harvesting, energy scavenging, power harvesting.
- Intervención (I): monitor, monitoring, device, system.
- Contexto (C): vital signs, vitals.

Los términos de comparación (C) y resultados (O) no se incluyeron, ya que no es pertinente comparar mecanismos de recolección de energía específicos, ni definir resultados previamente establecidos.

Las preguntas de investigación generadas como apoyo fueron las siguientes:

- RQ1: ¿Qué mecanismos de EH se utilizan en dispositivos de monitorización de signos vitales?
- RQ2: ¿Qué signos vitales se monitorizan con los dispositivos?
- RQ3: ¿Cuál es la producción energética de los distintos mecanismos de recolección de energía en cada caso?
- RQ4: ¿En qué parte del cuerpo se ubica el dispositivo de monitorización de signos vitales?

### **Fuentes de información y estrategia de búsqueda**

Las fuentes seleccionadas en esta investigación incluyeron Scopus, IEEE Xplore, ACM Digital Library, ScienceDirect y SpringerLink. Se consideraron varios requisitos para la selección de estas bases de datos científicas como: la relevancia que tienen en el ámbito

investigativo y el área de estudio, la posibilidad de utilizar búsqueda avanzada y que la integridad de la cadena de búsqueda en las diversas fuentes científicas se mantuviera.

Como parte de la estrategia de búsqueda, se emplearon las palabras claves de PICOC en conjunto con los operadores booleanos como AND y OR para establecer la siguiente cadena de búsqueda:

("energy harvesting" OR "energy scavenging" OR "power harvesting") AND ("device" OR "monitor" OR "monitoring" OR "system") AND ("vital sign" OR "vitals")

### **Criterios para selección de estudios**

La selección de estudios se llevó a cabo utilizando los resultados obtenidos de la cadena de búsqueda documental. Cada texto fue revisado inicialmente en función del título y resumen, posteriormente se aplicaron los criterios de inclusión y exclusión filtrando los archivos que cumplieran los requerimientos. Finalmente, se evaluó la calidad de los estudios seleccionados de manera individual mediante un análisis integral.

Como parte del protocolo de revisión, los criterios de inclusión y exclusión definidos consistieron en los siguientes:

Criterios de inclusión:

- Artículos de revista y de congresos.

Criterios de exclusión:

- Artículos no relacionados a propuestas de recolección de energía en dispositivos de monitorización de signos vitales.
- Artículos en idioma distinto al inglés.
- Artículos publicados antes del año 2018.
- Trabajos que no se encuentran accesibles.
- Documentos duplicados o que sean revisiones de literatura, editoriales, resúmenes, libros y capítulos de libros.

Los criterios de inclusión y exclusión se centraron en garantizar que no se omitieran estudios importantes. En particular, se eligió el idioma inglés porque la mayoría de las investigaciones relevantes se publican en este idioma; por otro lado, el año mínimo de publicación (2018) buscó garantizar que se seleccionaran trabajos actualizados, es así que el rango de búsqueda fue desde el año 2018 al mes de marzo del año 2024.

### **Evaluación de calidad**

Evaluar la calidad de los estudios permitió clasificar los trabajos de alta calidad que garantizan solidez en la investigación asegurando resultados confiables, separándolos de aquellos que se veían limitados en la metodología por sesgos que podrían terminar afectando las inferencias finales. Conforme a ello, en cada estudio se aplicaron varias preguntas y se estableció una puntuación mínima de 0 en caso de no responder a la interrogante, al obtener una respuesta parcial se calificó con 0.5 y el valor máximo de 1 se otorgó a los trabajos que cumplieran lo solicitado.

Criterios de evaluación (*Quality Criteria*, QC):

- QC1: ¿El estudio incluye el uso de un mecanismo de EH para alimentación del dispositivo de monitorización de signos vitales?
- QC2: ¿En el estudio se hacen pruebas con componentes reales?
- QC3: ¿El documento especifica qué tipo de signos vitales está monitorizando el dispositivo?
- QC4: ¿En el documento se menciona la ubicación del dispositivo de monitorización de signos vitales en el paciente de prueba?

El puntaje de corte que los estudios debieron mantener en la evaluación de calidad para ser considerados en la SLR fue de 2. Este valor se determinó según el promedio de los criterios de evaluación, certificando así la calidad de los trabajos seleccionados.

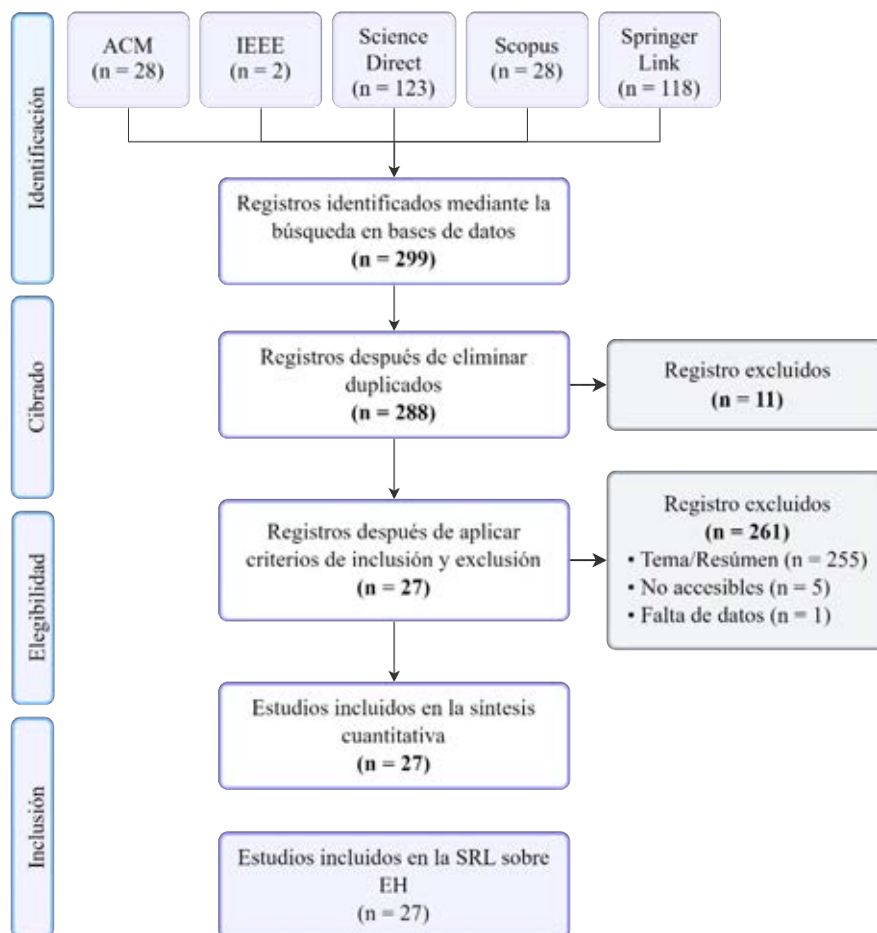
### Aplicación del protocolo de búsqueda y extracción de datos

En la Figura 2 se puede visualizar el diagrama con el resultado de la aplicación de los criterios previamente definidos como parte de la metodología PRISMA.

Primero, se realizó una indagación exhaustiva donde se aplicó la cadena de búsqueda en las diferentes bases de datos científicas, para identificar los trabajos relevantes. Para ello, se exportaron los datos de los estudios encontrados en formato Bibtex, conservando el contenido en archivos de texto plano. Luego se importaron en la plataforma Parsifal (<https://parsif.al/>), que sirvió de apoyo para el desarrollo de este trabajo investigativo.

**Figura 2**

*Diagrama de flujo PRISMA*



Adaptado de (García-Holgado & García-Peñalvo, 2019) - (Moher et al., 2009).

La plataforma Parsifal facilitó la gestión de los artículos, llevando el conteo de los duplicados, y categorizando los estudios aceptados y rechazados. También permitió evaluar la calidad de los documentos controlando su valoración, optimizando así el proceso de la SLR. Después de confirmar que los estudios se encontraran en la plataforma Parsifal, se aplicaron los criterios de inclusión y exclusión.

Finalmente, los artículos que superaron el filtro anterior fueron sometidos a una evaluación más detallada que involucró la revisión del documento completo para determinar si cumplían los estándares de calidad al sobrepasar el punto de corte.

Una vez aplicada cada una de las etapas de selección detalladas en la Figura 2, se obtuvo lo siguiente:

- En la fase de búsqueda exploratoria se encontró un total de 299 artículos en las diferentes bases de datos: 28 en ACM Digital Library, 2 en IEEE Xplore, 123 en ScienceDirect, 28 en Scopus y 118 en SpringerLink.
- Se registraron 11 trabajos duplicados, dejando 288 artículos restantes por analizar.
- Luego de aplicar los criterios de inclusión y exclusión permanecieron 27 estudios en el proceso de selección para el análisis detallado requerido en la SRL.

Tras completar la lectura de los trabajos aceptados, se utilizó una hoja de extracción de datos para tabular la información, considerando la importancia de cada variable y la capacidad de los hallazgos para dar respuesta a las preguntas de investigación. Los datos que se extrajeron de los documentos seleccionados comprendieron:

- Tipo de EH empleado (RQ1): fotovoltaica, híbrida, piezoeléctrica, termodinámica o triboeléctrica, etc.
- Signos vitales monitorizados (RQ2): presión arterial, frecuencia cardíaca (FC), frecuencia respiratoria (FR), saturación de oxígeno, temperatura (T), entre otros.
- Generación de energía (RQ3): potencia variable medida en vatios (W), voltios (V) o amperios (A) en el caso de la corriente.

Área del cuerpo donde se ubica el dispositivo de monitoreo de signos vitales (RQ4): varía de acuerdo con el estudio realizado.

### Resultados y Discusión

En la Tabla 1 se encuentran las citas de los artículos seleccionados y los datos que se obtuvieron de cada uno de ellos.

**Tabla 1**

*Datos obtenidos de los artículos analizados*

FUENTE	MECANISMO DE EH (RQ1)	SIGNO VITAL (RQ2)	GENERACIÓN DE ENERGÍA (RQ3)	UBICACIÓN DEL DISPOSITIVO (RQ4)
(Bose et al., 2020)	Termoeléctrico	Frecuencia cardíaca	4,6 $\mu$ W – 20 $\mu$ W	Pecho - Tórax
(Ghafouri & Manavizadeh, 2023)	Triboeléctrico	pH	N/A	N/A
(Qiu et al., 2019)	Triboeléctrico	Estado respiratorio	200 $\mu$ A 1000 V	Pecho - Tórax
(S. Wang et al., 2019)	Triboeléctrico	Frecuencia respiratoria	0,88 V	Rostro
(Sun et al., 2018)	Híbrido	Frecuencia cardíaca	55 V – 86 V	Muñeca

FUENTE	MECANISMO DE EH (RQ1)	SIGNO VITAL (RQ2)	GENERACIÓN DE ENERGÍA (RQ3)	UBICACIÓN DEL DISPOSITIVO (RQ4)
(Mao et al., 2023)	Triboeléctrico	Frecuencia cardíaca	N/A	N/A
(He et al., 2022)	Piezoeléctrico	Temperatura Frecuencia respiratoria	0,15 $\mu$ A 8 V	T: Mano (Palma y dedos) FR: Rostro
(Yi et al., 2022)	Triboeléctrico	Pulso arterial (Radial)	816 mW/ m <sup>2</sup>	Muñeca
(Lyu et al., 2020)	Híbrido	Frecuencia cardíaca Frecuencia respiratoria	1 $\mu$ W 1,3 V	N/A
(M. Wang et al., 2018)	Triboeléctrico	Estado respiratorio	1,7 $\mu$ A 2,4 V 1,3 mW	Rostro (Mascarilla)
(Wu et al., 2023)	Triboeléctrico	Frecuencia cardíaca	30 V 16 $\mu$ A	Muñeca
(Maity et al., 2023)	Híbrido	Frecuencia cardíaca Frecuencia respiratoria	N/A	FC: Muñeca FR: Rostro (Mascarilla)
(Panahi et al., 2020)	Piezoeléctrico	Frecuencia respiratoria	N/A	Pecho - Tórax
(Na et al., 2022)	Termoeléctrico	Estado respiratorio	18,13 mV 2,74 $\mu$ A 12,6 nW	Rostro (Mascarilla)
(Fu et al., 2021)	Triboeléctrico	Frecuencia cardíaca	0,6 $\mu$ A 10 V	Muñeca
(Kang et al., 2022)	Piezoeléctrico	Frecuencia cardíaca	1,16 $\mu$ A 97,5 V	Muñeca Cuello Tobillo
(Fahad et al., 2022)	Triboeléctrico	Frecuencia cardíaca Frecuencia respiratoria	N/A	Pecho - Tórax
(Gunasekhar & Anand Prabu, 2023)	Triboeléctrico	Frecuencia cardíaca Frecuencia respiratoria	0,85 V - 6,27 V	Pecho – Tórax Músculo trapecio
(Mokhtari & Al Ahmad, 2019)	Piezoeléctrico	Frecuencia respiratoria	N/A	Pecho - Tórax
(Zhang et al., 2023)	Termoeléctrico	Frecuencia cardíaca Temperatura	N/A	Muñeca
(Wen et al., 2023)	Híbrido	Estado respiratorio	N/A	Rostro (Mascarilla)
(Chung et al., 2020)	Radiofrecuencia	Frecuencia cardíaca Frecuencia respiratoria Temperatura Oxígeno en la sangre	Con batería: 45mAh Sin batería: suministro indefinido	Pecho - Tórax Tobillo Pie hacia los dedos Muñeca hasta la mano
(Gil et al., 2022)	Radiofrecuencia	pH	0,44 mA 1,8 V	Modelo anatómico realista de mama humano
(Ghosh et al., 2022)	Triboeléctrico	Frecuencia cardíaca Estado respiratorio	325 mW/ m2	FC: Muñeca - Cuello FR: Rostro (Surco naso labial)
(H. L. Wang et al., 2022)	Triboeléctrico	Frecuencia cardíaca	N/A	Muñeca
(Habibagahi et al., 2022)	Radiofrecuencia	Frecuencia cardíaca Temperatura Presión arterial Oxígeno en la sangre	3 V 0,1 W – 1 W	Cuello (Implante)
(Ahn et al., 2020)	Piezoeléctrico	Pulso arterial (Radial y carótida) Estado respiratorio	N/A	Muñeca

N/A: no disponible.

Después de la selección de los datos, se llevó a cabo un análisis de los aspectos asociados con las preguntas de investigación correspondiente:

### **RQ1: ¿Qué mecanismos de EH se utilizan en dispositivos de monitorización de signos vitales?**

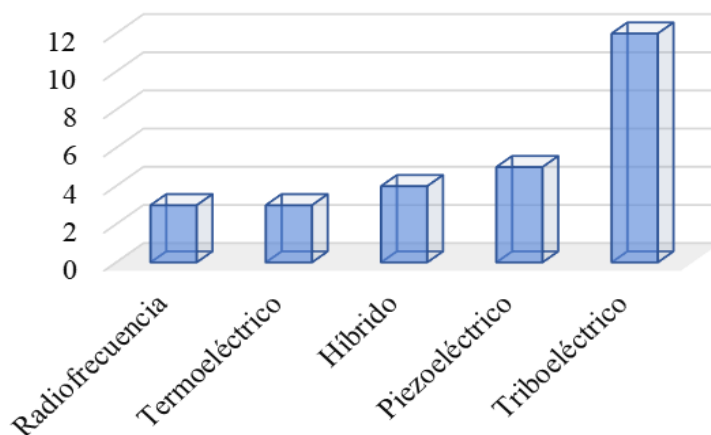
Para abordar la primera pregunta de investigación, es preciso recalcar la diversidad de mecanismos de recolección de energía aplicables en dispositivos de monitorización de signos vitales. En la revisión detallada de los artículos (Figura 3), se destacó que el tipo de mecanismo frecuentemente empleado para los dispositivos es la captación de energía triboeléctrica, pues fue mencionada en 12 ocasiones. En contraste con los mecanismos termoeléctrico y de radiofrecuencia que únicamente aparecieron 3 veces cada uno.



Siendo evidente que, aunque existen disímiles enfoques de EH, la opción preferida que sobresale para el desarrollo de dispositivos de monitoreo de signos vitales, según la literatura examinada, fue la recolección de energía triboeléctrica.

**Figura 3**

*Mecanismos de EH aplicados en los estudios*

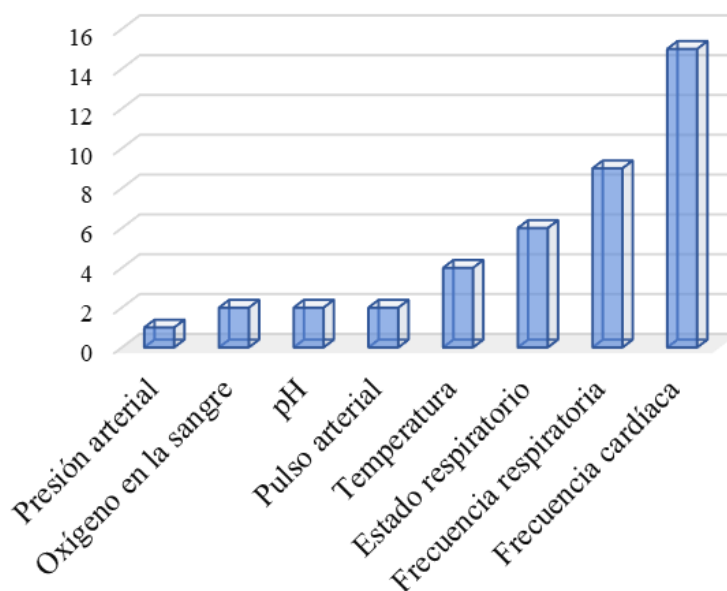


**RQ2: ¿Qué signos vitales se monitorizan con los dispositivos?**

La monitorización de ciertos signos vitales se vuelve fundamental cuando algunas enfermedades son desencadenadas por anomalías en alguna constante vital específica, o en otras ocasiones a modo de prevención se supervisa que los valores se mantengan en un rango normal.

**Figura 4**

*Signos vitales considerados en los dispositivos de monitorización*



La Figura 4 muestra los signos vitales considerados en los estudios analizados. La frecuencia cardíaca fue el signo vital mayormente monitorizado, ya que fue mencionado en 15 estudios. Luego apareció la frecuencia respiratoria que fue objeto de monitoreo en 9 artículos, y 6 investigaciones hicieron seguimiento del estado respiratorio, pues controlan cuando la

respiración es normal, lenta, rápida, superficial o profunda. En menor medida varios trabajos hicieron referencia en una sola ocasión a la presión arterial, el pH y los niveles de oxígeno en la sangre.

### **RQ3: ¿Cuál es la producción energética de los distintos mecanismos de recolección de energía en cada caso?**

Los mecanismos de recolección de energía mostraron una amplia variabilidad en producción de energía, tal como lo demuestra la Tabla 2 que indica la capacidad de generación energética de los tipos de EH identificados en esta revisión sistemática de literatura.

Por ejemplo, el sistema de radiofrecuencia ofreció una capacidad alta en producción de potencia alcanzando 1 W, mientras que los mecanismos termoeléctricos generaron energía más baja de aproximadamente 12,6 nW.

Por otro lado, la tecnología triboeléctrica presenta un valor mínimo de 0,6  $\mu\text{A}$  y máximo de 200  $\mu\text{A}$  en comparación con la radiofrecuencia que alcanza hasta 0,44 mA de corriente; además, el tipo de recolección triboeléctrica apareció exhibiendo una producción de voltaje inferior de alrededor de 0,88 V; sin embargo, logró una alta eficiencia teórica al generar hasta 1000 V bajo una frecuencia de 2.5Hz, de acuerdo a los investigadores que logran dicho valor.

Cabe aclarar que no en todas las publicaciones se mencionan los valores de potencia, corriente y voltaje obtenidos por el mecanismo de EH aplicado, por lo que la comparación de este criterio no fue muy equivalente; sin embargo, es posible ver en la Tabla 2 una tendencia del rango de valores para cada mecanismo.

**Tabla 2**

*Rango de valores de generación energética de los dispositivos, según mecanismos de EH*

MECANISMOS DE EH	POTENCIA (W)	CORRIENTE (A)	VOLTAJE (V)
Híbrido	1 $\mu\text{W}$	-	1,3 – 88 V
Piezoeléctrico	-	0,15 – 65 $\mu\text{A}$	8 V
Radiofrecuencia	0,1 – 1 W	0,44 mA	1,8 – 3 V
Termoeléctrico	12,6 nW – 20 $\mu\text{W}$	2,74 $\mu\text{A}$	18,13 mV
Triboeléctrico	1,3 mW – 816 mW/m <sup>2</sup>	0,6 – 200 $\mu\text{A}$	0,88 V – 1000 V

### **RQ4: ¿En qué parte del cuerpo se ubica el dispositivo de monitorización de signos vitales?**

El ser humano posee diferentes puntos estratégicos en el cuerpo para realizar mediciones de signos vitales, aunque la elección dependerá principalmente del parámetro vital que se pretende monitorizar. En el caso de los animales es algo similar.

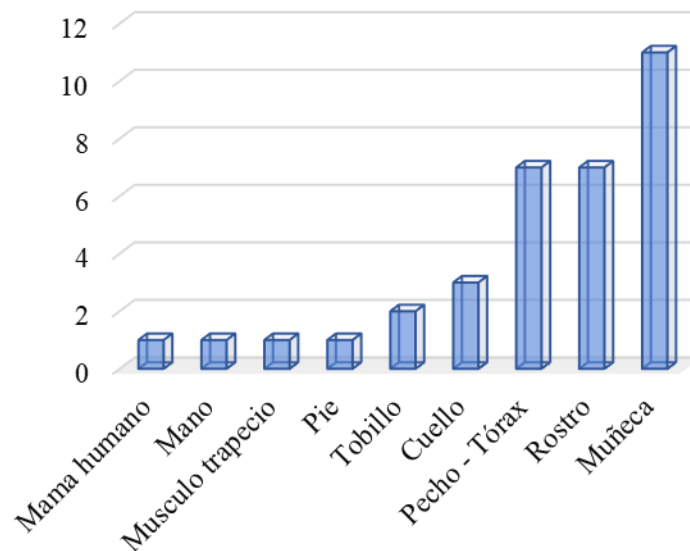
En la Figura 5 se observa que los dispositivos tienden a ubicarse con mayor énfasis en la muñeca, ubicación que fue mencionada 11 veces en los artículos analizados. Después se señala el área del pecho, tórax y el rostro como otras localizaciones comunes donde monitorizar, a diferencia de la mano, el músculo trapecio, el pie e inclusive de un modelo realista de mama humana que en el estudio utilizaron para las pruebas, que ocupan el último lugar en cuanto a preferencia de ubicación para dispositivos de medición.

En anteriores revisiones de literatura sobre recolección de energía, como la de Hezekiah et al. (2023) se mencionó que la radiofrecuencia es el mecanismo de EH más utilizado en forma

general en dispositivos inalámbricos; sin embargo, para el caso que se analizó (monitorización de signos vitales), se encontró que el método más aplicado fue el triboeléctrico. Esto demuestra que radiofrecuencia fue la opción principal en literatura general; no obstante, en aplicaciones como la monitorización de signos vitales prevalece la tecnología triboeléctrica, posiblemente porque se aprovechan las fuentes de energía disponibles de manera efectiva en este contexto.

**Figura 5**

*Parte del cuerpo para ubicación de dispositivos de monitoreo*



No obstante, Shuvo y colegas determinaron en su investigación del 2022 que los nanogeneradores triboeléctricos (TENGs) tienen limitaciones por baja corriente y daños en la fricción de las superficies de contacto, por lo que necesitan mejorar para adoptarlas en dispositivos de monitorización. Mientras, en esta investigación se demostraron que la mayoría de estudios que aplican esta técnica de energy scavenging se dan desde el año de publicación del mencionado estudio. Aunque hay que tener en cuenta que la energía recolectada en cada dispositivo puede variar según las condiciones ambientales, el tiempo, la ubicación en el paciente o el tipo de dispositivo que monitoriza los signos vitales.

El mecanismo híbrido, en comparación, obtuvo un porcentaje de trabajos encontrados relativamente bajo entre todos los incluidos; a pesar de esto, Mahmood et al. (2023) señalan en su investigación que en situaciones donde se requiere de mayor suministro de energía es conveniente aplicar *energy harvesting* híbrido, que al combinar múltiples fuentes energéticas, se logra cubrir las limitaciones de otra fuente particular con la finalidad de mejorar la confiabilidad de los dispositivos IoT sin baterías; por otro lado, según Navia et al. (2015), la implementación de sistemas y mecanismos híbridos en el campo tecnológico es una tendencia muy importante en las últimas décadas, dada la adaptabilidad que poseen para aprovechar las ventajas en diferentes enfoques.

Además, hay que recalcar que este estudio proporciona conocimiento potencial sobre los mecanismos de recolección de energía y la monitorización de signos vitales, sin embargo, podría verse limitado por posibles sesgos, relacionados con la selección de los estudios donde se podría haber excluidos inadvertidamente artículos relevantes debido a las restricciones de las bases de datos consultadas o por los años de publicación establecidos en los criterios de exclusión, influyendo en la interpretación de los resultados del trabajo.

## Conclusiones

Esta revisión sistemática de literatura enfocada en los mecanismos de recolección de energía utilizados en dispositivos de monitorización de signos vitales permite visualizar el avance constante de esta tecnología autónoma y sostenible empleada para el abastecimiento energético de dispositivos, destacando a su vez la diversidad de técnicas aplicadas para captar energía y convertirla en electricidad para el funcionamiento de éstos.

Se identifica que el mecanismo triboeléctrico es el predominante en los trabajos analizados. Este resalta por la versatilidad que tiene al captar energía a partir de la fricción de dos materiales, constituidos por el dispositivo de monitorización y la zona del cuerpo en que se ubica. Otra opción para la generación triboeléctrica, en el caso de dispositivos utilizados en seres humanos, sería la fricción entre el dispositivo y la ropa.

Si de producción de energía se trata, la radiofrecuencia ofrece mayor capacidad para generar potencia y corriente, aunque su voltaje disminuye considerablemente en comparación con el mecanismo triboeléctrico, lo que puede ser resuelto con mecanismos de transformación de voltaje; sin embargo, este tipo de EH requiere de una infraestructura adicional para poder funcionar.

La muñeca es el área principal donde se realiza el monitoreo de signos vitales, relacionándose completamente con el hecho de que la frecuencia cardíaca en esta ubicación puede ser más precisa que en otras partes del cuerpo; sin embargo, el pecho – tórax es otra ubicación manejable para el monitoreo de la FC, en comparación al rostro que está directamente vinculada con el control de la frecuencia respiratoria.

Los dispositivos, en su mayoría, son aplicables en lugares expuestos como la muñeca y el rostro, pues facilitan la medición dada la accesibilidad y conveniencia al momento de colocar los dispositivos de monitorización de signos vitales, sin afectar mayormente las actividades que realiza la persona.

Los mecanismos analizados pueden ser aplicados para el monitoreo de signos vitales en otros seres vivos, además de personas, ya que los seres humanos y varios tipos de animales domésticos comparten ciertas similitudes en cuanto a anatomía, fisiología y comportamiento; no obstante, se debe considerar principalmente el rango de funcionamiento normal de los signos vitales de cada especie, asimismo definir la adecuada ubicación para obtener mayor precisión en las mediciones.

Para trabajos posteriores, aún es necesario estudiar la optimización de la eficiencia energética y durabilidad del mecanismo triboeléctrico; también se puede analizar las características que hacen superior al EH por radiofrecuencia y adaptarlas para hacerlas más eficiente; por otro lado, aunque se encontraron pocos casos en el estudio, la aplicación de mecanismos híbridos podría combinar las fortalezas de dos mecanismos, al tiempo que se superan sus limitaciones.

Además, se debe enfatizar que el diseño de dispositivos debe contemplar que la tecnología utilizada no resulte intrusiva para el ser vivo, esperando que se puedan elaborar sistemas de monitorización en áreas externas del cuerpo del paciente para llevar a cabo el control de los signos vitales.

## Reconocimientos

Los autores declaran la contribución y participación equitativa de roles de autoría para esta publicación.

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## Evaluación de un algoritmo de control para video adaptativo empleando enrutamiento tradicional y SDN

### Evaluation of an Adaptive Video Control Algorithm using Traditional Routing and SDN

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Enviado: 2025/04/11  
Aceptado: 2025/05/15  
Publicado: 2025/06/30

#### Resumen

Actualmente, según el Cisco Annual Internet Report, entre el 80% y el 85% del tráfico de datos en Internet es generado por contenido en video. Esto hace imperativo desarrollar métodos o algoritmos que permitan una transmisión eficiente de contenido multimedia a través de la red. En este contexto, el presente artículo propone un algoritmo optimizado para el control de tráfico de video en un entorno SDN, con el objetivo de permitir una transmisión adaptativa en tiempo real. La metodología incluyó la transmisión de un video codificado a un *bitrate* mínimo; posteriormente, se midió el ancho de banda de la red a partir de los cuales se ajustó la tasa de codificación y la calidad del video; y, finalmente, el contenido se reprodujo en el lado del cliente. Los resultados obtenidos mediante el algoritmo de control se compararon con los generados por protocolos de enrutamiento comunes como *Routing Information Protocol* (RIP) y *Open Shortest Path First* (OSPF). El uso del algoritmo de control dio como resultado un retardo del 18.1% menor que RIP y del 94.8% menor que OSPF, con tráfico de fondo se obtuvo que SDN tiene un retardo del 27.23% menor que RIP y del 54.1% menor que OSPF. La principal contribución del trabajo es, mediante la implementación de un *testbed*, realizar el análisis del mecanismo que mejore la calidad de servicio y experiencia (QoS y QoE) que optimice la transmisión de video en tiempo real mediante la selección de la mejor ruta y/o el ajuste dinámico del *bitrate* del video según las condiciones de la red.

**Sumario:** Introducción, Materiales y Métodos, Resultados y Discusión, Conclusiones.

**Como citar:** Gomezcoello, M., Picón, J. & González, S. (2025). Evaluación de un algoritmo de control para video adaptativo empleando enrutamiento tradicional y SDN. *Revista Tecnológica - Espol*, 37(1), 264-284. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1308>



**Palabras clave:** streaming, adaptable, rip, ospf, redes definidas por software.

### Abstract

Currently, according to the Cisco Annual Internet Report, between 80% and 85% of internet data traffic is generated by video content, making it imperative to develop methods or algorithms that enable the efficient transmission of multimedia content over the network. In this context, this article proposes an optimized algorithm for video traffic control in an SDN environment, allowing for adaptive real-time transmission. The methodology consists of the following stages: first, the video is transmitted at a minimum encoded bitrate; then, the available network bandwidth is measured, based on which the encoding rate and video quality are adjusted; and finally, the video is played on the client side. The results obtained using the control algorithm were compared with those obtained using common routing protocols such as RIP (Routing Information Protocol) and OSPF (Open Shortest Path First). The use of the control algorithm resulted in an 18.1% lower delay compared to RIP and a 94.8% lower delay compared to OSPF. Under background traffic conditions, SDN demonstrated a 27.23% lower delay than RIP and a 54.1% lower delay than OSPF. The main contribution of this work is, through the implementation of a testbed, the analysis of a mechanism that improves quality of service (QoS) and quality of experience (QoE) by optimizing real-time video transmission through the selection of the best route and/or the dynamic adjustment of video bitrate according to network conditions.

**Keywords:** Streaming, adaptable, rip, ospf, software-defined networks.

### Introducción

Las Redes Definidas por Software (SDN) representan un paradigma innovador en el campo de las redes informáticas, en el cual los administradores emplean herramientas de software para gestionar sus infraestructuras de red. La SDN optimiza la capacidad de administración al enfocarse en un controlador lógicamente centralizado que proporciona interfaces de configuración de alto nivel y abstracciones de red (Bonaventure et al. 2017).

En el contexto de los proveedores de servicios de Internet (ISP) y las redes empresariales actuales, las redes SDN desempeñan un papel crucial. Esto se debe a que las demandas y requisitos de las redes de los ISP están en constante evolución debido al creciente consumo de contenido multimedia.

Un estudio de Sandvine revela que en 2022 el 65% del tráfico de Internet fue generado por el consumo de video, un aumento del 24% respecto al año anterior (Sam, 2023). Estos datos evidencian el papel crucial del video en las redes, destacando la necesidad de optimizar su gestión. Esto podría lograrse mediante sistemas de control que mejoren la entrega de contenido, ya sea, ajustando la calidad del video según el ancho de banda disponible.

A continuación, se discuten los principales trabajos relacionados disponibles en la literatura sobre el tema. En Makolkina et al. (2017), los autores destacan la importancia de explorar nuevas formas de entregar contenido de video a los usuarios, particularmente mediante redes definidas por software (SDN). En su estudio, implementaron una infraestructura de IPTV sobre SDN para evaluar el impacto de esta tecnología en la calidad de transmisión de video. La topología de prueba consistió en tres switches OpenFlow conectados en anillo. Se analizó el retardo de paquetes en una red con SDN y en una red tradicional sin controlador SDN. Los resultados muestran un retardo promedio de 1.8 ms en la red SDN frente

a 11.2 ms en la red tradicional, lo que sugiere que la arquitectura SDN es una opción eficaz para la distribución de contenido multimedia.

Para ajustar el tráfico de video según la congestión de la red y reducir los tiempos de carga, se emplea el método descrito en Lin (2015), que prioriza las necesidades de los usuarios. A cada usuario se le asigna una prioridad en función de sus requerimientos de calidad de video: por ejemplo, los usuarios que solicitan video en alta definición reciben mayor prioridad que aquellos que solicitan baja definición. El sistema utiliza un algoritmo de enrutamiento multitrayectoria que considera tanto las prioridades de los usuarios como la carga de la red para seleccionar las rutas óptimas para cada flujo de video, además, incorpora un mecanismo de control de congestión que, al detectar saturación, reduce el ancho de banda de los flujos de menor prioridad. Los experimentos muestran que los clientes de mayor prioridad cuentan con una tasa de datos garantizada de 1.5 Mbps, mientras que los de menor prioridad reciben 1 Mbps.

En Jiawei et al. (2018), se propone un algoritmo de enrutamiento multipath dinámico y adaptativo para redes definidas por software (SDN), que considera la pérdida de paquetes, el retardo y el ancho de banda como restricciones. Este algoritmo, llamado *Dynamic and Adaptive Multi-path Routing* (DAMR), emplea la información de estado global del controlador SDN para calcular rutas óptimas, distribuyendo el tráfico a través de múltiples caminos y mejorando así el rendimiento de la red, además, minimiza el impacto de fallas al redirigir rápidamente el tráfico a rutas alternativas. En simulaciones de redes SDN a gran escala, DAMR mostró solo un 10% de pérdida de paquetes frente al 60% del enrutamiento de un solo camino, y un retardo de 0.05 ms frente a 0.4 ms.

En Banchuen et al. (2018) se destaca la relevancia de la videoconferencia en telecomunicaciones y la necesidad de asegurar una alta calidad de servicio. Para optimizar el rendimiento sin modificar la aplicación cliente, se propone el uso de redes SDN, implementando la técnica de par de paquetes para evaluar el ancho de banda y el retardo entre clientes. Esto permite al controlador SDN elegir la mejor ruta, basándose en la topología, puertas de enlace, direcciones de host, latencia y ancho de banda disponible. En las pruebas, la red SDN mostró una latencia de 100 ms, significativamente menor que los 230 ms obtenidos en una red tradicional.

La construcción de árboles de multidifusión es una técnica común en redes tradicionales para implementar multicast. En Sheu et al. (2015), los autores proponen el algoritmo *Maximum Bandwidth Utilization Algorithms with Shortest Path* (MBUA-SP) para transmitir video en entornos SDN. Este algoritmo tiene como objetivo optimizar el ancho de banda máximo disponible entre el origen y cada cliente a lo largo de la ruta con menor latencia, maximizando el rendimiento del enlace servidor-cliente antes de enfrentar problemas de throughput. Los resultados experimentales muestran que el algoritmo reduce la tasa de rechazo en un 20% en comparación con el algoritmo de multicast *Shortest-path tree* (SPT) y aumenta la utilización del enlace en un 80%, es decir, el porcentaje de ancho de banda consumido respecto al total disponible en la red.

Khan (2023) propone el uso de un algoritmo centrado en el usuario, priorizando el contenido que más consume, además, si el usuario prefiere calidades de video altas, el algoritmo entrega dicha calidad, siempre y cuando el ancho de banda lo permita, para lo cual se realiza una medición.

En Abar et al. (2021), los autores aplican el método DASH en SDN para monitorear la calidad del video entregado al usuario, estructurando el enfoque en varias fases: una asignación inicial equitativa del *bitrate*, seguida de la mejora de la calidad visual mediante un algoritmo específico. El controlador SDN gestiona la red, mientras un modelo de procesos de Poisson y técnicas de *machine learning* optimizan la tasa de bits, incluyendo la selección de *bitrate*, cuadros por segundo y resolución del video. Simulaciones realizadas en Weka, usando Random Forest, AdaBoost y Stacking, mostraron que el método Stacking supera a Random Forest, logrando una métrica de recuperación de 0.95 frente a 0.92, por lo que es el más efectivo para predecir recursos óptimos según el comportamiento del usuario.

En Yamansavascular et al. (2020), los autores proponen un plano de datos tolerante a fallos denominado DPQoAP (*Protection with Quality of Alternative Paths*), que considera tanto los fallos de red como la calidad de las rutas alternativas. Para su implementación, se utilizan módulos de detección de congestión basados en DASH, que identifican la mejor ruta alternativa en función de la latencia. Este método establece una ruta primaria y dos de respaldo. Cuando la segunda ruta se satura, el módulo DPQoAP ajusta automáticamente la tercera como secundaria debido a su menor latencia. En caso de fallo en la ruta primaria, ya se ha evaluado la calidad de las rutas alternativas, garantizando una comunicación continua con calidad aceptable. Para validar este enfoque, se comparó con la "protección estática de enlace", donde el controlador busca una nueva ruta ante una falla. En una simulación de fallo en el enlace servidor-cliente, el método propuesto mantuvo el *throughput* cerca de 1000 paquetes/segundo, en contraste con una caída a 250 paquetes/segundo con la protección estática.

El estudio en Sayit et al. (2019) presenta una arquitectura altamente escalable para diferenciar servicios de red en el contexto de DASH sobre SDN. Esta arquitectura incluye dos componentes clave: módulos de control en el controlador SDN y un marco de optimización para establecer rutas de transmisión hacia los clientes DASH. En la capa de control, el controlador gestiona la red, definiendo rutas de flujo entre clientes y servidor y enviando estas reglas a los conmutadores. Una vez establecidas, las rutas se actualizan y envían a los conmutadores, permitiendo el enrutamiento dinámico de los paquetes. Los experimentos mostraron un aumento de hasta un 83% en la tasa de bits promedio y una reducción del 39% en la variación de calidad de video, en comparación con el enfoque de rutas más cortas.

En Abuteir et al. (2016) se describe una nueva técnica para mejorar la entrega de video de alta calidad en redes inalámbricas con múltiples clientes denominado *Wireless Network Assisted Video Streaming* (WNAVS), basado en Redes Definidas por Software (SDN). WNAVS realiza un modelado dinámico del tráfico y asigna ancho de banda en tiempo real a los clientes. En comparación con el método tradicional *Dynamic Adaptive Streaming over HTTP* (DASH), los experimentos demostraron que WNAVS logró una tasa de transmisión de 1000 Kbps para 8 clientes simultáneos, mientras que DASH solo alcanzó 500 Kbps.

En Storck et al. (2020) se implementa el protocolo de Transmisión Adaptativa Dinámica sobre HTTP (DASH, por sus siglas en inglés) en un servidor V2X, el gNodeB recibe las solicitudes de video enviadas por los vehículos a la vez que mide las condiciones de la red, para de esa manera entregar la mejor calidad de video de acuerdo con el ancho de banda disponible.

En la propuesta expuesta en Dac et al. (2021), el video a transmitir se divide en varios segmentos y cada segmento es codificado a diferente tasa, es decir, cada segmento tiene diferente calidad, los segmentos se almacenan en el lado del cliente en el búfer. Si este se mantiene lleno, indica que hay un buen ancho de banda, lo que permite descargar el segmento

de mejor calidad; en cambio, si el búfer no permanece lleno, significa que el ancho de banda ha disminuido, y se opta por descargar segmentos de menor calidad.

La mayoría de los reproductores utilizan algoritmos de tasa de bits adaptativa para elegir dinámicamente la tasa de bits para cada fragmento según la capacidad percibida de la red, lo que mejora la calidad de escenas dinámicas, pero ocupa mayor codificación de la necesaria para escenas estáticas, por lo que, en Li et al. (2023) se propone un algoritmo de tasa de bits adaptativa donde se seleccione una mayor tasa de codificación únicamente para fragmentos dinámicos.

A modo de resumen, en la metodología usada en los trabajos previos se elaboró una tabla que indica si cada trabajo fue implementado mediante simulación o con equipamiento físico. Los trabajos se presentan en el mismo orden que fueron expuestos.

**Tabla 1**

*Metodología usada en los trabajos previos*

TRABAJOS RELACIONADOS	SIMULACION	EQUIPAMIENTO
<i>Quality of experience estimation for video service delivery based on sdn core network Makolkina et al. (2017)</i>		X
<i>Research on video traffic control technology based on sdn Lin (2015)</i>	X	
<i>Dynamic and adaptive multi-path routing algorithm based on software-defined network Jiawei et al. (2018)</i>	X	
<i>An sdn framework for video conference in inter-domain network Banchuen et al. (2018)</i>	X	X
<i>Efficient multicast algorithms for scalable video coding in software-defined networking Sheu et al. (2015)</i>	X	
<i>User-centric algorithms: Sculpting the future of adaptive video streaming Khan (2023)</i>	X	
<i>Chapter five - user behavior-ensemble learning based improving qoe fairness in http adaptive streaming over sdn approach Abar et al. (2021)</i>	X	
<i>Fault tolerance in sdn data plane considering network and application based metrics Yamansavascilar et al. (2020)</i>	X	
<i>A scalable network layer service differentiation architecture for dash over sdn Sayit et al. (2019)</i>	X	
<i>An sdn approach to adaptive video streaming in wireless home network Abuteir et al. (2016)</i>	X	
<i>A performance analysis of adaptive streaming algorithms in 5g vehicular communications in urban scenarios Storck et al. (2020)</i>	X	
<i>Qoe-aware video adaptive streaming over http Dac et al. (2021)</i>	X	
<i>An apprenticeship learning approach for adaptive video streaming based on chunk quality and user preference Li et al. (2023)</i>	X	

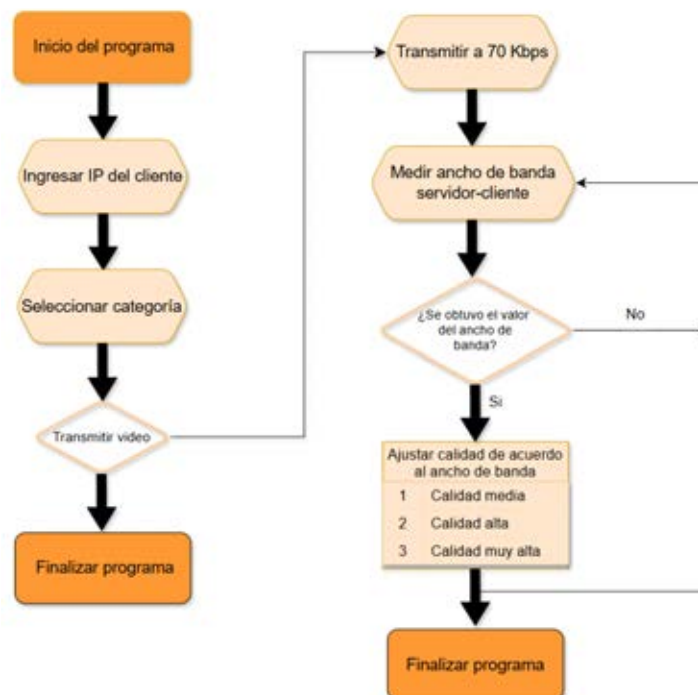
En tal contexto, a partir del análisis de los estudios previos, en el presente trabajo se propone el desarrollo e implementación de un algoritmo de control para la transmisión de video adaptativo en redes SDN, diseñado específicamente para entornos de redes de comunicaciones multimedia. Para evaluar la solución propuesta se implementó un *testbed* el cual consiste en un conjunto de cinco Raspberry Pi para emular una red SDN y comparar su rendimiento frente a esquemas de enrutamiento tradicional, en concreto *Routing Information Protocol (RIP)* y *Open Shortest Path First (OSPF)*. La implementación física de un banco de pruebas se debe a la necesidad de experimentar y analizar los resultados obtenidos en un medio que se asemeje a una red de uso real, ya que, la mayoría de los trabajos previos se centran en simulaciones y no en un banco de pruebas físico.

### Materiales y Métodos

Para ilustrar mejor la metodología de la lógica de control se ha desarrollado un diagrama de flujo que se ilustra en la Figura 1. Como se observa en dicha figura, en la interfaz gráfica, se debe ingresar la dirección IP del cliente y seleccionar la categoría del video a transmitir. Inicialmente, el sistema transmite a una tasa de 70 Kbps debido a la falta de conocimiento sobre el ancho de banda disponible entre el servidor y el cliente, dicho valor ha sido seleccionado debido a que, al realizar varios experimentos se observó que 70 Kbps es un valor de codificación en el que se puede obtener una calidad de imagen aceptable sin necesidad de usar mucho ancho de banda, a menores valores la calidad se degradaba mucho por lo que no era pertinente transmitir a dicha calidad. Durante esta transmisión, se mide el ancho de banda y, una vez obtenido, se ajusta la tasa de codificación. Si no se puede medir el ancho de banda, se mantiene la tasa actual y se intenta una nueva medición, asegurando así un control sobre la calidad del video sin exceder la capacidad de la red.

**Figura 1**

*Diagrama de flujo del sistema de control de video*



A continuación, se presenta un pseudocódigo para representar el mecanismo que hemos propuesto para la aplicación de nuestro mecanismo de control:

---

```

Inicializar programa
Ingresar IP del cliente
Seleccionar la categoría de video
Transmitir a una tasa = 70 Kbps y medir ancho de banda
  Si ancho de banda bajo
    Transmitir a 70 Kbps
    Medir ancho de banda
  Si ancho de banda medio
    Transmitir a tasa de codificación media según categoría
    Medir ancho de banda
  Si ancho de banda alto
    Transmitir a tasa de codificación alta según categoría
    Medir ancho de banda
  Si ancho de banda muy alto
    Transmitir a tasa de codificación muy alta según categoría
    Medir ancho de banda
Fin si
  Finalizar transmisión
Finalizar programa

```

---

## Metodología

Una vez expuesta la metodología del sistema de control, es fundamental detallar las herramientas y procesos necesarios para su correcta implementación. Este proceso y las herramientas utilizadas se describen detalladamente en la Figura 2.

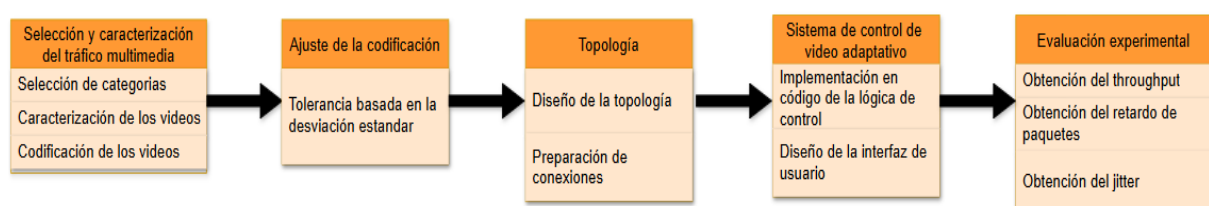
En la subsección de selección y caracterización del tráfico multimedia se describen los criterios definidos para escoger las distintas categorías de video que se va a utilizar, así como los criterios para establecer las tasas de codificación. En la subsección de ajuste de la codificación se presenta el uso de la desviación estándar para la correcta selección de las tolerancias de las tasas de codificación para las distintas categorías.

Luego, en la subsección de topología, se presenta la topología utilizada. En la subsección de preparación del sistema de control de video adaptativo se detalla cómo se implementó el sistema de control de video adaptativo, el mismo que ajusta la calidad del video al tener conocimiento del ancho de banda del enlace con el cliente. Finalmente, en la sección de Resultados y Discusión, se exponen los distintos experimentos que se realizaron.

Todos los comandos, códigos y *scripts* han sido liberados para su uso académico o investigativo en Gomezcoello et al. (2024).

**Figura 2**

*Herramientas y procesos para la implementación del sistema de control*



### Selección y caracterización del tráfico multimedia

En esta fase se procedió con la selección de las categorías de los siguientes videos que serán transmitidos:

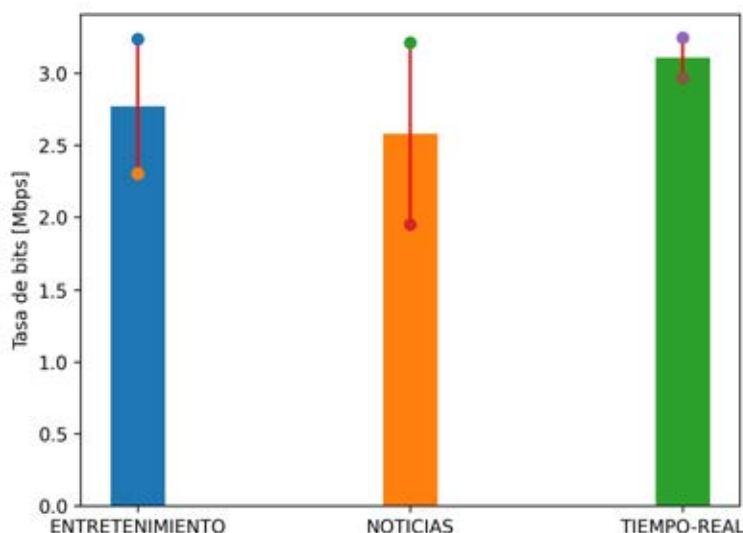
- Noticias
- Entretenimiento
- Tiempo real

Estas categorías fueron seleccionadas a base de la alta demanda actual.

En primer lugar, se capturó el tráfico de transmisiones en vivo según las clases de video previamente seleccionadas. Esto permitió obtener información sobre las tasas de codificación utilizadas en diferentes servicios de *streaming* de video dentro de las distintas categorías seleccionadas. Con estos datos, se puede establecer tasas de codificación realistas para los videos que se va a utilizar, asegurando así que reflejen las prácticas comunes de codificación en Internet. El resultado se presenta en la Figura 3.

**Figura 3**

*Tráfico real de diferentes categorías de servicio*



Para ilustrar los resultados de los experimentos realizados se ha utilizado un intervalo de confianza del 95% y barras que muestran los valores promedio.

La figura anterior muestra que la categoría de noticias tiene la tasa de codificación más baja (aproximadamente de 2.5 Mbps), además de contar con un intervalo de confianza más amplio, lo que indica que en algunos instantes la tasa de codificación fue inferior a 2 Mbps o superior a 3 Mbps, las tasas de codificación bajas indican que, al ser una secuencia con pocos cambios o movimientos entre *frames*, el video aprovecha la redundancia espacial y temporal cuando el presentador habla, permitiendo tasas menores sin perder calidad; sin embargo, cuando existen cambios de escenas entre noticias, se usa una codificación más alta, lo cual no sucede con mucha frecuencia, no siendo así el uso de escenas estáticas; en cambio, los contenidos de entretenimiento requieren una tasa más alta debido a los frecuentes cambios de escena, que aumentan la cantidad de información por segundo para mantener la calidad visual.

Por otro lado, los videos en tiempo real tienen una tasa de codificación ligeramente mayor a 3 Mbps, siendo esta, la tasa de codificación más alta de entre todas las categorías, además se observa un intervalo de confianza de menor amplitud, lo cual indica que en la mayor parte de tiempo la tasa de codificación se mantiene elevada (entre 2.8 Mbps y 3.2 Mbps). Esto se debe a la necesidad de procesar y transmitir simultáneamente el contenido, lo que exige una alta tasa para garantizar una transmisión fluida y de calidad, sin interrupciones ni retrasos.

Luego de analizar los resultados obtenidos, se llegó a la conclusión de que la tasa de bits a usar al momento de realizar nuestros experimentos serán diferentes para cada categoría de video, cuyos valores seleccionados serán presentados en la siguiente subsección.

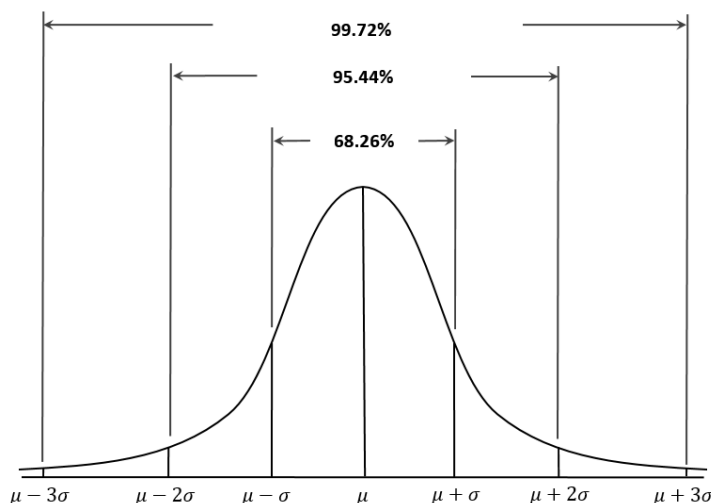
### Ajuste de la codificación

De acuerdo con la teoría del límite central, independientemente de la forma de la población, la distribución muestral de la media se aproxima a una curva normal si el tamaño de la muestra es, estadísticamente, significativo en Witte et al. (2017); por lo tanto, al tener claro este concepto, se modeló las muestras obtenidas del tráfico real como si tuvieran una distribución normal.

La regla empírica de probabilidad expone que, cada dato que se puede observar caerá bajo tres desviaciones estándar diferentes de la media en una distribución normal, de acuerdo con la regla, el 68% de los datos caerán en la primera desviación estándar, el 95% caerán en la primera y la segunda desviación y el 99,7% de los datos caerán en las tres desviaciones Team (2020). Dicho concepto se ilustra en la Figura 4.

**Figura 4**

*Regla empírica*



Luego de exponer los conceptos anteriores, se procedió a establecer los valores de codificación para las distintas calidades de acuerdo con la regla empírica; es decir, el valor para la codificación de la calidad media será restando una desviación estándar del valor promedio ( $\mu - \sigma$ ); el valor para la calidad alta será el valor del promedio ( $\mu$ ); y el valor para la calidad muy alta será sumando una desviación estándar al valor promedio ( $\mu + \sigma$ ). Esto se debe a que dichos valores tienen altas probabilidades de aparecer en una transmisión, logrando así un modelado más realista de cómo se codifican las distintas categorías. En todas las categorías, el único valor de codificación constante es de 70 Kbps, establecido debido a la necesidad de una codificación baja para iniciar la transmisión de video.



Los valores de codificación para las distintas categorías se exponen en la siguiente Tabla 2.

**Tabla 2**

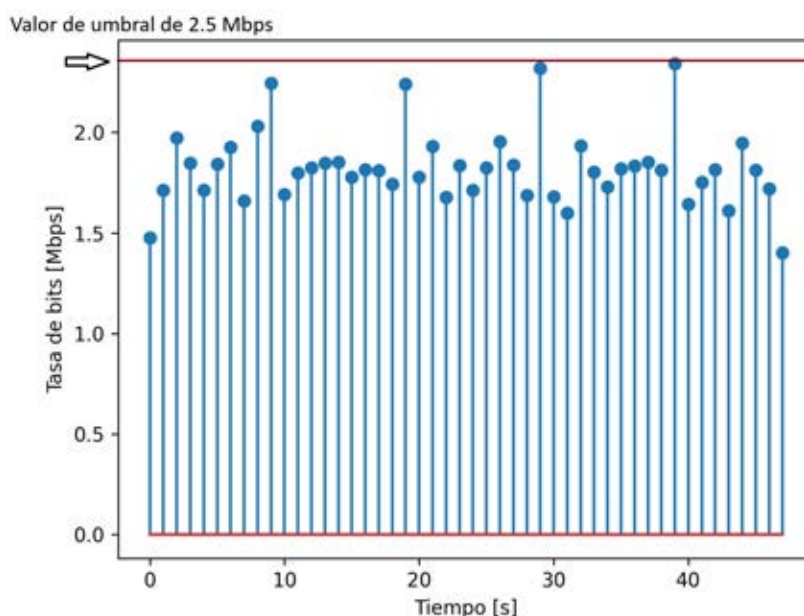
*Tasas de codificación para las distintas categorías y calidades*

CATEGORIA	BAJA	MEDIA	ALTA	MUY ALTA
Noticias	70 Kbps	1703 Kbps	2580 Kbps	3457 Kbps
Entretenimiento	70 Kbps	1829 Kbps	2770 Kbps	3712 Kbps
Tiempo real	70 Kbps	2051 Kbps	3107 Kbps	4164 Kbps

Con las codificaciones previas, se pudo obtener información relevante sobre el perfil de tráfico. Con los resultados obtenidos de los perfiles de tráfico, se procedió a configurar una tasa de codificación personalizada para cada categoría de tráfico y establecer los umbrales de ancho de banda para seleccionar el valor de codificación de acuerdo con el valor pico del perfil de tráfico; por ejemplo, para la categoría de noticias el perfil de tráfico para la calidad media cuenta con picos alrededor de 2.5 Mbps, como se observa en la Figura 5 por lo que, un valor de umbral adecuado debe ser superior a dicho pico.

**Figura 5**

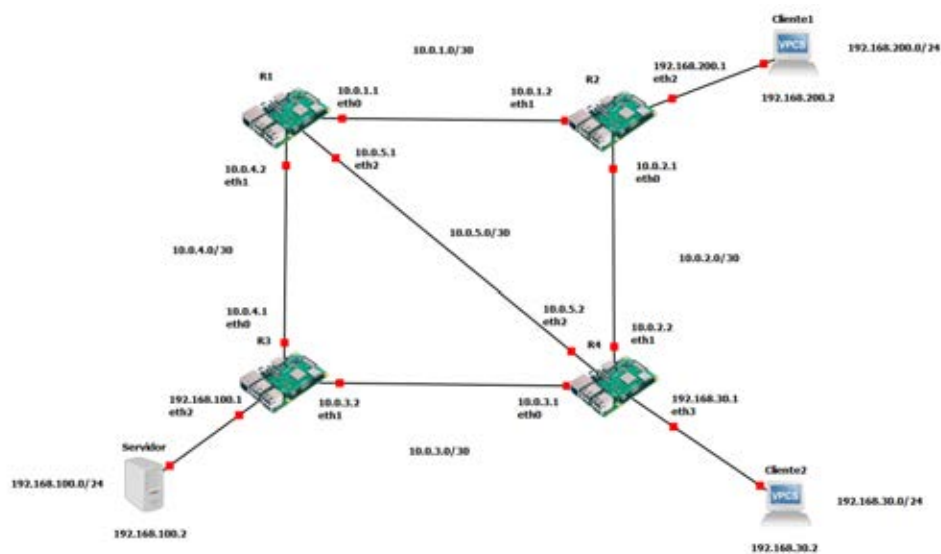
*Perfil de tráfico de la categoría noticias en calidad media*



En la siguiente subsección se expondrá la topología diseñada para la implementación de nuestro *testbed*.

### Topología

La topología implementada se expone en la Figura 6.

**Figura 6***Topología del testbed*

Como se puede observar en la Figura 6, la topología consta de cuatro Raspberry Pi que funcionan tanto como enrutadores como Open vSwitch. Se eligió esta topología debido a su redundancia y múltiples caminos. Se pueden apreciar todas las direcciones IP que se ha implementado al usar las Raspberry Pi como enrutadores. Al utilizar SDN, simplemente se configuran las direcciones IP de los clientes y del servidor, los cuales deben estar en la misma red. Luego de diseñar la topología a utilizar, se procedió con la implementación física de la misma, realizando todas las conexiones necesarias utilizando los adaptadores USB a RJ45 y cables Ethernet, como se ilustra en la Figura 7.

**Figura 7***Implementación física del testbed*

## Preparación del sistema de control de video adaptativo

El sistema de control de video adaptativo se lo realizó siguiendo la metodología expuesta en la Figura 1. Para su implementación se ha escrito un código en lenguaje Python, el mismo que se encuentra en Gomezcoello y Picón (2024).

El código implementado para el algoritmo de control de video adaptativo sigue una serie de pasos. Primero, se creó un diccionario para almacenar las rutas de los videos de las distintas categorías a transmitir; luego, se implementaron funciones para cargar y seleccionar estos videos. A continuación, se desarrolló una función para medir el ancho de banda utilizando la herramienta iPerf en Jon Dugan y Prabhu (2024). Basándose en los resultados de esta medición, se implementó una función que ajusta la tasa de codificación para cada categoría de video.

Posteriormente, se implementó la función de transmisión de video utilizando la herramienta FFmpeg en FFmpeg (2024). Si no se ha realizado la medición del ancho de banda, se transmite a una tasa de codificación de 70 Kbps. Una vez obtenido el valor del ancho de banda disponible, se ajusta la tasa de codificación según los umbrales establecidos.

Finalmente, se desarrolló la función de transmisión *demo*, que permite la transmisión a tres tasas de codificación diferentes: primero se transmite a la calidad más baja, luego a una calidad media y, finalmente, a una calidad alta. La última parte del código se encarga de la configuración para la implementación de la interfaz gráfica.

## Resultados y Discusión

El estudio realizado comparó el rendimiento de la transmisión de video en redes tradicionales (RIP y OSPF) frente a una red definida por software (SDN), en escenarios con y sin tráfico de fondo.

Los resultados mostraron diferencias claras en términos de *throughput*, retardo y *jitter*. Dichas métricas son fundamentales para garantizar una transmisión de video eficiente y de alta calidad. El *throughput* asegura que se transmitan suficientes datos para evitar almacenamiento en búfer, mientras que el *jitter*, que mide la variabilidad en la llegada de paquetes, es crucial para evitar interrupciones en la reproducción, por último, un bajo *delay* es esencial para aplicaciones en tiempo real, ya que permite una sincronización adecuada entre audio y video. El análisis de estas métricas permite diseñar algoritmos que se adapten dinámicamente a las condiciones de la red, optimizando así la experiencia del usuario.

### Resultados obtenidos con sistema de control sin tráfico de fondo

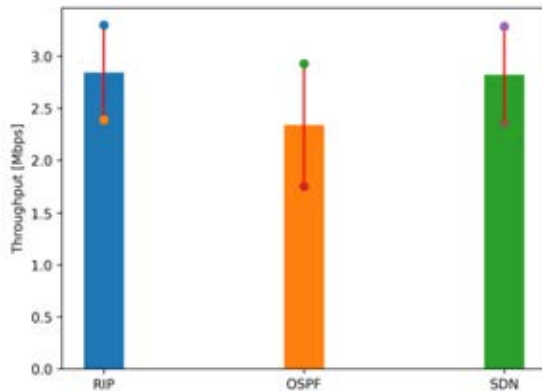
#### *Throughput*

En la Figura 8(a) que corresponde a la categoría de entretenimiento se observa que, el peor rendimiento en *throughput* lo obtiene OSPF con velocidad promedio de 2.3 Mbps y un intervalo de confianza amplio lo que indica una inestabilidad en la tasa de transmisión; por otro lado, RIP y SDN tienen un *throughput* (2.7 Mbps) y un intervalo de confianza similares las cuales son más estables, lo cual indica que OSPF no selecciona la ruta con mayor ancho de banda, no así RIP y SDN. El mismo análisis anterior aplica para las Figura 8(b) y 9(c).

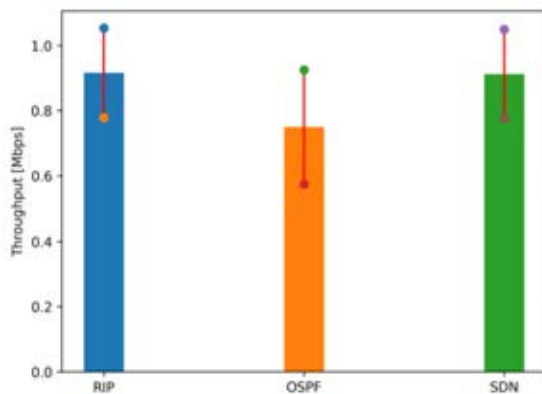
**Figura 8**

*Throughput obtenido para las diferentes categorías de video*

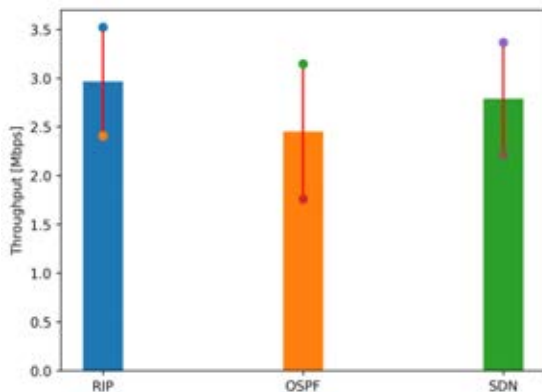
(a) Entretenimiento



(b) Noticias

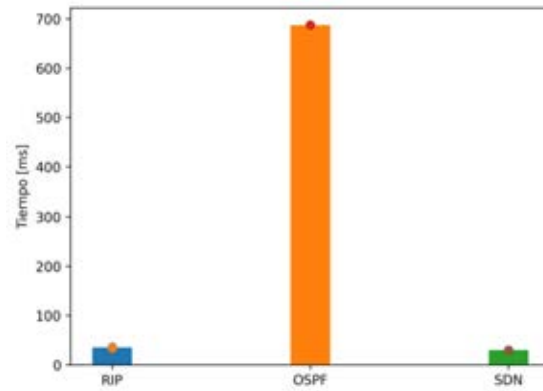


(c) Tiempo real

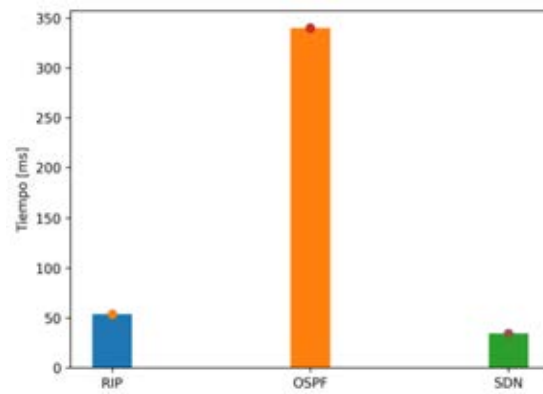
**Figura 9**

*Retardo obtenido para las diferentes categorías*

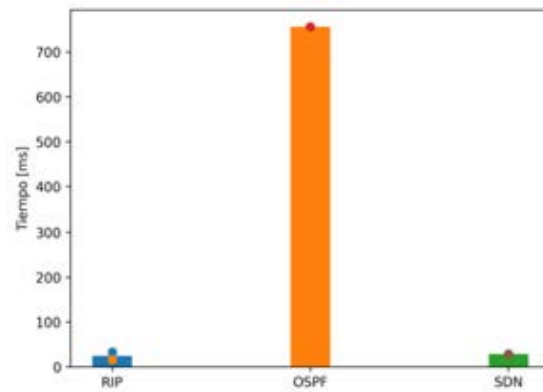
(a) Entretenimiento



(c) Noticias



(c) Tiempo real



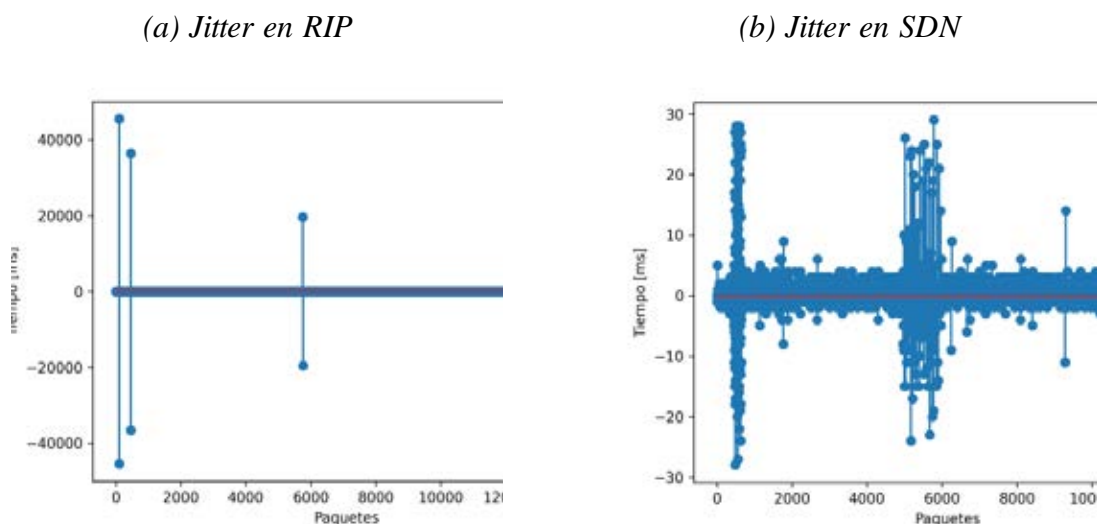
### **Retardo**

Las Figura 9(a), (b) y (c) evidencian que SDN y RIP cuentan con el menor retardo en la transmisión de video, seguido por OSPF, dichos resultados indican que SDN y RIP seleccionaron la ruta con mayor ancho de banda para la transmisión de video en todas las categorías; sin embargo, en la categoría de tiempo real, RIP tuvo un retardo 0.4 ms menor, pero con gran inestabilidad debido a que enviaba todo el tráfico por una única ruta. SDN mostró retardo más estable, garantizando que la ruta principal no se sature, mientras que OSPF seleccionó una ruta sin importar el ancho de banda.

### Jitter

En cuanto al *jitter*, SDN mostró una variabilidad más estable ( $\pm 30$  ms) como se muestra en la Figura 10(b) mientras que RIP presentó picos significativos, lo que confirma que SDN es superior en términos de estabilidad del retardo. Dichas fluctuaciones se muestran en la Figura 10(a).

**Figura 10**



### Resultados obtenidos con sistema de control con tráfico de fondo

En estos experimentos, el escenario incluyó tráfico de fondo mediante la descarga de un archivo de video de aproximadamente 200 MB.

### Throughput

OSPF presentó el mayor *throughput* (hasta 2.5 Mbps), mientras que SDN tuvo el menor rendimiento debido al balance de carga aplicado al descargar el archivo simultáneamente, llegando máximo hasta 1.5 Mbps. Los resultados obtenidos se presentan en la Figura 11.

En la Figura 11(a) se observan tasas de transmisión promedio de 2.1 Mbps, 2.4 Mbps y 1.5 Mbps para los protocolos RIP, OSPF y SDN, respectivamente, con intervalos de confianza de amplitud similar, lo que indica una variabilidad comparable entre los tres protocolos. OSPF presentó el mayor *throughput*, mientras que SDN registró el menor rendimiento, debido principalmente al mecanismo de balanceo de carga aplicado durante la descarga simultánea del archivo.

Este mismo análisis es aplicable a las Figura 11(b) y 11(c), ya que los resultados obtenidos son consistentes con los de la Figura 11(a).

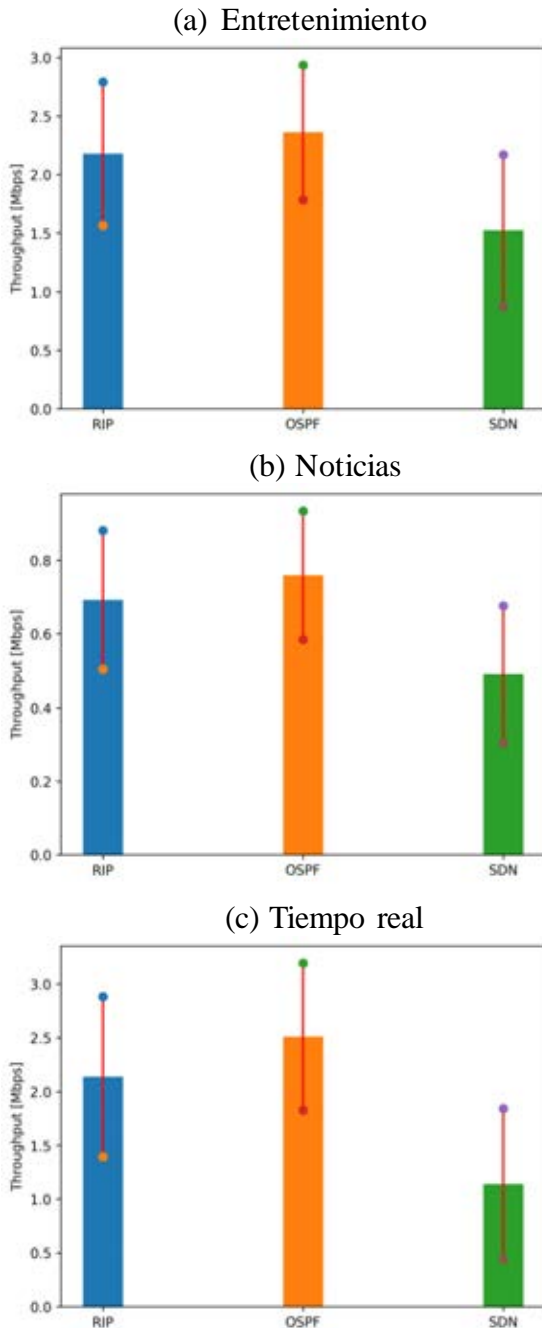
### Retardo

En las Figura 12(a) y 12(b), SDN presentó los menores valores de retardo en las categorías de entretenimiento y noticias, con aproximadamente 20 ms, mientras que RIP y OSPF registraron retardos cercanos a 40 ms y 50 ms, respectivamente. En la Figura 12(c), los retardos observados fueron de 28 ms para RIP, 58 ms para OSPF y 37 ms para SDN. En este caso particular, se evidenció un cambio de ruta en RIP que permitió una reducción del retardo, mientras que SDN experimentó un leve incremento debido al volumen de datos que debió gestionar mediante balanceo de carga. Este mecanismo, si bien sacrificó ligeramente el *throughput*, logró mejorar el retardo; por otro lado, OSPF y RIP presentaron mayores pérdidas

en la calidad del video, atribuidas a la congestión del único enlace disponible en las categorías de entretenimiento y noticias.

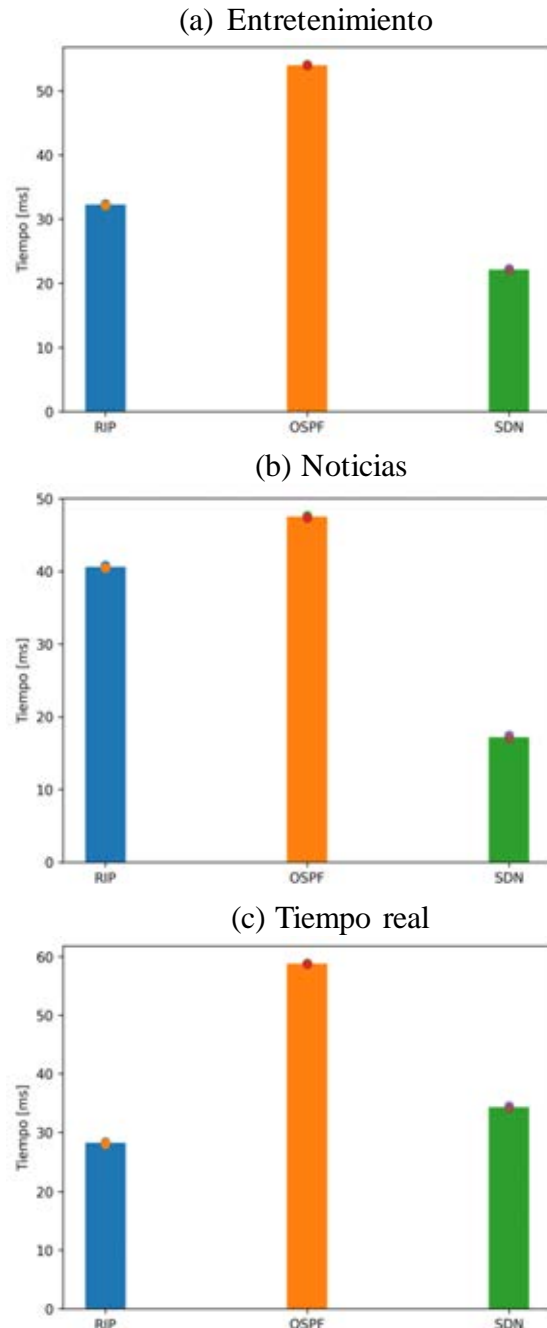
**Figura 11**

*Throughput obtenido para las diferentes categorías de video*



**Figura 12**

*Retardo obtenido para las diferentes categorías de video*



### **Calidad del video**

Las Figuras 13(a), 13(b) y 13(c), correspondientes a las categorías de noticias, entretenimiento y transmisión en tiempo real, respectivamente, evidencian una disminución en la calidad del video ante movimientos en los protocolos OSPF y RIP, mientras que en SDN la calidad se mantuvo más alta y estable. Los fotogramas analizados muestran que SDN conserva una mejor calidad visual en comparación con OSPF y RIP, incluso en escenarios con tráfico

de fondo. Es importante destacar que estas conclusiones se obtuvieron a partir de un proceso de evaluación subjetiva.

### Figura 13

*Fotogramas al usar SDN con tráfico de fondo y sistema de control*

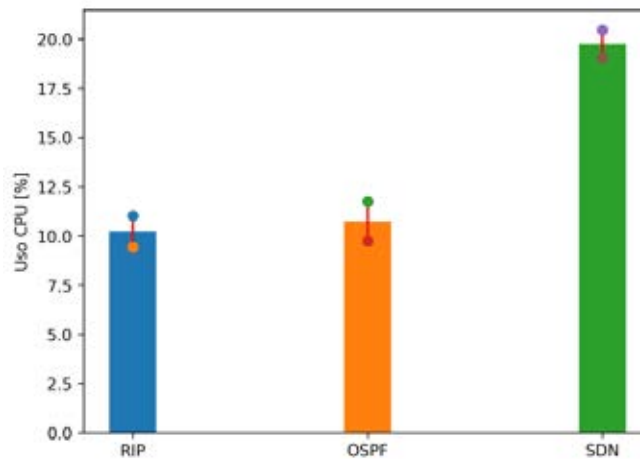
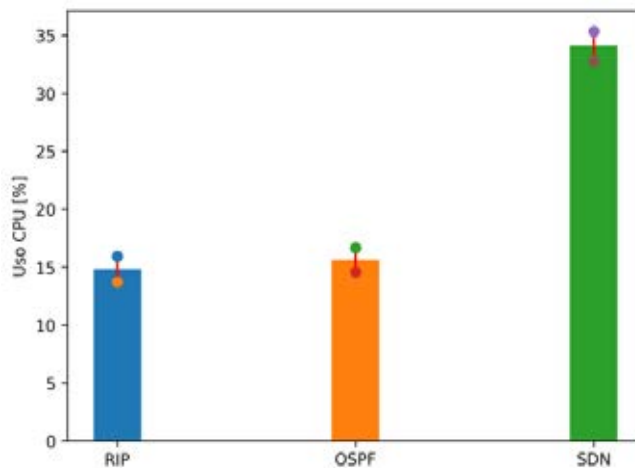


### Resultados obtenidos de carga de CPU

En este experimento se midió la carga del CPU del Raspberry Pi utilizado como *gateway* del servidor de video.

#### *Carga de CPU sin tráfico de fondo*

Con el sistema de control activo, se observó que SDN requiere una mayor carga de procesamiento en comparación con los protocolos tradicionales. Las mediciones de uso de CPU fueron de 10% para RIP, 11% para OSPF y 20% para SDN. Este incremento en el uso de CPU por parte de SDN se debe al mecanismo de balanceo de carga, mediante el cual los datos se distribuyen simultáneamente a través de múltiples rutas, a diferencia de RIP y OSPF, que establecen una única ruta fija para la transmisión de datos; no obstante, este aumento en la carga de procesamiento en SDN no resulta significativo y no genera degradación perceptible en los niveles de Calidad de Servicio (QoS) ni en la Calidad de Experiencia (QoE). Estos resultados se ilustran en la Figura 14.

**Figura 14***Comparación de carga de CPU***Figura 15***Carga del CPU****Carga de CPU con tráfico de fondo***

El tráfico de fondo aumenta aún más la carga del CPU, especialmente en el modo Open vSwitch utilizado por SDN, lo que confirma que SDN es más exigente en términos de procesamiento. Esto nos llevó a obtener los resultados de la Figura 15.

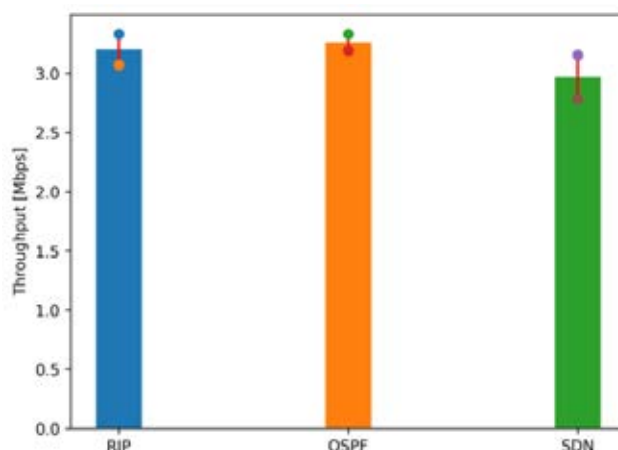
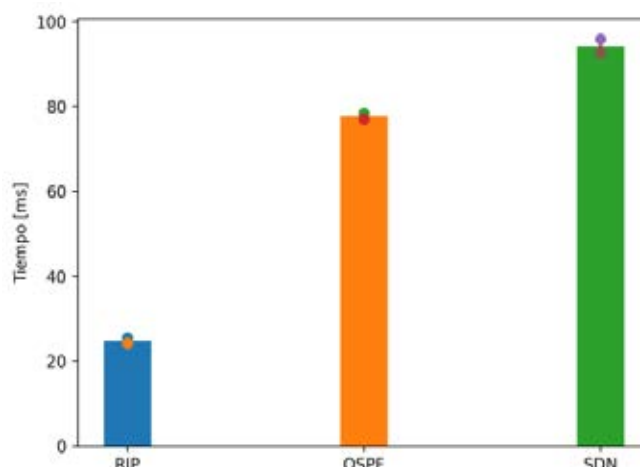
**Resultados obtenidos sin sistema de control y sin tráfico de fondo*****Throughput***

Los tres protocolos (SDN, RIP y OSPF) presentaron valores promedio de *throughput* de hasta 3 Mbps.

***Retardo***

RIP mostró el mejor rendimiento en términos de retardo, seguido por OSPF y SDN. Sin tráfico de fondo, los protocolos tradicionales son más eficientes, ya que envían todo el tráfico por un solo enlace, mientras que SDN presenta mayor retardo debido al balanceo de carga. Las métricas analizadas en este caso se presentan en las Figuras 16 y 17.



**Figura 16***Throughput de la categoría noticias sin tráfico y sin control***Figura 17***Retardo de la categoría noticias sin tráfico y sin control*

Presentaremos un consolidado de los resultados obtenidos donde compararemos los aspectos más relevantes de nuestro estudio en la Tabla 3.

**Tabla 3***Comparación de resultados*

Categoría	Métrica	Con tráfico	Sin tráfico
Entretenimiento	Throughput (Mbps)	1.5 (SDN) < 2.2 (RIP) < 2.4 (OSPF)	2.4 (OSPF) < 2.7 (SDN) < 2.71 (RIP)
	Delay (ms)	21 (SDN) < 31 (RIP) < 55 (OSPF)	40 (SDN) < 50 (RIP) < 680 (OSPF)
	Jitter (ms)	±32 (SDN) vs. ± 40000 (RIP y OSPF)	± 30 (SDN) vs. ± 40000 (RIP y OSPF)
	Carga CPU (%)	15 (RIP) < 16 (OSPF) < 34 (SDN)	10 (RIP) < 11 (OSPF) < 20 (SDN)
Noticias	Throughput (Mbps)	0.5 (SDN) < 0.7 (RIP) < 0.75 (OSPF)	0.75 (OSPF) < 0.9 (SDN) < 0.91 (RIP)
	Delay (ms)	18 (SDN) < 40 (RIP) < 47 (OSPF)	40 (SDN) < 51 (RIP) < 340 (OSPF)
	Jitter (ms)	±31 (SDN) vs. ± 40000 (RIP y OSPF)	± 35 (SDN) vs. ± 40000 (RIP y OSPF)
	Carga CPU (%)	14 (RIP) < 15 (OSPF) < 30 (SDN)	9 (RIP) < 10 (OSPF) < 22 (SDN)

Categoría	Métrica	Con tráfico	Sin tráfico
Tiempo real	Throughput (Mbps)	1.2 (SDN) < 2.1 (RIP) < 2.5 (OSPF)	2.47 (OSPF) < 2.75 (SDN) < 2.9 (RIP)
	Delay (ms)	28 (RIP) < 25 (SDN) < 58 (OSPF)	40 (RIP) < 41 (SDN) < 750 (OSPF)
	Jitter (ms)	±29 (SDN) vs. ±40000 (RIP y OSPF)	± 33(SDN) vs. ± 40000 (RIP y OSPF)
	Carga CPU (%)	15 (RIP) < 18 (OSPF) < 40 (SDN)	11 (RIP) < 12 (OSPF) < 19 (SDN)

Como se puede analizar en la Tabla 3, con tráfico de fondo, SDN muestra bajo ancho de banda efectivo; sin embargo, mantiene fluida la reproducción de los mismos gracias al mecanismo implementado. Siendo este un protocolo eficaz para el tipo de tráfico estudiado.

### Conclusiones

Al emplear este sistema de control sin tráfico de fondo, se observó que SDN presenta menores valores de retardo. Las categorías de video en las que más destacó fueron noticias y entretenimiento. Promediando los valores obtenidos de las tres categorías, SDN obtuvo un retardo de 30.89 ms, de igual manera, el protocolo RIP presentó un retardo de 37.72 ms, finalmente OSPF obtuvo un valor de 594.57 ms. Lo que significa que SDN tiene un retardo 18.1 % menor que RIP y 94.80 % menor que OSPF, de esta manera, se concluye que SDN tiene un mejor rendimiento al emplear nuestro sistema de control, con menores retardos, lo cual es muy importante debido al alto consumo multimedia actual, especialmente en lo que respecta al contenido en *streaming*.

En cuanto al experimento con sistema de control y tráfico de fondo, los valores de *throughput* fueron ligeramente inferiores a los de otros protocolos; sin embargo, promediando los valores de retardo de las tres categorías SDN obtuvo un retardo de 24.53 ms, RIP de 33.71 ms y OSPF de 53.43 ms, lo que significa que SDN tiene un *delay* 27.23 % menor que RIP y 54.1 % menor que OSPF. SDN emplea balance de carga, utilizando varias rutas para enviar los datos. Esto reduce el *throughput*, pero también disminuye el retardo, por tanto, SDN es una opción recomendada para redes en las que se puede tolerar una disminución de *throughput* pero no un aumento en el retardo, como en servicios de tiempo real, tales como videoconferencias o intervenciones quirúrgicas remotas.

El uso de SDN conlleva un costo relacionado con el procesamiento necesario en cada nodo para llenar sus tablas de flujo. Presentó un valor promedio más alto que los otros dos protocolos, lo que se traduce en un mayor consumo energético; por lo tanto, implementar SDN en un centro de datos implica un aumento en los gastos de climatización y energía eléctrica.

Cuando no está presente el sistema de control y no hay tráfico de fondo, el *throughput* fue similar. En términos de retardo, los protocolos tradicionales mostraron un mejor rendimiento, ya que, al no existir congestión en el enlace, el retardo es menor, el valor de retardo obtenido para la categoría de noticias en SDN fue de 94.21 ms, para RIP de 24.85 ms y para OSPF de 77.65 ms, lo que se traduce en que RIP tiene un retardo 73.62 % menor que SDN y OSPF un 17.57 % menor que SDN, cabe destacar que dichos valores fueron similares para el resto de las categorías.

A pesar de utilizar un *testbed*, se obtuvieron resultados significativos que demuestran que SDN en conjunto con un sistema de control es considerablemente superior a los protocolos tradicionales; por lo tanto, su implementación en redes complejas y congestionadas es una opción a considerar.

En la actualidad, implementar SDN es fundamental para mejorar la calidad de servicio y la calidad de experiencia en sistemas de transmisión multimedia, ya que permite una gestión centralizada e inteligente de la red, capaz de adaptarse dinámicamente a las condiciones cambiantes del tráfico. Dado que el video representa más del 80% del tráfico global en Internet, y exige bajos niveles de retardo, *jitter* y pérdida de paquetes, las redes tradicionales con protocolos como RIP u OSPF resultan insuficientes; en cambio, SDN posibilita priorizar flujos críticos, asignar ancho de banda de forma eficiente y enrutar el contenido por trayectorias óptimas, lo que se traduce directamente en una experiencia de usuario más fluida y estable frente al creciente consumo de contenidos como *streaming*, videollamadas, telemedicina y plataformas interactivas.

### Reconocimientos

Los autores agradecen al Departamento de Eléctrica, Electrónica y Telecomunicaciones de la Facultad de Ingeniería de la Universidad de Cuenca por el apoyo brindado durante el desarrollo del presente trabajo de investigación.

Los autores declaran la contribución y participación equitativa de roles de autoría para esta publicación.

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## Análisis predictivo y gestión optimizada de la cartera de clientes morosos en CNEL EP, unidad de Negocio Bolívar

### Predictive Analysis and Optimized Management of the Delinquent Customer Portfolio at CNEL EP Bolívar Business Unit

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Enviado: 2025/04/15  
Aceptado: 2025/05/15  
Publicado: 2025/06/30

#### Resumen

La morosidad representa un obstáculo estructural para la sostenibilidad financiera de las empresas públicas de distribución eléctrica; sin embargo, a diferencia del sector financiero, aún no se han adaptado modelos predictivos basados en aprendizaje automático a este contexto. En particular, CNEL EP enfrenta dificultades para anticipar el incumplimiento de sus clientes, lo cual limita la eficacia de su gestión comercial. Ante esta problemática, el presente estudio tiene como objetivo determinar el modelo de aprendizaje automático más preciso para predecir el riesgo de morosidad en la Unidad de Negocio Bolívar. Para ello, se adoptó un enfoque metodológico basado en Design Science Research y CRISP-DM, el cual permitió integrar una revisión sistemática de literatura (PRISMA), el análisis de un conjunto de 72.483 registros históricos y la aplicación de técnicas como PCA, SMOTE y modelos ensemble (RandomForest, Gradient Boosting, AdaBoost y VotingClassifier). Gradient Boosting y VotingClassifier alcanzaron métricas casi perfectas (Accuracy: 0.9982; F1 Macro: 0.9957; AUC ROC: 1.000) y (Accuracy: 0.9983; F1 Macro: 0.9959; AUC ROC: 1.000), incluso en escenarios de estrés con ruido, desbalance y pérdida de datos; además, la incorporación de SHAP y LIME facilitó la interpretación de las predicciones, garantizando transparencia para usuarios no técnicos. Los hallazgos evidencian que la solución es robusta, replicable y aplicable en la práctica. Este estudio constituye un aporte significativo al demostrar que los modelos de aprendizaje automático pueden fortalecer la gestión de cartera en el sector eléctrico público ecuatoriano.

**Sumario:** Introducción, Metodología, Resultados, Discusión, Conclusiones.

**Como citar:** Carrillo, M. & Aguilar, P. (2025). Análisis predictivo y gestión optimizada de la cartera de clientes morosos en CNEL EP, unidad de negocio bolívar. *Revista Tecnológica - Espol*, 37(1), 285-308. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1312>

**Palabras clave:** Aprendizaje Automático, Ciencia del Diseño, Evaluación de Modelos, Modelos Ensemble, Minería de Datos, Inteligencia Artificial Explicable, Riesgo de Morosidad.

### Abstract

Payment delinquency represents a structural barrier to the financial sustainability of public electricity distribution companies; however, unlike the financial sector, predictive models based on machine learning have not yet been adapted to this context. In particular, CNEL EP faces challenges in anticipating customer defaults, which limits the effectiveness of its commercial management. This study aims to identify the most accurate machine learning model to predict delinquency risk in the Bolívar Business Unit. A methodological approach based on Design Science Research and CRISP-DM was adopted, incorporating a systematic literature review (PRISMA), the analysis of 72,483 historical records, and the application of techniques such as PCA, SMOTE, and ensemble models (RandomForest, Gradient Boosting, AdaBoost, and VotingClassifier). Gradient Boosting and VotingClassifier achieved near-perfect performance metrics (Accuracy: 0.9982; F1 Macro: 0.9957; AUC ROC: 1.000) and (Accuracy: 0.9983; F1 Macro: 0.9959; AUC ROC: 1.000), even under stress scenarios involving noise, imbalance, and data loss. Furthermore, the integration of SHAP and LIME enabled transparent interpretation of predictions for non-technical users. The findings show that the proposed solution is robust, replicable, and applicable in practice. This study makes a significant contribution by demonstrating that machine learning models can enhance portfolio management in Ecuador's public electricity sector.

**Keywords:** Data Mining, Default Risk, Design Science, Ensemble Models, Machine Learning, Model Evaluation, Explainable Artificial Intelligence.

### Introducción

La morosidad en la cartera de clientes constituye un desafío estructural para la sostenibilidad financiera de las empresas públicas de distribución eléctrica; en contraste, en el sector financiero se han desarrollado modelos de aprendizaje automático altamente efectivos para predecir el riesgo de incumplimiento (Liu et al., 2024; Xu, 2024); no obstante, estos avances aún no han sido adaptados ni validados en contextos operativos del sector eléctrico, donde las particularidades institucionales y regulatorias exigen soluciones especializadas para anticipar el riesgo y optimizar la recuperación de cartera (Akinjole et al., 2024; Ha et al., 2024; Rios & Arbeláez, 2023).

En la literatura científica se han documentado múltiples enfoques exitosos de clasificación del riesgo crediticio, destacando el uso de modelos ensemble como Random Forest, Gradient Boosting y Voting Classifier, junto con técnicas de balanceo de clases como SMOTE y métodos de reducción de dimensionalidad como PCA (Dastile et al., 2020; Kim et al., 2020; Ren, 2025); sin embargo, la mayoría de estas aplicaciones se han desarrollado en el sector bancario, bajo condiciones de mercado muy distintas a las del sector eléctrico público.

No se han documentado estudios empíricos aplicados al sector eléctrico público que implementen y validen modelos de aprendizaje automático para la predicción del riesgo de morosidad, considerando la complejidad operativa, los esquemas tarifarios diferenciados y los factores sociales que influyen en el comportamiento de pago de los usuarios (Ha et al., 2024; Rios & Arbeláez, 2023). Esta brecha representa un obstáculo para incorporar soluciones tecnológicas en la gestión comercial de las empresas públicas de energía. (Mujo et al., 2025; Wang et al., 2025).

El objetivo del estudio es, determinar el modelo de aprendizaje automático más preciso mediante un proceso de minería de datos para gestionar de forma efectiva a los clientes en riesgo de morosidad en CNEL EP Unidad de Negocio Bolívar.

La investigación busca proporcionar una solución replicable, robusta y basada en evidencia que permita automatizar la clasificación de clientes morosos, reducir las pérdidas por incobrabilidad y fortalecer la gestión comercial mediante la incorporación de inteligencia artificial (Kim et al., 2020; Ren, 2025; Xu, 2024). Asimismo, aporta al desarrollo del conocimiento académico al extender la aplicación de modelos de aprendizaje automático hacia dominios no financieros, demostrando su utilidad en contextos operativos complejos como la gestión de cartera en empresas públicas del sector eléctrico (Akinjole et al., 2024; Ha et al., 2024).

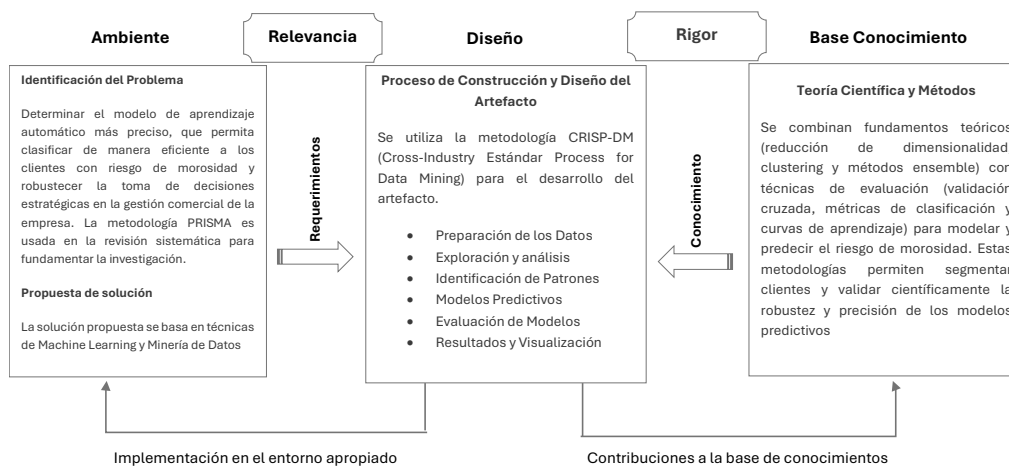
El artículo se organiza en cinco secciones: Sección 1, “Introducción, presentación del tema, relevancia, brecha de conocimiento, objetivo y justificación”; Sección 2, “Metodología, describe el enfoque Design Science Research y CRISP-DM para el desarrollo del artefacto, detalla las fases de Entendimiento del Negocio, Comprensión y Preparación de datos, Modelado y Evaluación”; Sección 3, “Resultados de los modelos implementados, su rendimiento comparativo, pruebas de estrés”; Sección 4, “Discusión, contraste entre los resultados alcanzados y los reportados en investigaciones previas”; Sección 5, “Conclusiones, se exponen las principales conclusiones y se sugieren futuras líneas de investigación para optimizar y ampliar la solución desarrollada.

## Metodología

El estudio se desarrolló bajo el marco metodológico de la Ciencia del Diseño (Design Science Research, DSR), un enfoque que permite abordar problemas complejos mediante la construcción y validación de artefactos tecnológicos en contextos reales (Akoka et al., 2023; Aurna & Richard, 2023; Goecks et al., 2021). Esta metodología ha demostrado ser particularmente eficaz en el desarrollo de modelos predictivos aplicables a contextos organizacionales, al permitir una articulación efectiva entre teoría y práctica. Su enfoque se sustenta en la interacción dinámica de tres ciclos fundamentales: el ciclo de rigor, el ciclo de relevancia y el ciclo de diseño (Delpont et al., 2024; Goecks et al., 2021; Montevechi et al., 2024). La Figura 1 detalla las actividades desarrolladas en cada ciclo.

**Figura 1**

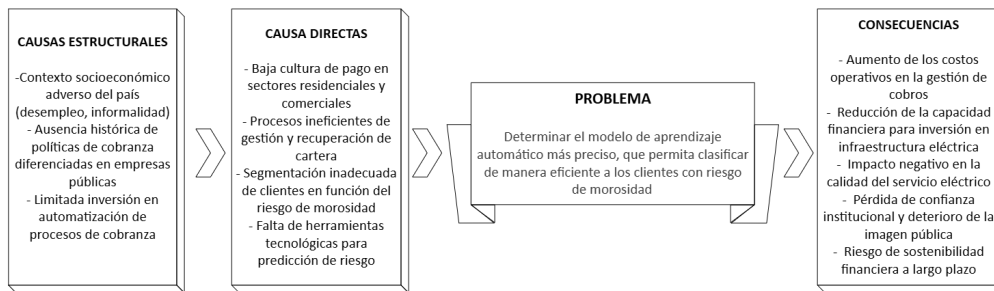
### *Metodología de la Ciencia del Diseño Aplicada (DSR)*



El Ciclo de Relevancia vinculó la solución propuesta con una necesidad institucional crítica: anticipar el riesgo de morosidad para optimizar la gestión de cartera. Esta necesidad se asocia con el problema formulado en la presente investigación, el cual muestra sus causas estructurales y efectos en la Figura 2. En consecuencia, la investigación inició con un proceso de revisión de la literatura a fin de determinar los modelos de aprendizaje automático más utilizados en la predicción del riesgo de morosidad y la recuperación de cartera en contextos generales.

**Figura 2**

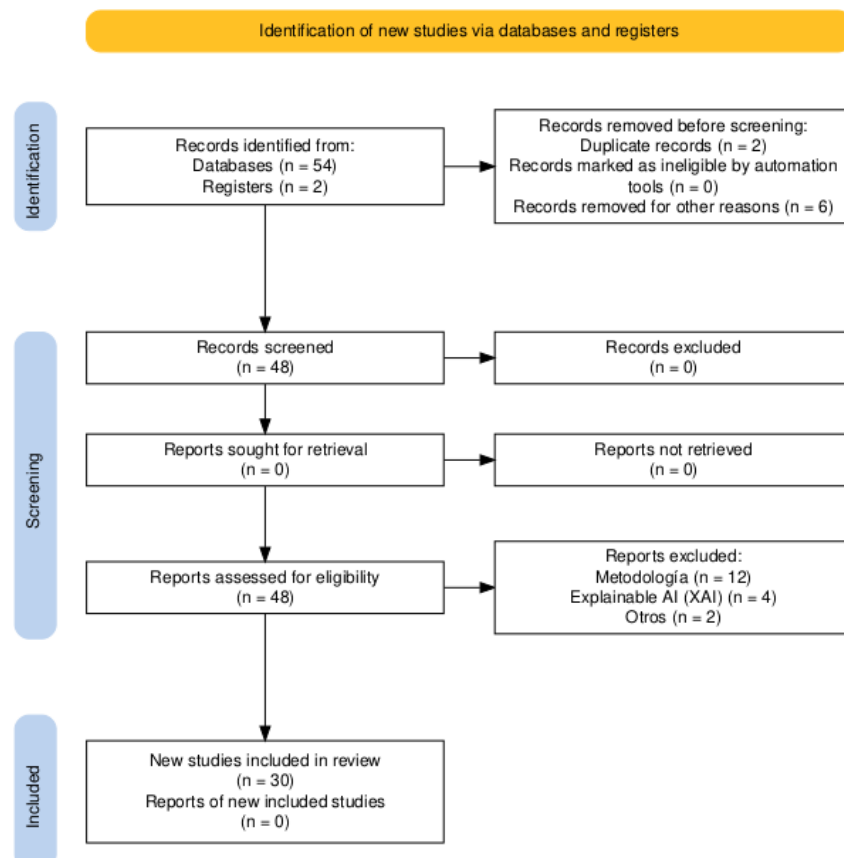
*Análisis de Causas Estructurales, Causas Directas y Consecuencias*



El proceso de revisión sistemática de literatura se realizó siguiendo el protocolo PRISMA, el diagrama de flujo de este proceso en esta investigación se observa en la Figura 3. Este protocolo permitió establecer criterios claros para la búsqueda, selección y evaluación de fuentes (Alvi et al., 2024; Kim et al., 2020).

**Figura 3**

*Diagrama de Flujo de la Metodología PRISMA para la Revisión de Literatura*





### Identificación

Se recopilaron un total de 56 registros iniciales, provenientes de bases de datos científicas reconocidas por su rigor académico, tales como IEEE Xplore, SpringerLink, Elsevier y ScienceDirect. En esta fase, se eliminaron 2 documentos duplicados y otros 6 artículos que no cumplían con los siguientes criterios temáticos, contextuales:

- Artículos que traten sobre modelos de aprendizaje automático.
- Artículos cuyo enfoque sea la predicción de riesgo de morosidad o default crediticio.
- Artículos que empleen técnicas de minería de datos.
- Artículos cuyo contexto del estudio sea operativo, no solo teórico o simulado.

### Screening (Cribado)

Se procedió al análisis preliminar de los 48 estudios restantes, sin que se registraran exclusiones adicionales en esta etapa, ya que todos los estudios cumplían con los requisitos básicos para pasar a la fase de evaluación completa.

### Elegibilidad

Se realizó un análisis en profundidad de los 48 estudios filtrados, de los cuales se excluyeron 18 trabajos por las siguientes razones:

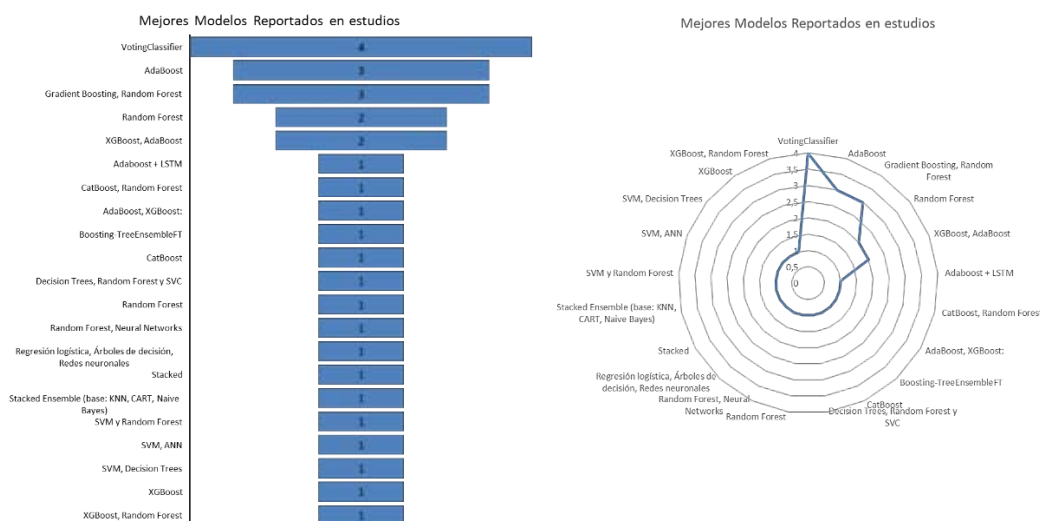
- 12 estudios se centraban exclusivamente en aspectos metodológicos sin aplicación directa a problemas de morosidad o riesgo crediticio.
- 4 estudios estaban orientados al desarrollo de técnicas de interpretabilidad (Explainable AI - XAI) sin abordar directamente la predicción de morosidad.
- 2 estudios fueron descartados por pertenecer a otras temáticas que no se alineaban con los objetivos de la presente investigación.

### Inclusión

Finalmente, se obtuvieron 30 estudios en la revisión final, los cuales aportaron evidencia empírica y mejores prácticas sobre la implementación de modelos de aprendizaje automático para la predicción de morosidad y riesgo crediticio en entornos organizacionales, conforme el detalle de la Figura 4.

**Figura 4**

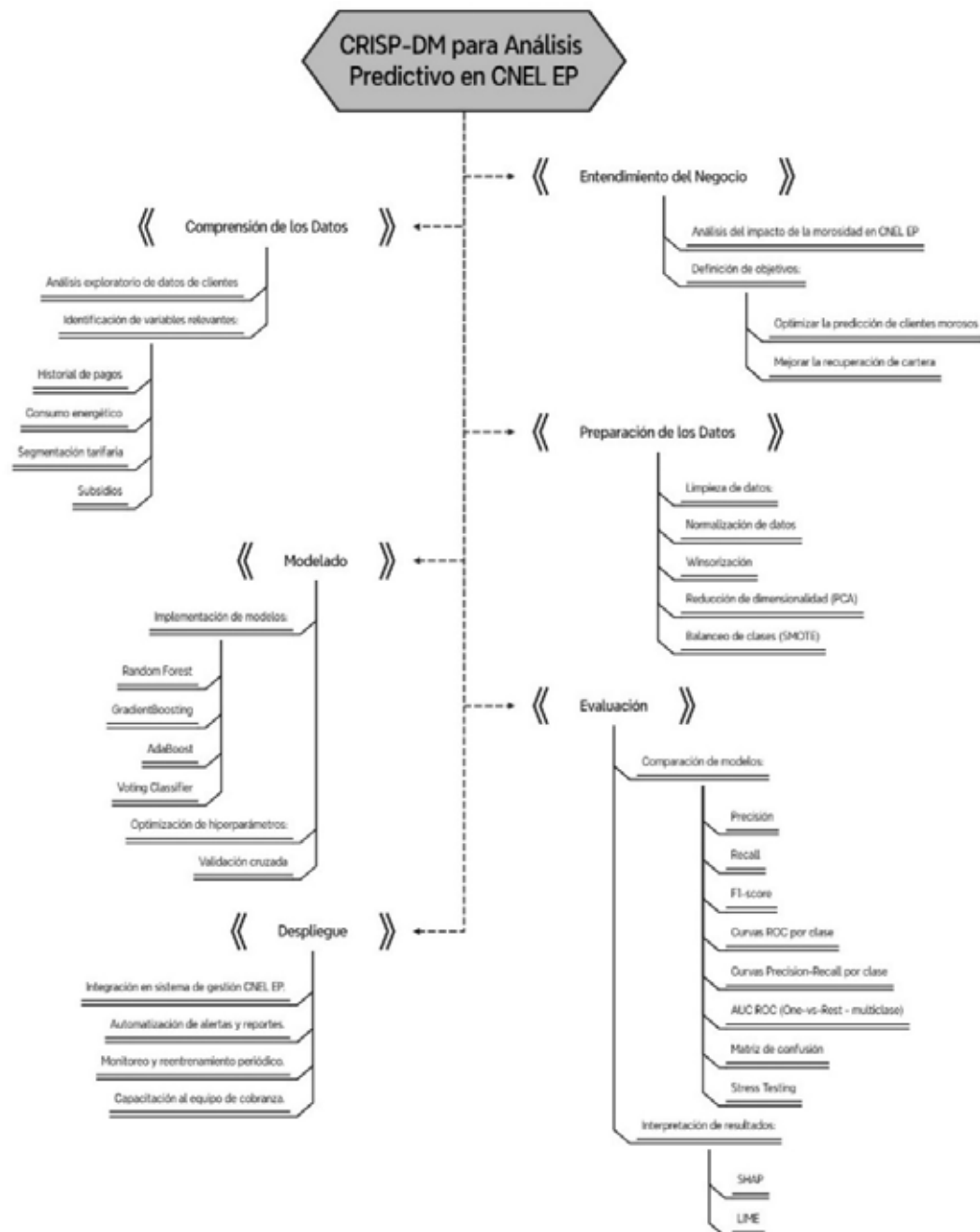
*Cantidad de modelos utilizados por estudio en los trabajos analizados*



El Ciclo del Diseño permitió la construcción del artefacto, facilitando la validación empírica de las soluciones propuestas. En esta etapa, se describe la construcción de los modelos predictivos propuestos orientados a resolver el problema identificado en el entorno organizacional. Para estructurar este proceso de manera sistemática y efectiva, se adoptó la metodología CRISP-DM (Cross Industry Standard Process for Data Mining), la cual se observa en la Figura 5.

**Figura 5**

*Metodología CRISP-DM para el análisis predictivo de CNEL EP*



### Entendimiento del Negocio

En una primera fase se analizó el impacto y estado de la cartera vencida en CNEL EP Unidad de Negocio Bolívar en la gestión financiera, identificándose un porcentaje de cartera vencida del 13,6% a diciembre de 2024, porcentaje considerado alto según el Banco Mundial

que recomienda para empresas de servicios públicos mantener este indicador por debajo del 5% para garantizar su sostenibilidad financiera. Así mismo, se realizó un análisis integral de las variables objeto del estudio.

### Comprensión de los Datos

La información analizada estuvo compuesta por 72.483 registros y 43 variables relacionadas con la gestión de cartera de CNEL EP Unidad de Negocio Bolívar. Esta incluye datos de identificación del cliente, ubicación geográfica, tarifas, aplicación de subsidios, nivel de morosidad y un desglose detallado de la deuda, como meses de mora, valor total de la deuda, fechas de última factura y suspensión, así como categorizaciones por rangos de antigüedad y valor. También se contemplan componentes específicos de valores vencidos por concepto de energía, alumbrado, intereses, entre otros.

### Análisis Exploratorio

Se realizó una depuración de columnas irrelevantes y se clasificaron las variables en numéricas y categóricas. Se identificaron valores atípicos utilizando el rango intercuartílico (IQR), detectándose anomalías especialmente en variables como "MESES\_DEUDA", "VALOR\_DEUDA", y "V\_VENCIDO\_ENERGIA".

Se implementaron histogramas, *boxplots*, gráficos de barras para categorías con menos de 20 niveles, mapas de calor de correlación entre variables numéricas, y diagramas de dispersión, como se muestra en las Figuras Figura 6 y Figura 7. Se identificó una alta dispersión y presencia de valores extremos, como deudas que alcanzan hasta los 27.854 USD y períodos de mora de hasta 193 meses. Este análisis permitió identificar patrones de comportamiento de la morosidad y sentó las bases para el preprocesamiento y modelado predictivo posterior (Alonso Robisco & Carbó Martínez, 2022; Kim et al., 2020; Shahid et al., 2023).

**Figura 6**

#### Gráficas Descriptivas

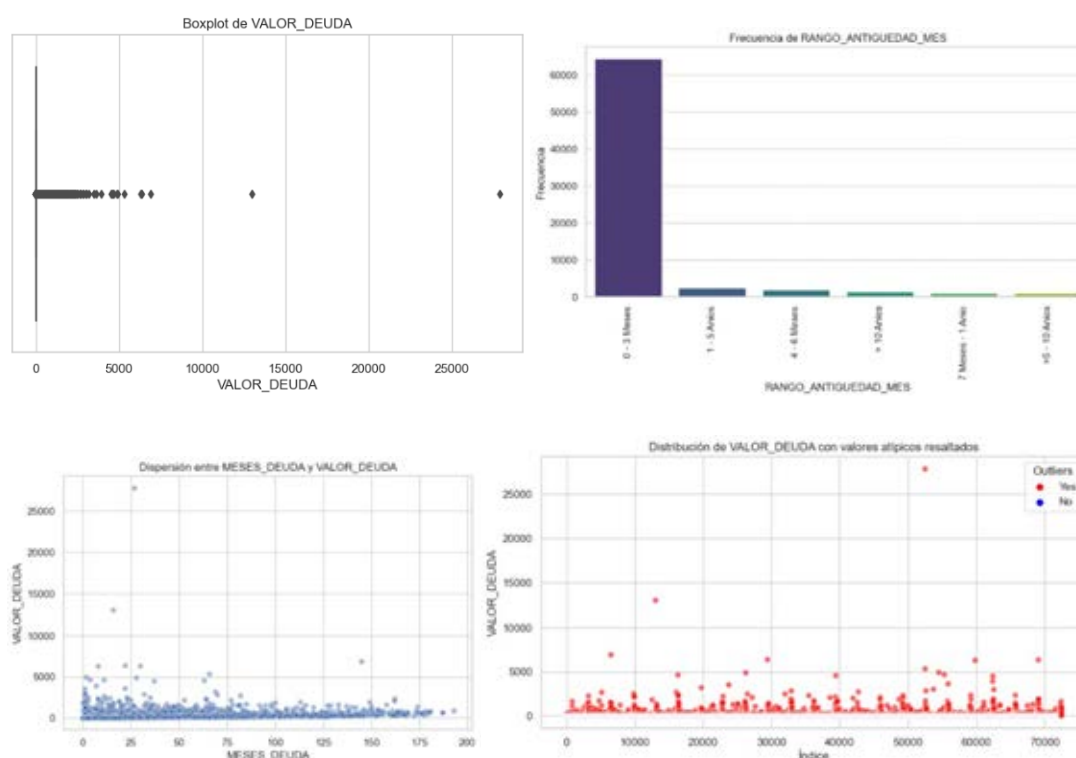
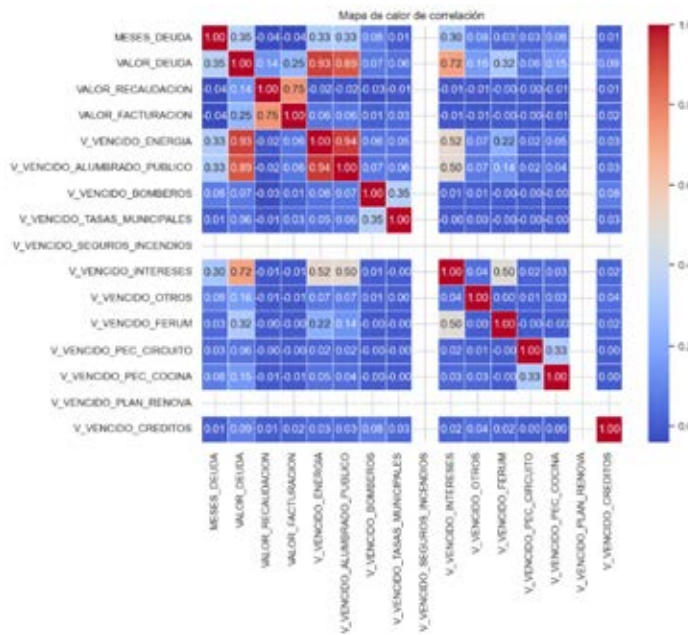


Figura 7

Mapa de calor de Correlación de variables

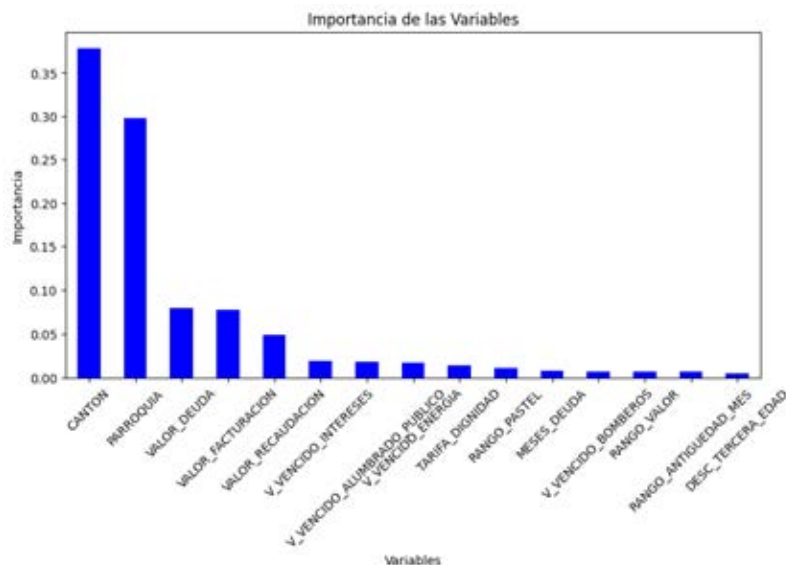


**Preparación de Datos**

Se realizó una depuración de registros. Se excluyeron clientes con estado “PASIVO” por representar casos en etapa coactiva, no aptos para predicción temprana, así como registros con deudas negativas y duplicados. Posteriormente, se eliminaron variables irrelevantes o redundantes, y se estandarizaron los nombres de las columnas. Se manejaron valores nulos, principalmente imputando la moda o eliminando registros según el caso. Se identificaron y trataron valores atípicos mediante IQR, y se aplicó winsorización para reducir su impacto sin eliminar datos. Finalmente, se implementó un modelo Random Forest con selección de características para reducir la dimensionalidad, mejorando la eficiencia del modelo y su capacidad de generalización sin comprometer la precisión (Akinjole et al., 2024; Alonso Robisco & Carbó Martínez, 2022), el resultado se muestra en la Figura 8.

Figura 8

Importancia de las Variables (Random Forest con selección de características)



## Implementación de Modelos

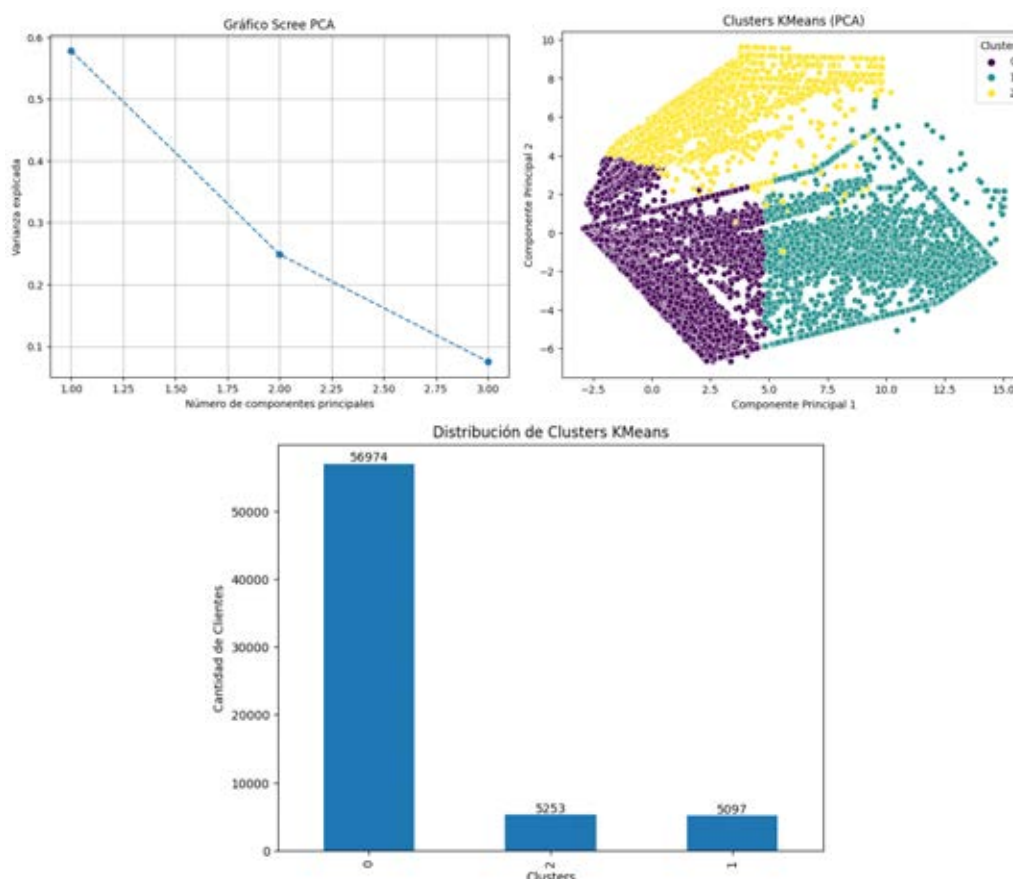
Para identificar el riesgo de morosidad, se desarrolló un enfoque en dos fases: una fase no supervisada, orientada a la segmentación de clientes mediante técnicas de agrupamiento y una fase supervisada, centrada en la construcción de modelos predictivos basados en aprendizaje automático.

### Fase No Supervisada

Se seleccionaron las 10 variables más relevantes y se aplicó RobustScaler para escalar los datos, mitigando el efecto de outliers. Posteriormente, se utilizó Análisis de Componentes Principales (PCA) para reducir la dimensionalidad, conservando más del 90% de la varianza. Sobre esta representación reducida se aplicó el algoritmo K-Means, para determinar el número óptimo de clústeres se empleó el método del codo, el cual indicó que tres clústeres ofrecían un buen equilibrio de agrupamiento, representados gráficamente en la Figura 9. El índice de Silhouette del modelo fue de 0.681, clasificando a los clientes en riesgo bajo (0), medio (1) y alto (2). Este enfoque permitió identificar patrones de morosidad sin necesidad de etiquetas predefinidas (Liu et al., 2024; Sheikh et al., 2020; Yemmanuru et al., 2024).

Figura 9

Clasificación con KMeans



### Fase Supervisada

A partir de un conjunto de datos previamente segmentado mediante técnicas no supervisadas, se procedió con la codificación de las variables categóricas mediante la técnica de Label Encoding y la selección de variables explicativas relevantes, entre ellas: VALOR\_DEUDA, VALOR\_FACTURACION, VALOR\_RECAUDACION, MESES\_DEUDA y los componentes del valor vencido, en función de su contribución al estudio. La variable objetivo fue RIESGO\_DE\_MOROSIDAD, categorizada en tres niveles

(bajo, medio y alto). Se dividió el conjunto de datos en subconjuntos de entrenamiento y prueba bajo una proporción 80/20. Dado que se identificó un desbalance entre las categorías de la variable objetivo, se aplicó la técnica SMOTE (Synthetic Minority Over-sampling Technique) exclusivamente al conjunto de entrenamiento, con el fin de equilibrar las clases mediante la generación de instancias sintéticas de las categorías minoritarias, mejorando así la representatividad de los datos y la capacidad del modelo para generalizar (Akinjole et al., 2024; Shahid et al., 2023).

Se implementaron tres algoritmos de aprendizaje ensemble: *Random Forest*, *Gradient Boosting* y *AdaBoost*, además de un *Voting Classifier* que integra las predicciones de los modelos base mediante votación suave.

Se realizó un ajuste de hiperparámetros clave en el caso de Random Forest, se aumentó el número de árboles ( $n\_estimators=150$ ) para incrementar la estabilidad del modelo, se limitó la profundidad máxima ( $max\_depth=12$ ) y se establecieron umbrales mínimos para divisiones y hojas ( $min\_samples\_split=5$ ,  $min\_samples\_leaf=3$ ) para evitar el sobreajuste, mientras que la selección aleatoria de características ( $max\_features="sqrt"$ ) y el ajuste de pesos por clase ( $class\_weight="balanced"$ ) permitieron mejorar la diversidad y compensar el desbalance de clases. Para Gradient Boosting, se incrementó el número de árboles ( $n\_estimators=200$ ) con una tasa de aprendizaje reducida ( $learning\_rate=0.05$ ) para estabilizar el aprendizaje progresivo, se limitaron los árboles base en profundidad y tamaño de partición, así mismo, se aplicó una técnica de muestreo parcial ( $subsample=0.8$ ) para aumentar la robustez frente al ruido. En el caso de AdaBoost, se configuraron 150 clasificadores débiles con una tasa de aprendizaje moderada ( $learning\_rate=0.1$ ) que permite mejorar la estabilidad del modelo sin comprometer su capacidad de ajuste. Estos hiperparámetros, para alcanzar altos niveles de precisión y reducir la tendencia al sobreajuste mejorando la generalización (scikit-learn.org, n.d.-b).

Se desarrollaron curvas de aprendizaje completas con el objetivo de identificar signos de sobreajuste.

Se aplicó validación cruzada estratificada con  $k=5$  asegurando que cada fold conserve la proporción original de clases (riesgo bajo, medio y alto), lo que es fundamental en problemas multiclase con datos desbalanceados (scikit-learn.org, n.d.-a).

Las métricas de evaluación empleadas incluyeron Accuracy, Balanced Accuracy, F1 Score Macro, Precision Macro, Recall Macro, Cohen's Kappa y Matthews Correlation Coefficient, lo que proporcionó una valoración robusta del desempeño de los modelos en contextos con clases desbalanceadas. Adicionalmente, se aplicaron métricas basadas en probabilidades, como AUC ROC (One-vs-Rest) y Average Precision Score (PR AUC), lo que permitió analizar su capacidad discriminativa entre clases y su rendimiento frente a clases minoritarias. También se elaboraron matrices de confusión, curvas ROC y curvas Precision-Recall por clase, lo cual enriqueció la interpretación visual de los resultados y fortaleció la validación de los modelos predictivos.

Se construyó un entorno de pruebas sistemático en el que, para cada modelo, se midió su capacidad de generalización y su sensibilidad frente a clases con menor representación. Los escenarios definidos incluyeron: (1) evaluación con el conjunto base original, (2) adición de ruido moderado ( $\sigma=0.3$ ) para simular datos con perturbaciones, (3) reducción del 50% de los datos correspondientes a la clase minoritaria (clase 2), y (4) eliminación aleatoria del 40% del total de muestras. Estos escenarios permitieron analizar la robustez y estabilidad de los modelos

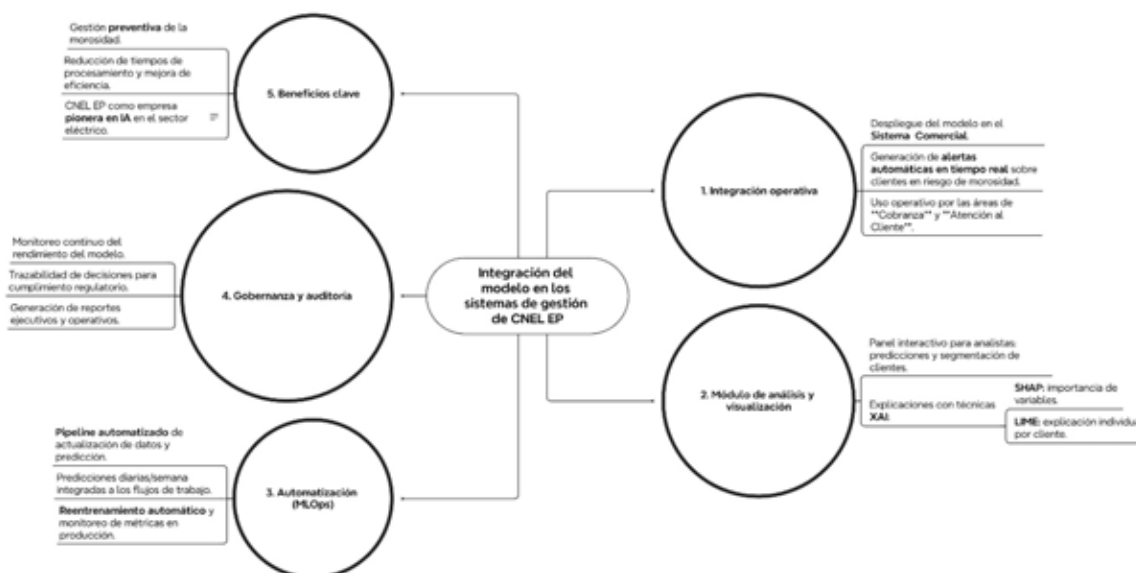
ante condiciones de incertidumbre, pérdida de información o desbalance inducido, consolidando una metodología orientada a validar el comportamiento de los algoritmos en situaciones cercanas a un entorno real de aplicación (Akinjole et al., 2024; Ren, 2025; Shahid et al., 2023).

También se implementaron técnicas de interpretabilidad en inteligencia artificial (*Explainable AI – XAI*), específicamente SHAP (Shapley Additive Explanations) y LIME (Local Interpretable Model-Agnostic Explanations). Estas herramientas permitieron analizar individualmente las decisiones del modelo, identificando el aporte específico de cada variable en la clasificación de riesgo de morosidad.

Finalmente, se realiza una propuesta de integración del modelo en los sistemas de gestión de CNEL EP, tal como se detalla en la Figura 10. La arquitectura propuesta incluye un módulo de alertas en tiempo real y un sistema de visualización interactiva que permite segmentar y priorizar clientes según su nivel de riesgo estimado. El sistema incorpora técnicas de interpretabilidad como SHAP y LIME, lo que garantiza la transparencia de las predicciones y facilita su evaluación por parte de usuarios no expertos; además, se plantea un entorno de actualización continua (MLOps) con monitoreo de desempeño y generación de reportes ejecutivos, alineado con principios de trazabilidad y auditoría en contextos regulados. Estos elementos permiten vincular los resultados obtenidos con aplicaciones prácticas en la gestión de cartera, conforme a lo sugerido en estudios previos (Qin et al., 2021; Dinh & Thanh, 2022; Zanke, 2023).

**Figura 10**

*Propuesta de integración del modelo en los sistemas de gestión comercial de CNEL EP  
Unidad de Negocio Bolívar*



### Ciclo de Rigor

La construcción del modelo se fundamentó en principios teóricos ampliamente validados en la literatura científica, los cuales fueron identificados de manera sistemática mediante el protocolo PRISMA. Esta revisión rigurosa permitió explorar y sintetizar críticamente los enfoques más relevantes en segmentación de clientes, técnicas de clasificación en contextos multiclase, y métodos para el tratamiento de desbalance de clases, como SMOTE (Synthetic Minority Over-sampling Technique). A partir de esta base teórica consolidada, se

justificó la selección de los algoritmos Random Forest, Gradient Boosting, AdaBoost y un Voting Classifier, cuya eficacia ha sido ampliamente demostrada en investigaciones aplicadas a problemáticas similares.

Asimismo, se adoptó el modelo metodológico CRISP-DM para estructurar el proceso de análisis en seis fases, desde el entendimiento del negocio hasta la evaluación de los modelos. El uso de esta metodología permitió implementar una limpieza exhaustiva de datos, selección de variables relevantes mediante Random Forest, reducción de dimensionalidad con PCA y una fase exploratoria que identificó valores atípicos críticos como deudas de hasta 27.854 USD o 193 meses de mora acumulada.

La robustez del diseño se reforzó a través de la validación cruzada estratificada ( $k=5$ ), y de un conjunto amplio de métricas de evaluación: Accuracy, F1 Score Macro, Balanced Accuracy, Matthews Correlation Coefficient, AUC ROC OVR y Average Precision Score (PR AUC). Las métricas fueron seleccionadas por su idoneidad en la evaluación de modelos predictivos multiclase con desbalance. Por ejemplo, el modelo Gradient Boosting alcanzó una accuracy del 0.9982 y una F1 Macro de 0.9957, mostrando desempeño casi perfecto incluso ante perturbaciones simuladas.

Se implementaron escenarios de stress testing, para evaluar la estabilidad de los modelos frente a la introducción de ruido ( $\sigma=0.3$ ), eliminación aleatoria del 40% de los registros, y reducción del 50% de la clase minoritaria. El modelo de Gradient Boosting y el Voting Classifier mantuvieron su capacidad de generalización con AUC ROC de 1.000 y PR AUC de 1.000, validando empíricamente su idoneidad para aplicaciones reales. De esta forma, el estudio no solo aplica conocimientos existentes, sino que contribuye al cuerpo científico con evidencia replicable sobre la aplicación de algoritmos ensemble en entornos públicos con alto grado de incertidumbre y desbalance estructural en los datos.

## Resultados

En esta sección, se presentan los resultados derivados de la implementación de los modelos de aprendizaje automático Random Forest, Gradient Boosting y AdaBoost, además de un Voting Classifier; se implementan curvas de aprendizaje para identificar tendencias de convergencia y posibles indicios de sobreajuste; se comparan las métricas de desempeño utilizando validación cruzada estratificada y escenarios simulados representativos de condiciones operativas reales; se evalúa la robustez de los modelos a través de análisis de sensibilidad y pruebas de estrés, complementadas con técnicas de inteligencia artificial explicable (SHAP y LIME) para interpretar la influencia de las variables en las predicciones y finalmente se propone un modelo matemático que aborde el problema de clasificación multiclase en la predicción del riesgo de morosidad.

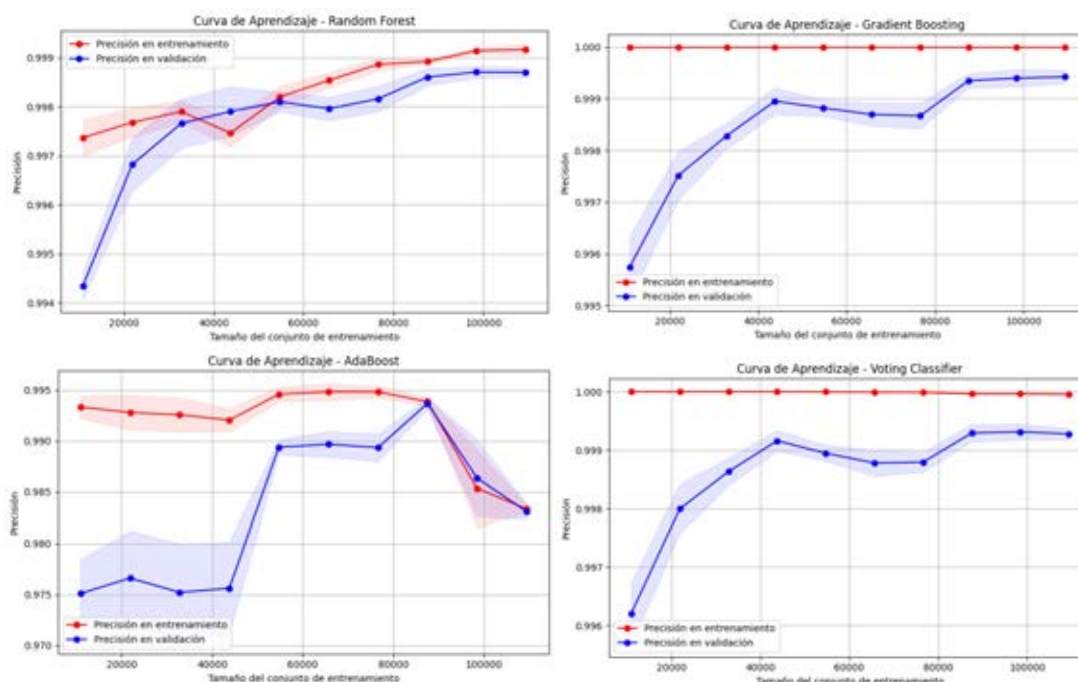
### Curvas de Aprendizaje

Los modelos Gradient Boosting y Voting Classifier presentaron un comportamiento altamente estable, con precisiones cercanas al 100%, lo que evidenció una sólida capacidad de generalización. Random Forest mantuvo también un desempeño consistente, con una brecha controlada entre ambas curvas. En contraste, el modelo AdaBoost evidenció una mayor variabilidad en la precisión de validación y una separación más pronunciada respecto al entrenamiento, lo que indicó una menor robustez frente a incrementos en el tamaño del conjunto de datos y una posible tendencia al sobreajuste, tal como se observa en la Figura 11.



**Figura 11**

*Clasificación con KMeans*



**Validación Cruzada**

Los modelos fueron evaluados mediante validación cruzada estratificada (k=5). Todos los modelos, excepto AdaBoost, presentan un rendimiento sobresaliente con una concordancia cercana entre el accuracy puntual y el promedio de validación cruzada, lo que sugiere una alta capacidad de generalización y robustez, los resultados se presentan en la Tabla 1. GradientBoosting y VotingClassifier emergen como las opciones más sólidas para entornos críticos, mientras que AdaBoost, aunque funcional, podría no ser óptimo en contextos con alta variabilidad o donde las clases minoritarias son relevantes.

**Tabla 1**

*Resultados Validación Cruzada (k=5)*

Modelo	Accuracy	Cross-Validation	Análisis
<b>RandomForest</b>	0.997	0.999	Excelente capacidad de ajuste, con mínima diferencia entre entrenamiento y validación, lo que indica buena generalización y bajo riesgo de sobreajuste.
<b>GradientBoosting</b>	0.998	0.999	Ligeramente superior en precisión puntual. Su alto desempeño en validación cruzada refuerza su confiabilidad, incluso en entornos variados.
<b>AdaBoost</b>	0.984	0.983	Notablemente menor que los otros modelos. Puede tener mayor sensibilidad al ruido o menor capacidad de adaptación a patrones complejos, pese al balanceo con SMOTE.
<b>VotingClassifier</b>	0.998	0.999	Iguala el rendimiento del GradientBoosting y lo supera en robustez al combinar varios algoritmos, lo que le permite mantener consistencia entre precisión individual y validación cruzada.

**Evaluación de modelos**

Los resultados mostrados en la Tabla 2 indican que el modelo GradientBoosting obtuvo el mejor desempeño global con métricas casi perfectas en todas las clases. VotingClassifier también mostró resultados sobresalientes, siendo robusto y estable, ideal para escenarios operativos. RandomForest alcanzó una precisión muy alta y balance entre clases. En contraste, AdaBoost, aunque competitivo, presentó menor rendimiento en clases minoritarias. La

evaluación incluyó métricas tradicionales y probabilísticas, así como análisis gráfico (ROC y Precision-Recall), confirmando la efectividad de SMOTE en mejorar el aprendizaje de clases minoritarias.

**Tabla 2**

*Evaluación de Modelos*

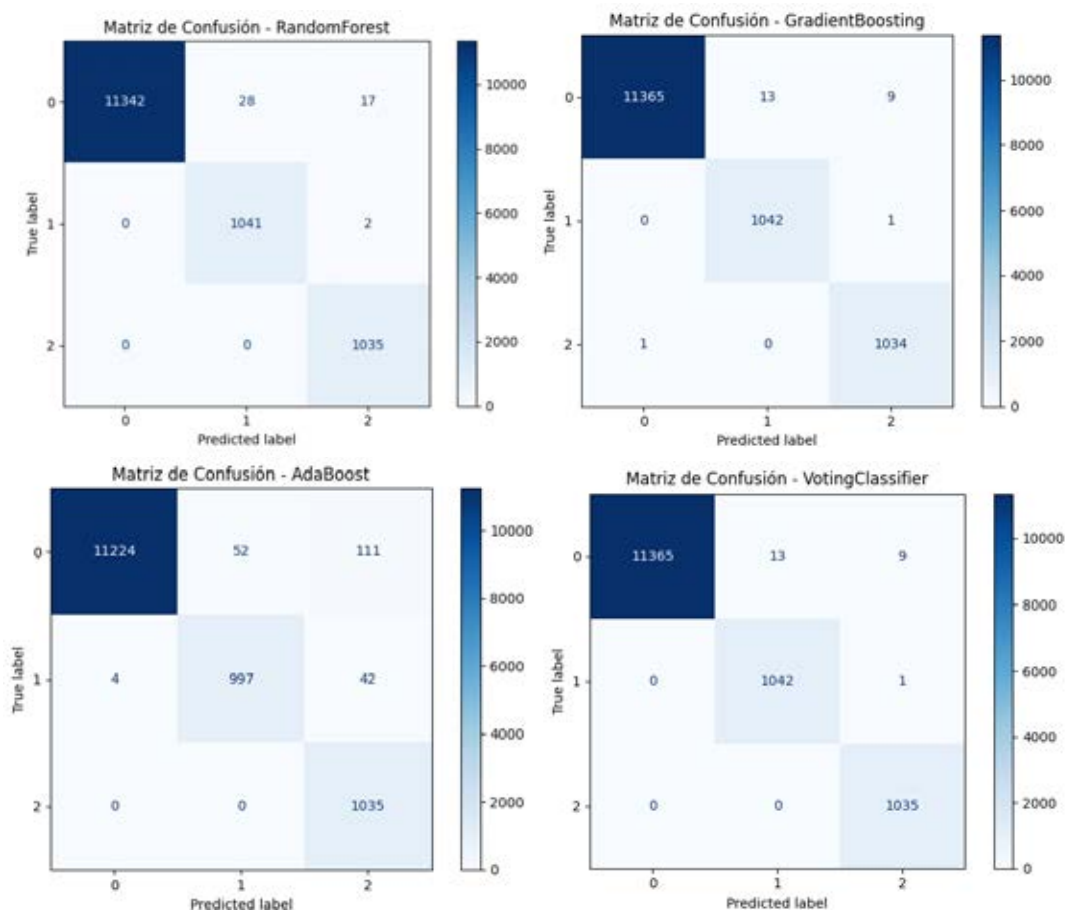
Modelo	Accuracy	Balanced Accuracy	F1 Macro	Precision Macro	Recall Macro	Cohen's Kappa	Matthews Corrccoef	AUC ROC (OVR)	Avg. Precision (PR AUC)
RandomForest	0.9965	0.9980	0.9916	0.9853	0.9980	0.9873	0.9874	1.0	0.9998
GradientBoosting	<b>0.9982</b>	<b>0.9987</b>	<b>0.9957</b>	<b>0.9927</b>	<b>0.9987</b>	<b>0.9935</b>	<b>0.9935</b>	<b>1.0</b>	<b>1.0</b>
AdaBoost	0.9845	0.9805	0.9590	0.9404	0.9805	0.9450	0.9459	0.9997	0.9981
VotingClassifier	<b>0.9983</b>	<b>0.9990</b>	<b>0.9959</b>	<b>0.9927</b>	<b>0.9990</b>	<b>0.9938</b>	<b>0.9938</b>	<b>1.0</b>	<b>0.9999</b>

**Matrices de Confusión**

Las matrices de confusión muestran que GradientBoosting y VotingClassifier son los modelos con mejor desempeño general, presentando apenas 23 errores cada uno y una excelente capacidad para discriminar entre las tres clases de riesgo de morosidad (bajo, medio y alto). RandomForest también demuestra alta precisión, aunque con un leve incremento en errores de clasificación, especialmente en la clase 0. En contraste, AdaBoost es el modelo con menor desempeño relativo, acumulando más errores en las clases 0 y 1, lo que evidencia una menor sensibilidad frente a clases minoritarias, a pesar de clasificar correctamente todos los casos de la clase 2, tal como se observa en la Figura 12.

**Figura 12**

*Matrices de Confusión modelos implementados*

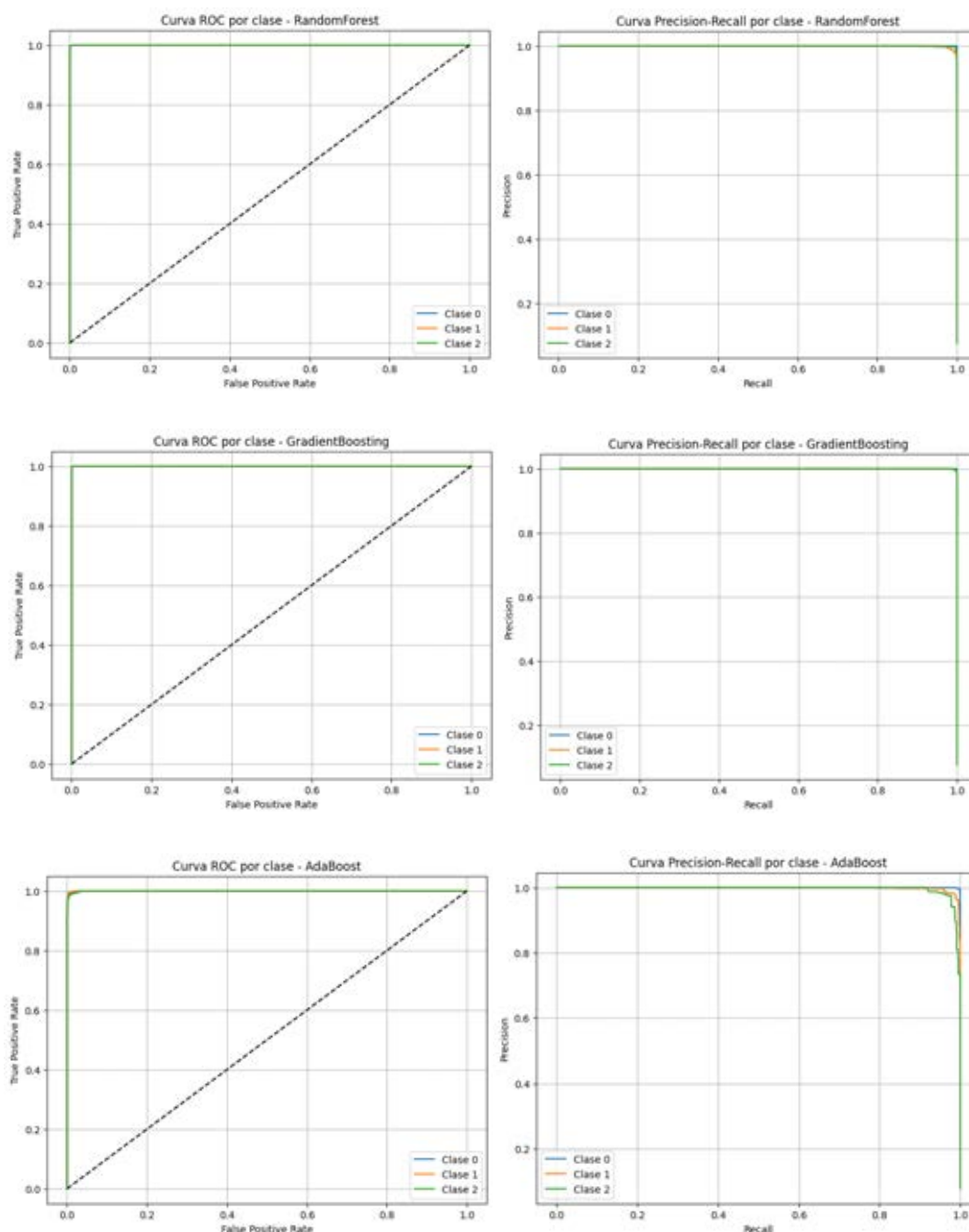


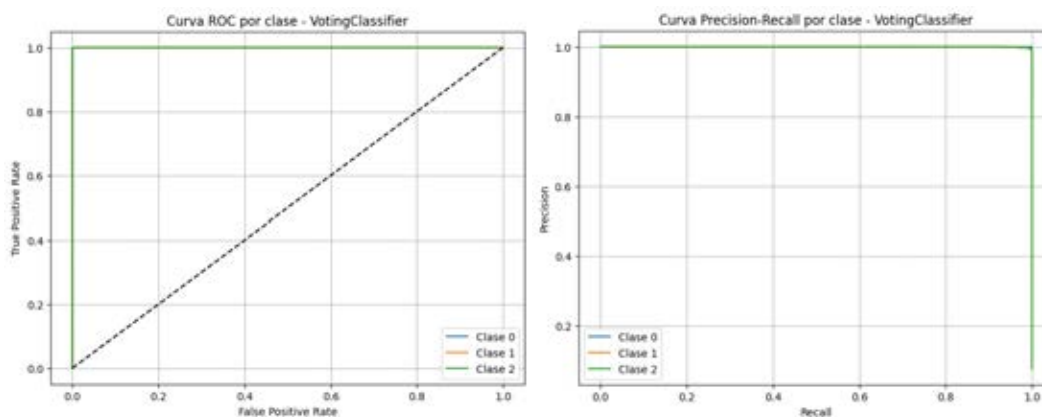
## Curvas Precision-Recall y ROC

Las curvas ROC y Precision-Recall por clase reflejaron un desempeño sobresaliente en todos los modelos evaluados. GradientBoosting y VotingClassifier, cuyos perfiles se mantuvieron próximos al punto ideal, evidenciando una excelente capacidad de discriminación y precisión en la clasificación de las tres clases. RandomForest mostró un comportamiento igualmente sólido, aunque con leves desviaciones en la clase 1. Por su parte, AdaBoost presentó una ligera disminución en la precisión y sensibilidad, particularmente en las clases minoritarias, lo que se tradujo en curvas menos ajustadas al óptimo, como se ilustra en la Figura 13.

Figura 13

*Curva ROC y Curva de Precisión-Recall de los modelos implementados*





## Stress Testing

Los resultados del stress testing demostraron que todos los modelos evaluados mantuvieron un alto rendimiento en el escenario base, destacándose GradientBoosting y VotingClassifier con métricas cercanas a la perfección en precisión, sensibilidad, F1, AUC y PR AUC. Ante escenarios adversos como ruido, reducción de clases y eliminación de datos, GradientBoosting mostró la mayor robustez y consistencia, con caídas mínimas en las métricas clave, mientras que VotingClassifier también mantuvo un desempeño muy alto, aunque con una leve sensibilidad al balance de clases. En contraste, AdaBoost evidenció mayor vulnerabilidad, especialmente en escenarios de reducción de datos o desbalance. En función de estos resultados, GradientBoosting se perfila como el modelo más adecuado para entornos operativos exigentes, donde la precisión y la resiliencia frente a condiciones cambiantes son fundamentales, como se detalla en la Tabla 3.

**Tabla 3**

### *Stress Testing modelos implementados*

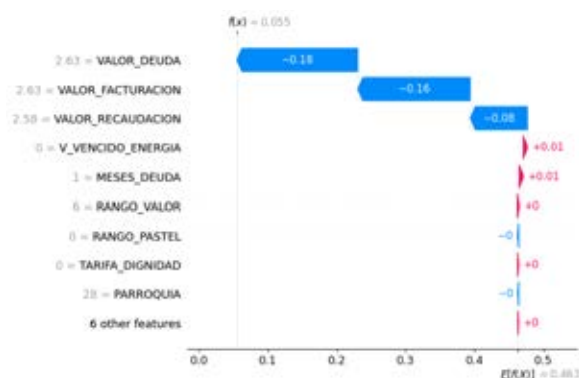
Modelo	Escenario	Accuracy	Balanced Accuracy	F1 Macro	Precisión Macro	Recall Macro	AUC ROC (OVR)	Avg. Precisión (PR AUC)	Observaciones
RandomForest	Base (original)	0,9965	0,998	0,9916	0,9853	0,998	1	0,9998	Desempeño sólido y estable.
GradientBoosting	Base (original)	0,9982	0,9987	0,9957	0,9927	0,9987	1	1	Máxima precisión y robustez.
AdaBoost	Base (original)	0,9845	0,9805	0,959	0,9404	0,9805	0,9997	0,9981	Alta precisión pero menor balance.
VotingClassifier	Base (original)	0,9983	0,999	0,9959	0,9927	0,999	1	0,9999	Desempeño sólido y estable.
RandomForest	Ruido moderado ( $\sigma=0.3$ )	0,9926	0,9939	0,9823	0,9711	0,9939	0,9997	0,9982	Ligeramente afectado por ruido.
GradientBoosting	Ruido moderado ( $\sigma=0.3$ )	0,9952	0,9903	0,9865	0,983	0,9903	0,9999	0,9994	Buena tolerancia al ruido.
AdaBoost	Ruido moderado ( $\sigma=0.3$ )	0,9811	0,9783	0,9517	0,9302	0,9783	0,9995	0,9962	Disminución significativa por ruido.
VotingClassifier	Ruido moderado ( $\sigma=0.3$ )	0,9954	0,9941	0,9885	0,9831	0,9941	0,9999	0,9993	Resistente a ruido con leve pérdida.
RandomForest	Reducción clase 2 al 50%	0,9964	0,998	0,9886	0,9795	0,998	1	0,9997	Pérdida de sensibilidad clase 2.
GradientBoosting	Reducción clase 2 al 50%	0,9982	0,999	0,9943	0,9896	0,999	1	1	Reducción marginal con buena generalización.
AdaBoost	Reducción clase 2 al 50%	0,9839	0,9805	0,939	0,9074	0,9805	0,9997	0,9973	Menor precisión en clase minoritaria.
VotingClassifier	Reducción clase 2 al 50%	0,9982	0,999	0,9943	0,9896	0,999	1	0,9999	Mantuvo desempeño elevado.
RandomForest	Eliminación aleatoria del 40%	0,9965	0,9982	0,9917	0,9854	0,9982	1	0,9998	Afectado por reducción de muestra.
GradientBoosting	Eliminación aleatoria del 40%	0,9984	0,9989	0,9962	0,9936	0,9989	1	1	Estable bajo eliminación aleatoria.
AdaBoost	Eliminación aleatoria del 40%	0,9853	0,9821	0,961	0,9427	0,9821	0,9998	0,9983	Alto impacto por pérdida de datos.
VotingClassifier	Eliminación aleatoria del 40%	0,9984	0,9994	0,9962	0,9931	0,9994	1	0,9999	Alto rendimiento con buena resiliencia.

### Aplicación de técnicas de interpretabilidad de modelos (Explainable AI - XAI)

El análisis SHAP aplicado al modelo VotingClassifier mostró que la predicción individual se ajustó desde un valor esperado de 0.463 a una probabilidad final de 0.055 de morosidad. Las variables que más contribuyeron a esta reducción fueron VALOR\_DEUDA = 2.63 (-0.18), VALOR\_FACTURACION = 2.63 (-0.16) y VALOR\_RECAUDACION = 2.58 (-0.08), todas asociadas a bajos montos que disminuyeron significativamente el riesgo estimado. Otras variables como MESES\_DEUDA = 1, V\_VENCIDO\_ENERGIA = 0 y RANGO\_VALOR = 6 tuvieron un impacto marginal positivo (+0.01 o menor), sin alterar el resultado final. En conjunto, el modelo clasificó correctamente al cliente como No Moroso, basándose en características económicas clave, como se visualiza en la Figura 14.

**Figura 14**

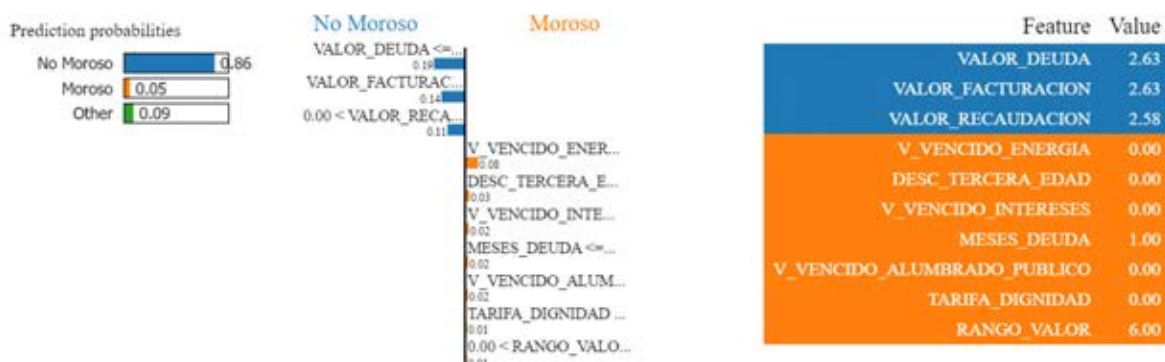
*SHAP aplicado al modelo VotingClassifier*



Así mismo, LIME de VotingClassifier mostró que el cliente fue clasificado como No Moroso con una probabilidad del 86%, frente a un 5% de ser considerado moroso. Las variables que más contribuyeron a esta decisión fueron VALOR\_DEUDA = 2.63 (+0.19), VALOR\_FACTURACION = 2.63 (+0.14) y VALOR\_RECAUDACION = 2.58 (+0.11), todas asociadas a montos bajos que redujeron el riesgo proyectado. En contraste, factores como V\_VENCIDO\_ENERGIA = 0 (+0.08), DESC\_TERCERA\_EDAD = 0 (+0.03) y MESES\_DEUDA = 1 (+0.02) tuvieron un efecto leve hacia la morosidad, pero sin suficiente peso para alterar la clasificación. Esta interpretación confirma la consistencia del modelo al otorgar mayor peso a variables económicas directas en su decisión final, como se muestra en la Figura 15.

**Figura 15**

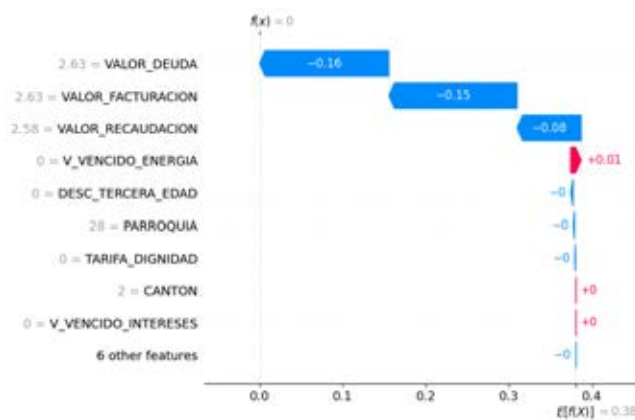
*LIME aplicado al modelo VotingClassifier*



SHAP aplicado al modelo Gradient Boosting indicó que la predicción final fue 0, a partir de un valor esperado del modelo de 0.38, lo que refleja una fuerte inclinación hacia la clasificación de No Moroso. Las variables que más contribuyeron a esta disminución fueron VALOR\_DEUDA = 2.63 (-0.16), VALOR\_FACTURACION = 2.63 (-0.15) y VALOR\_RECAUDACION = 2.58 (-0.08), evidenciando que valores bajos en estos indicadores financieros son determinantes para reducir el riesgo. En contraste, V\_VENCIDO\_ENERGIA = 0 aportó ligeramente a la morosidad (+0.01), pero sin impacto relevante. Otras variables como DESC\_TERCERA\_EDAD, PARROQUIA, CANTON, TARIFA\_DIGNIDAD y V\_VENCIDO\_INTERESES no influyeron significativamente. Esta interpretación muestra que el modelo priorizó información cuantitativa sobre deuda y facturación como factores clave para una decisión confiable, como se representa en la Figura 16.

**Figura 16**

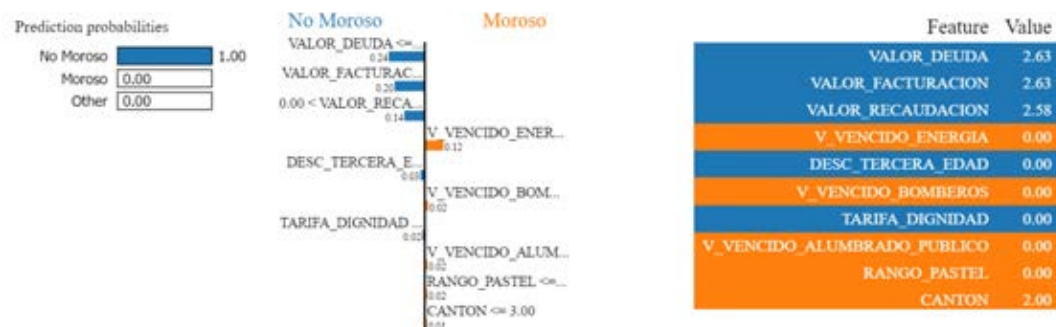
*SHAP aplicado al modelo Gradient Boosting*



Mientras que LIME mostró que el cliente fue clasificado como No Moroso con una probabilidad del 100%. Las variables que más contribuyeron a esta decisión fueron VALOR\_DEUDA = 2.63 (+0.24), VALOR\_FACTURACION = 2.63 (+0.20) y VALOR\_RECAUDACION = 2.58 (+0.14), indicando que estos montos bajos o adecuados tuvieron un peso determinante en la reducción del riesgo proyectado. En contraste, V\_VENCIDO\_ENERGIA = 0.00 (+0.12) fue la única variable con una contribución moderada hacia la morosidad, mientras que otras como DESC\_TERCERA\_EDAD = 0, V\_VENCIDO\_BOMBEROS = 0, CANTON = 2 y RANGO\_PASTEL = 0 mostraron impactos muy bajos (+0.01 a +0.02). Esta explicación confirma que el modelo priorizó los indicadores económicos directos para tomar la decisión, descartando variables estructurales por su escasa influencia en esta observación, como se muestra en la Figura 17.

**Figura 17**

*LIME aplicado al modelo Gradient Boosting*



### Modelo matemático

Finalmente, se propone un modelo matemático formulado para abordar el problema de clasificación multiclase en la predicción del riesgo de morosidad. Este modelo busca proporcionar una base teórica rigurosa que respalde la validación técnica del enfoque implementado y, al mismo tiempo, facilite su replicabilidad en otros entornos operativos con características comparables (Akinjole et al., 2024; Gao & Balyan, 2022; Qin et al., 2021).

- Clase 0 (Riesgo Bajo): Clientes con baja probabilidad de incumplimiento.
- Clase 1 (Riesgo Medio): Clientes con una probabilidad intermedia de incumplimiento.
- Clase 2 (Riesgo Alto): Clientes con alta probabilidad de incumplimiento.

Se define  $X_i \in R^n$  como el vector de características asociadas al cliente  $i$ , donde  $n$  es el número de variables predictoras relevantes (monto de deuda, meses de mora, consumo de energía, tipología tarifaria, entre otras).

Se busca encontrar una función de clasificación multiclase:

$$f: R^n \rightarrow \{0,1,2\}$$

Donde  $y_i = f(x_i)$  representa la clase de riesgo asignada al cliente.

### Estructura del sistema ensemble

El sistema ensemble implementado agrupa  $m$  clasificadores individuales  $f_j$ , cada uno entrenado de manera independiente bajo metodologías basadas en árboles y boosting. Entre estos se encuentran: Random Forest, Gradient Boosting, AdaBoost.

Cada clasificador  $f_j$  produce una probabilidad vectorial sobre las tres clases posibles:

$$p_j(x_i) = [p_j^{(0)}(x_i), p_j^{(1)}(x_i), p_j^{(2)}(x_i)]$$

Donde:

- $p_j^{(k)}(x_i) \in [0,1]$  es la probabilidad de que el cliente  $i$  pertenezca a la clase,  $k \in \{0,1,2\}$  según el clasificador  $j$ ,
- $\sum_{k=0}^2 p_j^k(x_i) = 1$  para cada  $j$  e  $i$ .

### Votación ponderada (Soft Voting Multiclase)

Ensemble integra las predicciones individuales mediante una votación ponderada, asignando un peso  $w_j$  a cada clasificador base, donde  $w_j > 0$  y  $\sum_{j=1}^m w_j = 1$ .

Para cada clase  $k$  la probabilidad agregada es:

$$p^k(x_i) = \sum_{j=1}^m w_j \cdot p_j^k(x_i), \quad k = 0,1,2$$

La asignación de la clase al cliente  $i$  se realiza seleccionando la clase con la probabilidad conjunta máxima:

$$f(x_i) = \operatorname{arg\,max}_{k \in \{0,1,2\}} p^k(x_i)$$

La optimización del ensemble multiclase se realiza minimizando la pérdida logarítmica categórica (categorical cross-entropy):

$$L = -\frac{1}{N} \sum_{i=1}^N \sum_{k=0}^2 \mathbb{I}\{y_i = k\} \cdot \log P^k(x_i)$$

Donde:

- $\mathbb{I}\{y_i = k\}$  es una función indicadora que vale 1 si el cliente  $i$  pertenece a la clase  $k$  y 0 en caso contrario.
- $P^k(x_i)$  es la probabilidad estimada de la clase  $k$  para el cliente  $i$ ,
- $N$  es el total de observaciones en el conjunto de entrenamiento.

### Gradient Boosting Multiclase

Gradient Boosting construye una función de decisión compuesta como suma de árboles de decisión:

$$F^k(x_i) = \sum_{t=1}^T r_t^k h_t^k(x_i) \quad \text{Para } k \in \{0,1,2\}$$

Donde:

- $h_t^k(\cdot)$  es el árbol base número  $t$  especializado de la clase  $k$ ,
- $r_t^k$  es el peso del árbol  $h_t^k$
- $T$  es el número total de iteraciones (boosting rounds).

La función de predicción utiliza la normalización softmax para convertir los scores  $F^k(x_i)$  en probabilidades:

$$P^k(x_i) = \frac{e^{F^k(x_i)}}{\sum_{j=0}^2 e^{F^j(x_i)}}, \quad \text{Para } k = 0,1,2$$

La clase predicha es la que tiene la mayor probabilidad estimada:

$$f(x_i) = \operatorname{arg\,max}_{k \in \{0,1,2\}} p^k(x_i)$$

### Función de Pérdida

El entrenamiento de Gradient Boosting optimiza la función de pérdida categórica (log-loss) sobre  $N$  ejemplos del conjunto de entrenamiento:

$$L = -\frac{1}{N} \sum_{i=1}^N \sum_{k=0}^2 \mathbb{I}\{y_i = k\} \cdot \log P^k(x_i)$$



- $\mathbb{I} \{y_i = k\}$  es una función indicadora que vale 1 si el cliente  $i$  pertenece a la clase  $k$  y 0 en caso contrario.
- $P^k(x_i)$  es la probabilidad estimada de la clase  $k$  para el cliente  $i$ .

### Discusión

El presente estudio permitió identificar el modelo de aprendizaje automático con mayor capacidad predictiva para anticipar el riesgo de morosidad en clientes de CNEL EP Unidad de Negocio Bolívar, a partir de un enfoque metodológico riguroso sustentado en Design Science Research (DSR). Esta perspectiva metodológica facilitó la integración de evidencia empírica con la construcción de un artefacto tecnológico alineado a las necesidades operativas institucionales, identificadas en el Ciclo de Relevancia. La aplicación de DSR resultó adecuada para el contexto de la ingeniería aplicada, al permitir la solución de problemas prácticos mediante la construcción y validación iterativa de artefactos, como señalan Goecks et al., 2021; Gregor, 2021. Asimismo, la relevancia y madurez de este enfoque en entornos organizacionales complejos ha sido ratificada por estudios recientes que reconocen su contribución tanto al desarrollo de conocimiento científico como a la transformación digital de procesos en sectores intensivos en datos (Akoka et al., 2023).

Se evidencia un desempeño sobresaliente del modelo Gradient Boosting, el cual alcanzó métricas cercanas a la perfección (Accuracy: 0.9982; F1 Macro: 0.9957; AUC ROC: 1.000). El modelo VotingClassifier presentó un rendimiento igualmente elevado (Accuracy: 0.9983; F1 Macro: 0.9959; AUC ROC: 1.000). Al comparar estos resultados con hallazgos previos en la literatura, se constata una mejora significativa. (Xu, 2024) reportó para Gradient Boosting un Accuracy del 92% y un AUC de 0.85, mientras que (Lai, 2020) informó un Accuracy del 95.2% y un AUC de 0.94 para XGBoost. Asimismo, (Akinjole et al., 2024) alcanzaron un Accuracy del 93.7% y un AUC de 96.5% utilizando un enfoque ensemble basado en VotingClassifier. Estos antecedentes respaldan la superioridad de los modelos desarrollados en este estudio, particularmente en contextos caracterizados por desbalance de clases y elevada exigencia en capacidad discriminativa.

La aplicación de técnicas de preprocesamiento como SMOTE y PCA resultó fundamental para la mejora del desempeño predictivo. En particular, SMOTE contribuyó significativamente al equilibrio de clases, incrementando la capacidad del modelo para identificar correctamente observaciones pertenecientes a clases minoritarias, como ha sido evidenciado también por (Akinjole et al., 2024), quienes reportan mejoras sustanciales al combinar métodos de sobremuestreo con algoritmos ensemble. Por su parte, el uso de PCA permitió reducir la dimensionalidad del conjunto de datos manteniendo el 90.21% de la varianza explicada, lo cual optimizó la eficiencia computacional sin afectar la precisión, coincidiendo con lo planteado por (Liu et al., 2024), quienes subrayan los beneficios que la transformación basada en árboles aporta al desempeño de los modelos logísticos. Asimismo, la calidad de la segmentación previa al modelado supervisado fue validada mediante un índice de Silhouette de 0.681, reforzando la solidez de las agrupaciones generadas y la pertinencia del enfoque adoptado.

Una limitación relevante del estudio es la falta de validación externa en contextos distintos al conjunto de entrenamiento. Aunque se aplicaron validación cruzada y pruebas de estrés, se requiere contrastar los resultados en otros entornos operativos para confirmar la generalización del modelo, como recomiendan (Alonso Robisco & Carbó Martínez, 2022) en aplicaciones financieras reguladas.

Desde una perspectiva aplicada, los modelos desarrollados presentan un alto potencial para ser integrados como herramientas de apoyo a la toma de decisiones en la gestión de cartera, permitiendo la priorización de intervenciones en función del nivel de riesgo estimado. Para investigaciones futuras, se sugiere evaluar su desempeño en entornos productivos reales, a fin de validar su eficacia operativa. Asimismo, se recomienda la incorporación de técnicas de interpretabilidad, como SHAP o LIME, que faciliten la comprensión de las predicciones individuales, lo cual es particularmente relevante en contextos regulados. Finalmente, se plantea como línea de trabajo futura la exploración de modelos híbridos basados en arquitecturas neuronales o enfoques secuenciales que capturen la dinámica temporal del comportamiento del cliente, siguiendo propuestas recientes como las de (Zhang & Wang, 2023).

En síntesis, la investigación demuestra la viabilidad de adaptar metodologías avanzadas de ciencia de datos al sector eléctrico público, logrando soluciones predictivas precisas, replicables y contextualizadas operativamente. Estos resultados respaldan las metas de sostenibilidad tanto operativa como financiera de CNEL EP, y se relacionan con estudios previos que destacan la efectividad de los modelos ensemble en dominios de riesgo crediticio (Akinjole et al., 2024; Dastile et al., 2020), así como con la aplicabilidad del enfoque de Design Science Research para generar artefactos útiles en contextos reales (Delpont et al., 2024).

### Conclusiones

El presente estudio tuvo como objetivo identificar el modelo de aprendizaje automático más preciso para predecir el riesgo de morosidad en los clientes de CNEL EP, Unidad de Negocio Bolívar enmarcándose en la necesidad institucional de mejorar la sostenibilidad financiera a través de la optimización de la gestión de cartera.

Se aplicaron diversas técnicas de preprocesamiento y modelos de clasificación multiclase, destacando Gradient Boosting y VotingClassifier como los más eficaces. Ambos modelos alcanzaron métricas de desempeño sobresalientes (Accuracy: 0.9982–0.9983; F1 Macro: 0.9957–0.9959; AUC ROC: 1.000) incluso bajo condiciones simuladas de ruido, desbalance y pérdida de datos.

Los resultados refuerzan la validez de aplicar técnicas de aprendizaje automático en contextos distintos al financiero, como el sector eléctrico público. Además, contribuyen al cuerpo de conocimiento al evidenciar que, mediante PCA, SMOTE y modelos ensemble, es posible desarrollar soluciones predictivas robustas y replicables que superan el rendimiento reportado en estudios previos.

Una limitación clave del estudio es la ausencia de validación externa en otros entornos geográficos o temporales. Aunque se realizaron pruebas de estrés y validación cruzada, se recomienda aplicar el modelo en otros contextos reales para evaluar su generalización.

Los modelos propuestos pueden ser integrados como herramientas de apoyo en la gestión comercial de CNEL EP, permitiendo priorizar intervenciones según el riesgo de morosidad. Para investigaciones futuras, se sugiere validar el modelo en tiempo real, incorporar variables temporales y explorar arquitecturas híbridas con redes neuronales que capturen la dinámica del comportamiento del cliente.

Este estudio demuestra la factibilidad de adaptar técnicas avanzadas de ciencia de datos al sector eléctrico público, generando artefactos predictivos precisos y útiles. Su contribución se manifiesta no solo en el fortalecimiento de la gestión operativa de CNEL EP, sino también

en la ampliación del alcance de la inteligencia artificial explicable a contextos no financieros, promoviendo una toma de decisiones más informada y transparente.

### Reconocimientos

Deseo expresar mi más sincero agradecimiento a la Escuela Superior Politécnica de Chimborazo, así como a nuestros docentes, el distinguido Dr. Wilson Gustavo Chango Sailema por su valiosa colaboración y apoyo en la realización de este estudio.

Los autores declaran la contribución y participación equitativa de roles de autoría para esta publicación.

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**Sección Abierta Multidisciplinaria: Ciencia para el Desarrollo**  
**Open Multidisciplinary Section: Science for Development**

# **Agroindustria y Medio Ambiente / Agro-industry and Environment**



## Virulencia de *Phytophthora* sp en brotes de cacao (*Theobroma cacao* L.) a nivel *in vitro*

## Virulence of *Phytophthora* sp in cocoa (*Theobroma cacao* L.) shoots at *in vitro* level

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Enviado: 2024/07/15  
Aceptado: 2025/04/29  
Publicado: 2025/06/30

### Resumen

*Phytophthora* sp. es un fitopatógeno significativo que afecta frutos, tallos, hojas, brotes de cacao (*Theobroma cacao* L.) causando considerables pérdidas en la producción. La caracterización de cepas patógenas es de gran utilidad para optimizar el manejo de la enfermedad. Por esta razón, este estudio tuvo como objetivo evaluar la virulencia de *Phytophthora* sp. en brotes de cacao bajo condiciones controladas de cultivo *in vitro*. Inicialmente se llevó a cabo una caracterización morfológica de los aislados de *Phytophthora*. Posteriormente se inoculó este fitopatógeno en brotes desinfectados de dos variedades de cacao: Nacional fino de aroma y CCN-51, siguiendo un diseño completamente al azar factorial con siete repeticiones, utilizando los brotes como unidades experimentales. Las variables evaluadas incluyeron incidencia, severidad, resistencia y el área bajo la curva del progreso de la enfermedad, las cuales fueron evaluadas diariamente durante cuatro días. La identificación del género *Phytophthora* sp fue realizado mediante la prueba molecular con *primers Internal transcribed spacer* ITS4-ITS6. Los resultados mostraron que la incidencia y severidad en los brotes de cacao Nacional Fino de aroma alcanzaron el 100% cuando fueron infectados con la cepa PP8, evidenciando una alta susceptibilidad a la enfermedad conocida como como mazorca

**Sumario:** Introducción, Materiales y Métodos, Resultados y Discusión, Conclusiones.

**Como citar:** Amaya-Márquez, D., Peñaherrera-Morales, A. & Farah, S. (2025). Virulencia de *Phytophthora* sp en brotes de cacao (*Theobroma cacao* L.) a nivel *in vitro*. *Revista Tecnológica - Espol*, 37(1), 310-320. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1218>

negra. En contraste, los brotes de cacao CCN-51 no presentaron ninguna infección por las cepas evaluadas. Se concluye que la virulencia de *Phytophthora* sp. muestra dependencia específica tanto de la cepa del patógeno como del hospedero. Estos hallazgos resaltan la importancia de considerar la variabilidad fenotípica del patógeno y la resistencia del hospedero para gestionar el manejo fúngico en cultivos de cacao.

**Palabras clave:** Brotes, inoculación, molecular, susceptible, resistencia.

### Abstract

*Phytophthora* sp. is a significant phytopathogen that affects fruits, stems, leaves, and shoots of cocoa (*Theobroma cacao* L.), causing considerable yield losses. The characterization of pathogenic strains is very useful to optimize disease management. For this reason, the objective of this study was to evaluate the virulence of *Phytophthora* sp. in cocoa shoots under controlled in vitro culture conditions. Initially, a morphological characterization of *Phytophthora* isolates was carried out. Subsequently, this phytopathogen was inoculated into disinfected shoots of two cocoa varieties: Nacional fino de aroma and CCN-51, following a completely randomized factorial design with seven replications, using the shoots as experimental units. *Phytophthora* sp. is a significant phytopathogen that affects fruits, stems, leaves, and shoots of cocoa, causing considerable yield losses. The variables evaluated included incidence, severity, resistance, and the area under the disease progress curve, which were evaluated daily for four days. Identification of the genus *Phytophthora* sp was performed through molecular testing using internal transcribed spacer primers ITS4-ITS6. The results showed that the incidence and severity in National Fine aroma cocoa shoots reached 100% when infected with strain PP8, evidencing a high susceptibility to the disease known as black pod. In contrast, CCN-51 cocoa shoots did not show any infection by the strains evaluated. It is concluded that the virulence of *Phytophthora* sp. depends specifically on both the pathogen strain and the host. These findings highlight the importance of considering the phenotypic variability of the pathogen and host resistance to effectively manage fungal diseases in cocoa crops.

**Keywords:** outbreaks, inoculation, molecular, susceptible, resistance.

### Introducción

El género *Phytophthora* es uno de los patógenos fúngicos que afecta gravemente las plantaciones de cacao (*Theobroma cacao* L.) a nivel mundial (Ferrer et al., 2022). En el país, las plantaciones de cacao están expuestas a pérdidas económicas debido a la incidencia de enfermedades que afectan la producción del mismo (Abad et al., 2018); en este sentido, es agravante la situación debido a que se ha reportado recientemente especies más agresivas (*Phytophthora megakarya*) que *P. palmivora* utilizando marcadores moleculares en la caracterización (Ali et al., 2016; Cedeño et al., 2020). La variación poblacional que experimentan los patógenos en la búsqueda adaptativa contra el hospedante, perjudica el manejo de enfermedades en el cacao.

Esta variabilidad patogénica resalta la influencia del patógeno y hospedero en la magnitud del daño, lo que subraya la necesidad de obtener nuevas estrategias para el manejo eficaz de la enfermedad, una de ellas es conocer el comportamiento de *Phytophthora*.

En consecuencia, es importante que los estudios de virulencia no solo se realicen en órganos como frutos, hojas o plantas, se debe explorar el efecto en brotes de cacao (Ali et al., 2016). A pesar de que estudios en variedades de cacao comercial existen, es necesario

profundizar el efecto del tipo patógeno y hospedante para entender el comportamiento del patógeno a nivel local (Ali et al., 2016).

Según Arellano (2023), evaluó la infección de *P. palmivora* en tres variedades de cacao, el cual señaló que la variedad CCN-51 es más susceptible a la afectación por mazorca negra, y entre los menos afectados se encuentra el cacao trinitario. La hipótesis de este estudio plantea que el nivel de afectación inducido por *Phytophthora* sp. puede diferir a nivel fenotípico entre distintos materiales de cacao sometidos a inoculación artificial. En este contexto, se ha demostrado con eficacia que los métodos de patogenicidad permiten evaluar la tolerancia, susceptibilidad o resistencia de los materiales de cacao (Cedeño et al., 2020). Como parte de la investigación, se llevó a cabo una evaluación de la virulencia de la mazorca negra provocada por *Phytophthora* sp. en brotes de cacao bajo condiciones controladas, proporcionando información relevante para el manejo fitosanitario de la enfermedad.

### Materiales y Métodos

El muestreo se realizó en plantaciones de cacao en la provincia de Los Ríos, Ecuador, donde se detectaron síntomas de mazorca negra. A partir de frutos afectados, se aislaron dos cepas pertenecientes al género *Phytophthora* sp. La selección de muestras incluyó tanto mazorcas con necrosis como frutos sanos, los cuales fueron posteriormente trasladados al laboratorio de biotecnología agrícola para su análisis y procesamiento, con el objetivo de caracterizar la patogenicidad del agente causal.

La desinfección de los frutos fue hecha mediante una inmersión inicial en alcohol al 70%, seguida de un tratamiento con hipoclorito de sodio al 2%. Posteriormente, los frutos fueron enjuagados con agua destilada estéril, garantizando la eliminación de posibles contaminantes superficiales y optimizando las condiciones para su análisis microbiológico. Se extrajeron fragmentos de 0.5 cm de la región media tanto de frutos afectados como sanos. Estos fragmentos fueron cultivados en placas Petri que contenían medio PDA (Potato Dextrose Agar), enriquecido con jugo de zanahoria al 5%, con el objetivo de favorecer el desarrollo del patógeno y facilitar su aislamiento para su posterior análisis (Ivors, 2015).

Las placas fueron incubadas a temperatura ambiente 22-28°C durante 3-4 días. Cuando se observaron colonias con características de *Phytophthora* sp. se realizaron subcultivos de puntas de hifas para obtener aislados puros en nuevas placas con el mismo medio de cultivo; Las cepas purificadas fueron conservadas para siguientes análisis. Posterior a cinco y diez días de crecimiento, se evaluó la morfología de las colonias de *Phytophthora* sp., es decir, se observó la forma de las colonias (estrella y color blanco algodonoso) y el tiempo requerido para que el patógeno cubriera toda la superficie de las placas Petri. La identificación del tipo de micelio, esporangios y clamidosporas se realizó mediante tinción de azul de metileno y Lugol, y observación bajo un microscopio óptico a 40x.

La identificación molecular del género *Phytophthora* sp. se hizo utilizando la técnica de Reacción en cadena de la Polimerasa (PCR) con primers ITS4, mediante el uso de primers ITS4 (5'-TCCTCCGCTTATTGATATGC-3') y ITS6 (5'-GAAGGTGAAGTCGTAACAAGG-3'). Para ello, se extrajo ADN de un fragmento de micelio, raspando la superficie de la colonia con un palillo estéril, y se realizó pre-tratamiento de ebullición a 95.9 C. La reacción de PCR se desarrolló con el siguiente máster mix: la mezcla de reacción para la amplificación de ADN incluyó componentes clave en concentraciones específicas. Se empleó ADN en un rango de 1 a 3 ng/μl, acompañado de nucleótidos trifosfatados (dNTP) a una concentración de 200 μM. Los cebadores ITS6 e ITS4, con una concentración inicial de 10 μM, se añadieron en una proporción final de 0.4 μM cada uno. El



búfer de Taq, en una concentración de 10x con 15 mM de MgCl<sub>2</sub>, aseguró un entorno óptimo para la actividad enzimática, mientras que la polimerasa Taq se incorporó a razón de 0.05 u/μl.

Finalmente, se utilizó agua libre de contaminantes para completar el volumen total de reacción, garantizando la eficiencia del proceso de amplificación de regiones ITS del ADN ribosomal (Grünwald, 2011), y se amplió en un termociclador (Bio- Rad) siguiendo el protocolo descrito a continuación: la amplificación en el termociclador siguió una serie de pasos clave para la amplificación eficiente del ADN. Inicialmente, se realizó la fase de desnaturalización a 94°C durante 3 minutos, seguida por ciclos de desnaturalización de 1 minuto a la misma temperatura. Posteriormente, se llevó a cabo 35 ciclos en los que se alternaron la fase de alineamiento a 55°C por 1 minuto y la fase de extensión a 72°C por 1 minuto.

Para concluir, se aplicó una extensión final a 72°C durante 10 minutos, garantizando la completa amplificación del material genético. Posteriormente, las muestras se almacenaron a -20°C hasta su uso, asegurando su estabilidad para análisis posteriores (Grünwald, 2011). La presencia y tamaño de los amplicones se verificaron mediante electroforesis en gel de agarosa al 1% con tinción de SYBR Safe DNA (Invitrogen), y se compararon con un marcador de peso molecular (Mixed DNA Ladder, Bionner).

Los brotes de cacao de las variedades Nacional Fino de Aroma y CCN-51 fueron cortados a una longitud de 6.8 cm y desinfectados con hipoclorito al 5% durante dos minutos, seguido de lavados en agua destilada estéril y secado en papel toalla estéril. Se realizó una herida en forma de equis en la parte media de los brotes usando un bisturí estéril y en las heridas fueron colocados fragmentos de micelio de una colonia esporulada de *Phytophthora sp.* Los brotes inoculados se colocaron en cajas Petri estériles de 90 mm con dos láminas de papel filtro humedecidas para crear una cámara húmeda y se incubaron en oscuridad. La evaluación de la virulencia se realizó diariamente durante cuatro días (Nyassé et al., 1995). A partir del segundo día, posterior a la inoculación, se estimó el porcentaje de daño midiendo la longitud de la necrosis en los brotes. La severidad del daño se evaluó visualmente utilizando una escala cualitativa ordinal: 0) sin síntomas, 1) puntos pequeños de penetración, 2) fusión de las manchas marrones, 3) lesiones grandes con puntos coloreadas marrones oscuros, menora 4 lesiones marrones grandes y extendidas (Nyassé et al., 1998). La resistencia del huésped se midió siguiendo la metodología de Nyassé et al., (1995); además, se estimó el área bajo la curva del progreso de la enfermedad (ABCPE) usando la fórmula de Shaner & Finney (1977).

El experimento utilizó un diseño completo al azar de tipo factorial. El factor A constó de dos aislados del patógeno más un testigo absoluto y el factor B correspondió a variedades de cacao, la unidad experimental fue un brote de cacao, en total siete repeticiones corresponden a tres tratamientos de *Phytophthora sp.* (dos cepas y uno sin inóculo) y el factor B a dos variedades de cacao. Las variables calificaron los supuestos para realizar un análisis estadístico paramétrico, por ello, se emplearon modelos lineales generalizados mixtos y una prueba no paramétrica, utilizando el software libre Infostat versión 2020 y el software R (Di Rienzo et al., 2010).

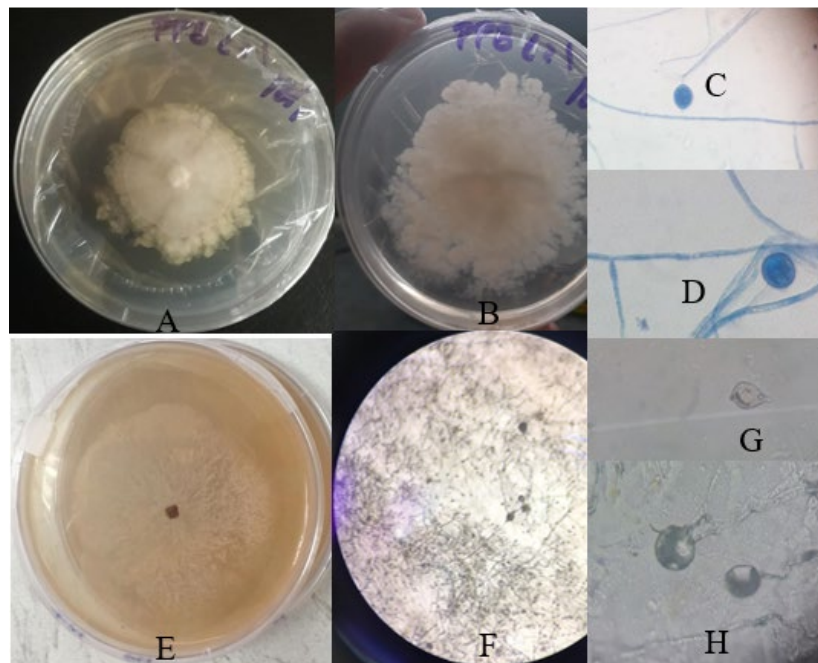
## Resultados y Discusión

Las características morfológicas coincidieron con las esperadas para el género *Phytophthora*, entre las que se menciona micelio algodonoso con apariencia blanca que cubre la superficie de la caja Petri 90 mm en un intervalo de 15 a 18 días. El micelio observado fue de tipo cenocítico con hifas ramificadas. Las papilas se mostraron pronunciadas y el esporangio ovoide y periforme, estos rasgos se atribuyen al género en estudio (Figura 1), esto coincidió

con lo reportado por Erwin & Ribeiro (1996). Además, se identificó clamidosporas de tipo esférica de pared gruesa (Figura 1). Las propiedades mencionadas del patógeno coincidieron con Eden et al. (2020) para especies de *Phytophthora*.

**Figura 1**

*Características morfológicas de aislados de Phytophthora sp*



*Nota:* Colonia de *Phytophthora sp* *in vitro*. La primera fila corresponde a la cepa PP8, segunda fila cepa PPAGR. A, B y D: crecimiento de colonia. C, E y F: Micelio y clamidospora circular. G: Esporangio. H: esporangio y zoospora.

### Caracterización molecular

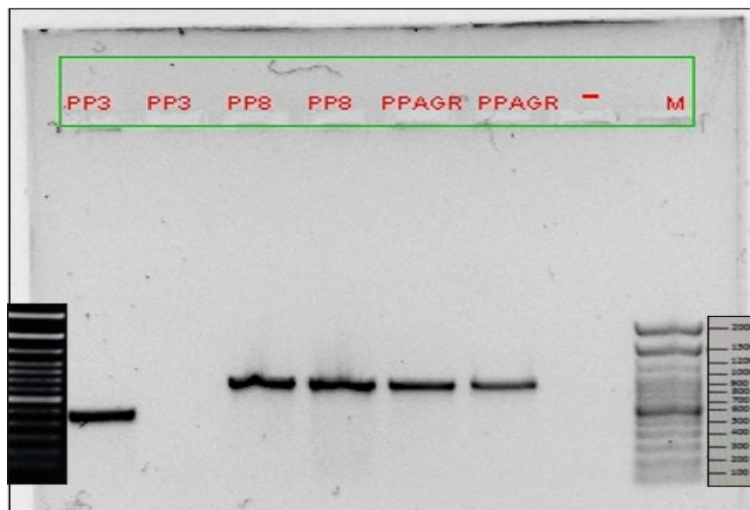
La caracterización molecular mediante la amplificación de la región ITS (*Internal transcribed spacer*) usando *primers* ITS6 e ITS4 permitió obtener fragmentos de ADN de aproximadamente 862 a 941 pares de bases en todas las muestras de *Phytophthora*, excepto en el control negativo (Figura 2). El tamaño de estos fragmentos fue consistente con los reportados previamente para *Phytophthora palmivora* y *P. nicotinae* por Grünwald et al., (2011). También son semejantes a los establecidos por estudios previos realizados por Bowman et al. (2007), así como por Cooke et al. (2000), es decir, se demostró que la amplificación mediante los cebadores ITS6 e ITS4 en la región ITS del ADN ribosomal nuclear de *Phytophthora* permite una identificación precisa del género en muestras analizadas; no obstante, fue fundamental resaltar que la determinación a nivel de especie puede requerir estudios filogenéticos adicionales basados en secuenciación y comparación con bases de datos de referencia; además, se logró producir un producto de PCR característico de *P. palmivora* y *P. nicotinae*, con tamaños aproximados de 900 pb, resultado que fue corroborado recientemente por Latifah et al. (2018), reforzando la validez de esta metodología en la identificación del patógeno.

En el primer gráfico de la Figura 3 se muestra los resultados de la inoculación de patógeno en los brotes de cacao según la incidencia y severidad. En este sentido, la cepa PP8 causó una mayor incidencia y necrosis en el cacao Nacional Fino de aroma en comparación con el CCN-51. El análisis de la severidad externa provocada por *Phytophthora* en brotes de cacao durante un periodo de cuatro días reveló que la interacción entre las cepas (A) y los materiales de cacao (B) tuvo un impacto significativo en la magnitud del daño ( $p < 0.001$ ). En

particular, la cepa PP8 generó una afectación severa en los brotes de cacao a partir del segundo día de evaluación. Asimismo, los brotes de la variedad Cacao Nacional Fino de Aroma fueron los más perjudicados, mostrando una diferencia estadística significativa ( $p < 0.01$ ) en comparación con el testigo absoluto, mientras que la variedad CCN-51 no presentó afectación por ninguna de las cepas evaluadas.

**Figura 2**

*Identificación molecular de Phytophthora palmivora*

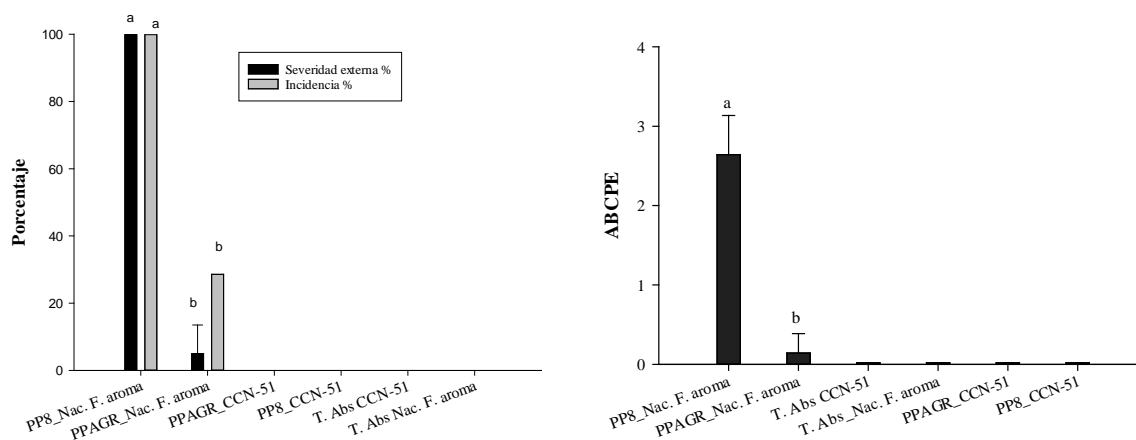


*Nota:* Amplificación por PCR primers ITS6/ITS4 fragmentos 862-941pb en 1% de gel de agarosa. Control negativo (-) PPAGR y PP8= *Phytophthora* PP3= *Fusarium*. M= marcador molecular

En el segundo gráfico de la Figura 3, se observa el área bajo la curva del progreso de la enfermedad con base en el tamaño diario de la necrosis provocada por *Phytophthora* en los brotes de cacao. Esta ecuación establece que valores más elevados en el eje de las ordenadas (Y) corresponden a una mayor superficie afectada en los brotes de cacao, lo que concuerda con los resultados obtenidos en la evaluación de severidad externa. En consecuencia, el aislado PP8 ocasionó el mayor impacto en los brotes de Cacao Nacional Fino de Aroma, con una interacción A×B que mostró una diferencia estadística ( $p < 0.01$ ) altamente significativa.

**Figura 3**

*Evaluación de Phytophthora palmivora en brotes de cacao*



*Nota:* a la izquierda se muestra la severidad externa e incidencia de *Phytophthora* sp. en brotes de cacao, a la derecha el área bajo la curva del progreso de la enfermedad. Letras diferentes señalan diferencias significativas ( $p < 0.01$ ).

El uso de brotes de cacao permitió estimar el grado de afectación que ejerce *Phytophthora*, esto fue similar a lo señalado por Latifah (2018), quien explicó que las hojas desprendidas de cacao ofrecieron información importante en estudios de patogenicidad. Este estudio sostuvo que el tipo de aislado influyó en los alcances de daño en cacao, aunque CCN-51 no mostró perjuicios significativos respecto del cacao Nacional. La no correspondencia estuvo relacionada al nivel de virulencia de los aislados, según estudios, algunas cepas patogénicas expresaron mayor agresividad en ciertos huéspedes de cacao (McMahon y Purwantara, 2004). Estas aseveraciones obedecieron a la variabilidad patogénica también reportada en otros cultivos (Boccas, 1973), así como en huéspedes como coco, cacao y pimienta negra (Slamet, 1991); de tal forma, esta investigación sustentó que debe ser continuo el estudio de fitopatógeno en cacao con el fin de estimar interacciones que aporten al desarrollo de nuevas alternativas de manejo.

La estimación del efecto de patógenos como *Phytophthora* en cacao ha sido evaluado ya por un tiempo (Phillips-Mora y Galindo, 1989), los frutos han sido incluidos como unidad experimental y asperjados con solución de zoosporas. Nyassé et al. (1995) también señalan un estudio mediante la inoculación artificial de *P. palmivora* y *P. megakarya* hojas, ramas no lignificadas con el fin de mediar el nivel de tolerancia a la enfermedad.

En este sentido, los brotes empleados en el presente estudio fueron clave para identificar cultivares de cacao con resistencia a *Phytophthora* sp., al tiempo que permitieron evaluar la virulencia de cepas locales del patógeno, proporcionando información relevante para el manejo fitosanitario de la enfermedad. De acuerdo con estos antecedentes, las plantas, y órganos del cacao pueden responder al efecto de patógenos, este trabajo señaló que al menos uno de los aislados de *Phytophthora* sp fue virulento en brotes de cacao Nacional, mostrando alta susceptibilidad ante el patógeno; por tanto, se aceptó la hipótesis de que existe interacción entre el tipo de aislado y hospedante. Sin bien es cierto este estudio fue llevado a cabo bajo condiciones controladas en laboratorio; sin embargo, dos aislados, dos materiales de cacao y una época de evaluación no fueron suficientes para sostener estos hallazgos, por tanto, se sugiere utilizar brotes similares en tamaño, edad, grosor e incorporar un mayor número de cepas del patógeno y, finalmente, llevar el experimento en condiciones de campo (Latifah, 2018), donde el ambiente natural puede influir en estas aseveraciones (Nyassé et al., 1995).

### Conclusiones

Este estudio determinó que el tipo de aislado de *Phytophthora* sp puede influir en los daños que ejerce el patógeno en brotes no lignificados, los brotes de cacao Nacional fueron muy susceptible a la inoculación según la incidencia y severidad de la infección causado por el patógeno conocido como mazorca negra. Los brotes pueden ser usados para explorar el alcance de la enfermedad a través de la técnica de inoculación dirigida con micelio y determinar de forma rápida la tolerancia de genotipos de cacao.

### Reconocimientos

Se agradece a la Universidad Agraria del Ecuador por las instalaciones facilitadas para hacer posible la investigación.

Los autores declaran que autor D.A. gestionó el financiamiento y todos los autores tuvieron una contribución y participación equitativa de los demás roles de autoría para esta publicación.

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## Evaluación de la incidencia de insectos plaga en el cultivo de arroz (*Oryza sativa* L.) en el cantón Nobol en la provincia del Guayas, Ecuador

### Evaluation of the incidence of insect pests in rice (*Oryza sativa* L.) cultivation in Nobol canton, Guayas Province, Ecuador

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Enviado: 2025/04/06  
Aceptado: 2025/06/16  
Publicado: 2025/06/30

#### Resumen

El arroz (*Oryza sativa* L.) es uno de los cereales de mayor consumo a nivel mundial, con alta relevancia socioeconómica en Ecuador, constituyéndose así en un cultivo fundamental. Los insectos plaga representan una amenaza significativa para esta plantación, por lo que su identificación es esencial para el desarrollo de estrategias de manejo más efectivas. El objetivo de la presente investigación fue identificar las especies de insectos plaga y evaluar su incidencia, riqueza y abundancia en el cultivo de arroz en el cantón Nobol, provincia del Guayas. Se reconocieron siete especies plaga: *Hydrellia* sp., *Tagosodes orizicolus*, *Spodoptera*

**Sumario:** Introducción, Materiales y Métodos, Resultados y Discusión, Conclusiones.

**Como citar:** Farah, S., Bajaaná, M., Andrade, P., Macias, O., Calle, K. & Sanchez, L. (2025). Evaluación de la incidencia de insectos plaga en el cultivo de arroz (*Oryza sativa* L.) en el cantón Nobol en la provincia del Guayas, Ecuador. *Revista Tecnológica - Espol*, 37(1), 321-331.  
<https://rte.espol.edu.ec/index.php/tecnologica/article/view/1305>

*frugiperda*, barrenador *Rupella albinella* y *Diatraea saccharalis*, *Tibraca limbativentris* y *Oebalus* sp. La mayor incidencia se registró durante la etapa vegetativa del cultivo (40 a 70 días posterior al trasplante). El índice de diversidad de Menhinick (0,40) evidenció una baja riqueza específica, mientras que el índice de dominancia de Simpson (0,23) indicó una distribución equitativa entre las especies, sin presencia de una plaga dominante. Estos hallazgos constituyen una base para la implementación de programas de monitoreo y control fitosanitario ajustados a la dinámica fenológica del cultivo.

**Palabras clave:** agroecosistema arrocerero, entomofauna, fenología del cultivo, manejo integrado de plagas.

### Abstract

Rice (*Oryza sativa* L.) is one of the most widely consumed cereals worldwide and holds high socioeconomic importance in Ecuador, making it a key crop. Insect pests represent a significant threat to rice cultivation, and their identification is essential for developing more effective management strategies. The objective of this research was to identify insect pest species and evaluate their incidence, richness and abundance in rice crop in Nobol canton, Guayas province. Seven pest species were identified: *Hydrellia* sp., *Tagosodes orizicolus*, *Spodoptera frugiperda*, *Rupella albinella* and *Diatraea saccharalis*, *Tibraca limbativentris* and *Oebalus* sp. The highest incidence was recorded during the vegetative stage of the crop (40 to 70 days after transplanting). The Menhinick diversity index (0.40) showed low specific richness, while the Simpson dominance index (0.23) indicated an even distribution among species, with no dominant pest present. These findings provide a basis for implementing phytosanitary monitoring and control programs tailored to the phenological dynamics of the crop.

**Keywords:** rice agroecosystem, entomofauna, crop phenology, integrated pest management.

### Introducción

El arroz (*Oryza sativa* L.) es un cereal perteneciente a la familia de las gramíneas, cultivado como una planta anual en diversas regiones del mundo bajo condiciones ambientales tropicales y templadas (Pérez et al., 2023). Es uno de los cereales más consumidos a nivel mundial por su alto valor nutricional y contenido calórico. Para muchas naciones la producción del cultivo del arroz constituye un rubro fundamental en el desarrollo socio económico de la población, al generar ingresos a través de diversas actividades ligadas al proceso productivo (Helfgott et al., 2020).

En el caso de Ecuador, el arroz constituye uno de los alimentos básicos de la dieta nacional, siendo cultivado durante todo el año bajo dos sistemas principales: secano y riego. En el sistema de riego, se emplea infraestructura hidráulica para asegurar la disponibilidad de agua; en cambio, el sistema de secano depende de las precipitaciones estacionales, por lo que la siembra se sincroniza con el inicio de las lluvias (Cadena et al., 2021; Farah et al., 2022). En el año 2023, en el Ecuador se registraron 358.231 hectáreas cultivadas de arroz, siendo la provincia del Guayas, específicamente el cantón Daule la principal zona productora (SIFA, 2024).

El cultivo de arroz prospera en climas húmedos y cálidos, condiciones que también favorecen la proliferación de organismos plaga. Se entiende por plaga agrícola a cualquier organismo cuya presencia cause pérdidas económicas, abarcando insectos fitófagos, patógenos (virus, bacterias, hongos), nematodos, malezas y vertebrados (FAO, 2016; Moraleso y Zamora, 2023). Las pérdidas causadas por estos organismos en arroz pueden superar el 34% del

rendimiento, siendo los insectos plaga responsables de aproximadamente el 12% de las pérdidas, afectando al cultivo en diversas etapas de su desarrollo (Junaid y Gokce, 2024; Soundararajan, 2020).

En Ecuador, además de insectos, se consideran plagas importantes a los caracoles, roedores y aves debido al daño que provocan en los cultivos (Medina et al., 2021; Pérez et al., 2018). Por ello, la identificación y el manejo oportuno de estos organismos resulta necesario para asegurar la productividad y sostenibilidad del sistema agrícola (Caldas et al., 2020).

Los insectos plaga afectan diferentes partes de la planta de arroz, semillas, plántulas, raíces, tallos, hojas, flores y granos, generando daños de variada intensidad (Arias, 2021; Farah et al., 2022). En los agroecosistemas arroceros se encuentran tanto insectos dañinos como benéficos (Ghiglione et al., 2021). Entre los principales fitófagos reportados están los succionadores de savia como *Tagosodes oryzicolus* Müir, *Oebalus ornatus*, *Tibraca limbativentris* (Sánchez et al., 2023; Sánchez y Vélez 2022), los barrenadores de tallo como *Diatraea saccharalis*, *Rupella albinella* y *Spodoptera frugiperda* (Lizondo et al., 2021; Vivas y Astudillo, 2022); y la mosca minadora *Hydrellia* sp. que forma galerías en el interior de las hojas (Caldas et al., 2020).

Una vigilancia de forma continua de las amenazas que afectan los cultivos de arroz es esencial para garantizar un control fitosanitario efectivo (Obregón et al., 2021). Identificar los insectos y entender sus hábitos alimenticios, así como el tipo de daño que infligen a las plantas, su fase de ataque durante el crecimiento del cultivo y la temporada en que aparecen es esencial para gestionar y controlar de manera eficaz los insectos fitófagos (Laguna et al., 2023). Esta comprensión permite una administración óptima y eficiente de estos insectos, promoviendo una producción agrícola más efectiva y rentable (Cuevas y Pérez, 2018).

Así mismo, el monitoreo y la identificación se llevan a cabo de manera sistemática, permitiendo distinguir entre los insectos dañinos y aquellos que actúan como controladores naturales (Cruz y Garay, 2024). Esta información permite establecer estrategias de control en el momento adecuado, reduciendo así las pérdidas en las plantaciones de arroz, enfocándose en observar la presencia, distribución y el daño causado, lo que a su vez ayuda en la toma de decisiones durante el cultivo. El objetivo es implementar medidas de control efectivas y eficientes sin perjudicar el cultivo, el entorno o a otros artrópodos, lo que a su vez contribuye a reducir o evitar el uso excesivo de insecticidas (Pérez et al., 2018).

Los hábitos en el comportamiento de los insectos plaga en las plantas cultivadas son característicos de cada especie. En general pueden estar presentes en especies vegetales específicas y causar daños en estados fenológicos particulares, de igual manera, la incidencia y las poblaciones de los insectos plaga pueden variar de acuerdo con las condiciones climáticas, la época de siembra, la fase vegetativa de la planta y la variedad del vegetal. (Imarhiagbe et al., 2023; Jindo et al., 2021).

La riqueza de los organismos en un ecosistema representa de forma directa y sencilla la definición de la biodiversidad, enfocándose en la cantidad de especies que se encuentran presentes, dejando de lado la influencia relativa de cada una de ellas dentro del ecosistema en estudio (Dagatti et al., 2024). Dentro del aspecto ecológico, la abundancia de un organismo en un ecosistema se refiere a un componente esencial de la biodiversidad, ya que se manifiesta qué tan frecuente o infrecuente puede llegar a ser una especie cuando es comparada con otras dentro de una comunidad biológica o en una ubicación específica. La abundancia relativa se puede expresar como un porcentaje del total de organismos en un área determinada, siendo en

este caso el 100% el que representa la totalidad de los organismos que se encuentran en esa área (Flota et al., 2024; Loáisiga y Jiménez, 2022).

Comprender la dinámica poblacional de la entomofauna permite diseñar estrategias de manejo integrado que sean sostenibles y respetuosas con el medio ambiente (Martins et al., 2019; Hernández et al., 2022). En este contexto, el objetivo de la presente investigación fue analizar la incidencia de los insectos plaga en las diferentes etapas fenológicas del cultivo de arroz en el cantón Nobol, provincia del Guayas, Ecuador.

### **Materiales y Métodos**

La investigación se realizó en la zona arrocerá de Petrillo, ubicada en el cantón Nobol, provincia del Guayas, Ecuador. Esta zona representa un entorno característico de producción de arroz en condiciones tropicales, con alta humedad y temperaturas favorables para el desarrollo del cultivo y la proliferación de insectos plaga. La zona se caracteriza por una temperatura media anual de alrededor de 24°C con humedad relativa de 75% o superior.

El estudio fue de carácter descriptivo, enfocado en la evaluación de la incidencia y diversidad de insectos plaga presentes durante el ciclo fenológico del cultivo de arroz (*Oryza sativa* L.); para ello, se recolectaron especímenes mediante métodos directos e indirectos, y se aplicaron herramientas taxonómicas y fórmulas ecológicas para estimar su riqueza y abundancia.

La obtención de los datos se realizó mediante la captura o trapeo de los especímenes durante todo el ciclo del cultivo, desde los 10 días después del trasplante (DDT) hasta la madurez fisiológica, con un total de ocho monitoreos de arroz en sus diferentes etapas fenológicas a intervalos quincenales. Se emplearon dos métodos de captura. El primero fue captura indirecta (sin operador) (Ruiz et al., 2021), para esto se utilizó trampas de tipo cromática (amarillas) colocadas en el campo, las cuales fueron revisadas de forma periódica (García, 2021; Gutiérrez et al., 2023). El segundo método de captura fue el directo (con operador), (López et al., 2022). Se aplicaron tres técnicas: red entomológica, barrido doble en áreas seleccionadas, (Castillo et al., 2021), succionador o aspirador entomológico para la captura de los insectos de pequeño tamaño mediante succión (Khanal et al., 2021), además, se realizó la captura manual directa con pinzas (Figura 1).

Los especímenes recolectados fueron depositados en frascos de vidrio o plástico con alcohol al 70% para su preservación. En el caso de adultos de lepidópteros, se utilizaron triángulos de papel para evitar daños estructurales que dificulten su identificación (Márquez et al., 2022).

En laboratorio, los especímenes fueron preparados mediante técnicas de montaje adecuadas para facilitar su observación con estereomicroscopio (Pittman, 2022; Villagrán et al., 2021). En el proceso de la identificación de los insectos se utilizaron claves taxonómicas, dicotómicas, guías entomológicas, artículos científicos, colecciones de referencia, así como la colaboración de especialista en entomología agrícola.

Para el análisis de la incidencia y poblaciones de los insectos plaga en el cultivo en la presente investigación se emplearon expresiones matemáticas con el fin de evaluar la riqueza y abundancia de insectos colectados durante el periodo previsto.

**Figura 1***Trampeo y colecta de insectos plaga en el cultivo de arroz*

Con el fin de determinar la riqueza se implementó el índice de diversidad de Menhinick, el cual se obtiene del resultado de la división del número total de especies presentes para el número total de individuos encontrados en un lugar determinado. El índice determina que mientras mayor es el número de especies de insectos, mayor es la riqueza de estas especies (Manzanilla et al., 2020). Para ello, se utilizó la siguiente fórmula:

$$D_{Mn} = \frac{S}{\sqrt{N}}$$

Donde:

- $D_{MH}$  = índice de diversidad de Menhinick
- $S$  = número de especies
- $N$  = número total de individuos

La abundancia de especímenes se refiere a la cantidad de individuos de una especie específica en un lugar determinado. Para establecer la abundancia se utilizó el índice de Dominancia de Simpson, que evalúa cuán dominante o diversa es la especie con mayor valor en el sitio; si el índice es alto significa que el número de especies es muy común en el área de estudio, y si es bajo las especies están distribuidas de forma equitativa (Manzanilla et al., 2020). Para determinar la abundancia se utilizó la siguiente fórmula:

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

Donde:

- $D$  = índice de Simpson
- $n$  = número total de organismos de una especie
- $N$  = número total de organismos de todas las especies.

## Resultados y Discusión

Durante el monitoreo entomológico realizado en el cultivo de arroz en la zona de Petrillo, cantón Nobol provincia del Guayas, se capturaron e identificaron siete especies de insectos plaga asociadas a distintas etapas fenológicas del cultivo. Estas especies fueron *Hydrellia* sp. (minador de la hoja), *Tagosodes oryzicola* (sogata), *Rupella albinella* (novia del arroz) y *Diatraea saccharalis* (barrenador del tallo), *Tibraca limbativentris* (chinche de la pata) y *Oebalus* sp. (el chinche de la espiga), estas se presentan en diferentes etapas fisiológicas del cultivo. La mayor incidencia se observó entre los 40 y 70 días después del trasplante (DDT), coincidiendo con la fase vegetativa. La especie con mayor número de individuos fue la *Tagosodes oryzicola*, especialmente entre los 25 y 55 DDT, seguida de la *Hydrellia* sp. en etapas iniciales (10–25 DDT) y la *Rupella albinella* en la etapa vegetativa avanzada (Tabla 1).

**Tabla 1**

*Insectos plaga en el cultivo del arroz en el cantón Nobol, Ecuador*

Especies	MONITOREOS								TOTAL
	10 <sup>1</sup> DDT	25 DDT	40 DDT	55 DDT	70 DDT	85 DDT	100 DDT	115 DDT	
<i>Hydrellia</i> sp.	27	20	10	2	0	0	0	0	59
<i>Tagosodes oryzicola</i>	15	22	27	35	11	1	0	0	111
<i>Spodoptera frugiperda</i>	5	4	0	0	0	0	0	0	9
<i>Rupella albinella</i>	0	0	5	10	25	18	0	0	58
<i>Diatraea saccharalis</i>	0	0	2	3	6	1	0	0	12
<i>Tibraca limbativentris</i>	0	0	3	6	5	0	0	0	14
<i>Oebalus</i> sp.	0	0	0	0	4	20	14	11	49

Nota: <sup>1</sup>Días después del trasplante

Estos datos muestran una clara variación en la aparición y distribución de las especies en función del desarrollo del cultivo. La etapa vegetativa (40 a 70 DDT) fue crítica por la elevada presencia de especies fitófagas de importancia económica como la *R. albinella* y *D. saccharalis*, mientras que en las fases más avanzadas prevaleció la *Oebalus* sp., afectando principalmente la espiga del arroz.

### Incidencia y distribución temporal de los insectos plaga

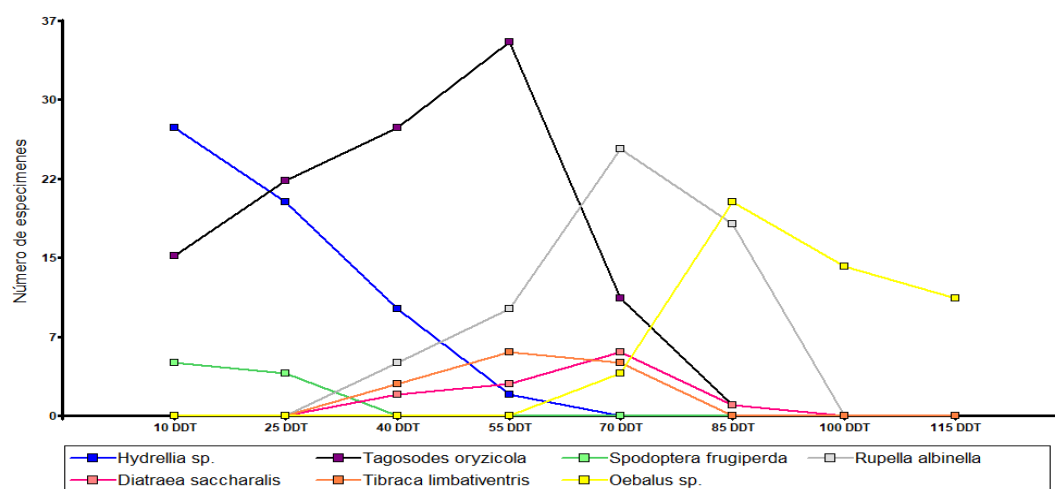
La Figura 2 muestra la distribución temporal de las especies plaga a lo largo del ciclo del cultivo. Desde los 10 hasta los 115 días después del trasplante (DDT). Se observa una distribución diferenciada por especie, reflejando patrones temporales que pueden guiar el monitoreo y control de plagas. En la etapa inicial (10–25 DDT) predominó *Hydrellia* sp., con un descenso drástico después de los 40 DDT, lo que indica su preferencia por el estado vegetativo temprano, donde las hojas tiernas son más susceptibles al minado. Durante este mismo periodo, se registraron los picos más altos de *Tagosodes oryzicola*, insecto succionador de savia que afectó principalmente entre los 25 y 55 DDT, coincidiendo con la fase de máximo desarrollo foliar.

La etapa vegetativa intermedia y avanzada (40–70 DDT) fue la etapa más crítica en términos de diversidad e incidencia. Aquí se evidenció el aumento de especies de lepidópteros barrenadores como *Rupella albinella* y *Diatraea saccharalis*, cuyos daños estructurales en tallos impactan directamente el transporte de nutrientes y la estabilidad del cultivo. En este mismo periodo se identificó *Tibraca limbativentris*, chinche de la pata, que produce lesiones mecánicas en tallos y vainas. En la etapa reproductiva y de llenado de grano (85–115 DDT), la especie predominante fue la *Oebalus* sp., también conocida como chinche de la espiga, cuya acción directa sobre el grano afecta el rendimiento y la calidad del producto cosechado.

Estos resultados coinciden con lo reportado por Sánchez y Vélez (2022), quienes identificaron a *Hydrellia* sp. y *T. oryzicola* como especies frecuentes en las fases iniciales, y a *R. albinella* y *D. saccharalis* como principales plagas en la fase vegetativa (Lizondo et al., 2021; Vivas y Astudillo, 2022). En la fase reproductiva, la *Oebalus* sp. fue destacada por Demera et al. (2023) como una plaga clave por su impacto en el grano. De acuerdo con el estudio de Sánchez et al. (2023), la distribución espacial de la población de insectos está en dependencia de las etapas fenológicas del cultivo del arroz, los resultados mostraron la preferencia de las especies fitófagos en fases fenológicas y órganos específicos del vegetal para su alimentación, a excepción de la *T. oryzicola*, la cual mostró un comportamiento diferente atacando en varias etapas fenológicas del cultivo.

**Figura 2**

*Incidencia de insectos plaga en el cultivo de arroz*



### Riqueza de insectos plaga

Se identificaron siete especies con un total de 312 individuos, resultando en un índice DMH de 0,40, lo que indicó baja riqueza específica. Estos resultados difieren del estudio realizado por Ghiglione et al. (2021), este valor contrasta con lo reportado por Ghiglione et al. (2021), quienes encontraron una mayor diversidad funcional en agroecosistemas arroceros, incluyendo insectos benéficos como depredadores, parasitoides y descomponedores (Tabla 2).

**Tabla 2**

*Riqueza de insectos plaga en el cultivo del arroz*

Ordenes	Número de especies	Número de especímenes	DMH*
<i>Hydrellia</i> sp.	1	59	
<i>Tagosodes oryzicola</i>	1	111	S/√N
<i>Spodoptera frugiperda</i>	1	9	
<i>Rupella albinella</i>	1	58	7/√312
<i>Diatraea saccharalis</i>	1	12	
<i>Tibraca limbativentris</i>	1	14	
<i>Oebalus</i> sp.	1	49	
		312	0.40

Nota: \*Índice de diversidad de Menhinick

Este valor se considera bajo, ya que un DMH inferior a 1 sugiere que el sistema presenta poca variedad específica en relación con la cantidad de individuos registrados. Esta baja

diversidad puede estar asociada a la homogeneidad del sistema productivo, al uso de prácticas convencionales que favorecen especies generalistas, o a condiciones ambientales que limitan la colonización por parte de otros grupos funcionales.

En contraste, estudios como el de Ghiglione et al. (2021) reportaron una mayor riqueza y diversidad funcional en agroecosistemas arroceros más complejos, con presencia simultánea de insectos fitófagos, polinizadores, depredadores y parasitoides. Esto resalta la importancia de considerar prácticas agrícolas más sostenibles que favorezcan la biodiversidad funcional.

### Abundancia y dominancia de insectos plaga

La abundancia relativa y dominancia de especies se observa en la Tabla 3. El valor obtenido fue de 0,23, lo cual indica baja dominancia y una distribución relativamente equitativa entre las especies. Aunque la *T. oryzae* representó el 36% de los individuos recolectados, no alcanzó niveles de dominancia absoluta. En sistemas productivos manejados como monocultivos la aplicación calendarizada de insecticidas sintéticos favorece a pocas especies; al desarrollar resistencia las poblaciones prevalecen constantes en el tiempo. Esto contrasta con lo informado por Laguna et al. (2024), quienes reportaron dominancia de esta especie en sistemas arroceros intensivos.

Estos resultados reflejan una comunidad entomológica de baja especialización en cuanto a dominancia, posiblemente influenciada por factores agroecológicos locales y prácticas de manejo que limitan la proliferación excesiva de una sola especie (Hernández et al., 2022; Loáisiga y Jiménez, 2022).

**Tabla 3**

*Abundancia de insectos plaga en el cultivo del arroz*

Insecto plaga	Número de especímenes	Abundancia relativa (pi)	pi <sup>2</sup>
<i>Hydrellia</i> sp.	59	0.19	0.04
<i>Tagosodes oryzae</i>	111	0.36	0.13
<i>Spodoptera frugiperda</i>	9	0.03	0.00
<i>Rupella albinella</i>	58	0.19	0.03
<i>Diatraea saccharalis</i>	12	0.04	0.00
<i>Tibraca limbativentris</i>	14	0.04	0.00
<i>Oebalus</i> sp.	49	0.16	0.02
	312	<sup>1</sup> D	0.23
		<sup>2</sup> 1-D	0.77

Nota: <sup>1</sup>Índice de dominancia de Simpson, <sup>2</sup>Índice de diversidad de Simpson.

### Conclusiones

La incidencia y distribución de insectos plaga en el cultivo de arroz en el cantón Nobol evidencian una estructura comunitaria de baja riqueza y dominancia, con mayor presión entomológica durante la etapa vegetativa, lo que resalta la necesidad de implementar estrategias de manejo integrado enfocadas en ventanas fenológicas críticas, para optimizar la eficacia del control y reducir el uso indiscriminado de insecticidas.

### Reconocimientos

El presente trabajo se basa en el proyecto de investigación desarrollado por la Srta. Mirlen Selena Bajaña Carpio, como parte de los requisitos para la obtención del título de Ingeniera Agrónoma en la Universidad Agraria del Ecuador. Los datos y contenidos utilizados



fueron empleados con la debida autorización de la autora, a quien se agradece su valiosa contribución al presente estudio.

Los autores declaran la contribución y participación equitativa de roles de autoría para esta publicación.

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## Elaboración de helado de Morete (*Mauritia flexuosa* L.f.) con adición de suero lácteo

## Production of Morete (*Mauritia flexuosa* L.f.) ice cream with whey addition

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Enviado: 2025/03/31  
Aceptado: 2025/06/18  
Publicado: 2025/06/30

### Resumen

En la industria láctea se excluyen enormes cantidades de suero lácteo, generalmente vertido a modo de residuo, su contenido nutricional, le confiere un interés en ser utilizado como un sustituto en la elaboración de alimentos. Este estudio tiene como objetivo desarrollar un helado a base de la pulpa de Morete (*Mauritia flexuosa* L.f.) con el empleo de suero lácteo en la sustitución parcial de leche entera. En la fase experimental se realizaron cinco formulaciones con distintas concentraciones de suero (0%, 25%, 50%, 75% y 100%). El análisis sensorial se llevó a cabo con 50 panelistas utilizando una escala hedónica de cinco puntos que permitió evaluar el color, el sabor, la textura y el aroma del helado. La fórmula con mayor aceptación sensorial fue el helado con 75% de suero lácteo donde el sabor presentó una valoración de 2, la textura 4, el color y aroma de 3. La caracterización fisicoquímica y microbiológica fueron evaluadas de las formulaciones que obtuvieron mayor puntaje en el análisis sensorial. Este

**Sumario:** Introducción, Materiales y Métodos, Resultados y Discusión, Conclusiones.

**Como citar:** Echeverría, M., Cahajuishca, C., Chavez, B. & Ortega, A. (2025). Elaboración de helado de Morete (*Mauritia flexuosa* L.f.) con adición de suero lácteo. *Revista Tecnológica - Espol*, 37(1), 332-347. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1301>

estudio respalda la viabilidad de utilizar suero lácteo a pesar de que la calidad nutricional del helado se vio disminuida al adicionar suero lácteo; sin embargo, la inclusión de pulpa de Morete compensó en parte la pérdida de algunos nutrientes. Los análisis microbiológicos demostraron que el helado cumplió con los estándares de la NTE INEN 0706 2013 en seguridad alimentaria, independientemente del porcentaje de suero lácteo utilizado. Esta propuesta puede ser una opción beneficiosa y prometedora para amenorar el impacto ambiental de este tipo de industria al mejorar la eficiencia del proceso de producción con el uso de un residuo lácteo.

**Palabras clave:** análisis de aceptación, helado, Morete (*Mauritia flexuosa* L.f.), suero lácteo.

### Abstract

In the dairy industry, large quantities of whey are discarded and usually treated as waste. However, due to its nutritional content, whey is of interest as a substitute ingredient in food production. This study aims to develop an ice cream made from Morete pulp (*Mauritia flexuosa* L.f.) by partially replacing whole milk with whey. During the experimental phase, five formulations were prepared with different concentrations of whey (0%, 25%, 50%, 75% and 100%). Sensory analysis was carried out with 50 panelists using a five-point hedonic scale to evaluate the color, flavor, texture, and aroma of the ice cream. The formulation with the highest sensory acceptance was the one with 75% whey, in which flavor received a score of 2, texture 4, and both color and aroma 3. Physicochemical and microbiological characterization was conducted on the formulations with the highest scores in the sensory analysis. The study supports the feasibility of using whey despite a decrease in the nutritional quality of the ice cream due to this addition. However, the inclusion of Morete pulp partially compensated for the loss of certain nutrients. Microbiological analyses showed that the ice cream met the NTE INEN 0706 2013 food safety standards, regardless of the percentage of whey used. This proposal presents a beneficial and promising alternative to reduce the environmental impact of the dairy industry by improving production efficiency through the use of a dairy by-product.

**Keywords:** acceptance analysis, ice cream, Morete (*Mauritia flexuosa* L.f.), whey.

### Introducción

La selva amazónica representa un 48 % del territorio nacional de las cuales el 15 % del área es ocupada por frutas exóticas que sorprende a la mayoría de las personas que la visitan por su extraordinaria diversidad (Álvarez, 2012), lográndose identificar 67 especies frutales nativas como fuente de alimento o de uso medicinal por parte de los pueblos aborígenes. Por otra parte, los desafíos actuales referente a los agronegocios, es la creación de empresas dedicadas a la transformación y comercialización de las frutas exóticas que carecen de una organización definida en la agroindustria para lograr el aprovechamiento de las frutas nativas; debido a su desconocimiento, no han logrado fortalecer el conocimiento científico ni generar nuevas tecnologías para usos industriales de dichas especies (Romero et al., 2022).

La fruta amazónica más emblemática conocida como Morete (*Mauritia flexuosa* L.f.), también llamado aguaje en otras regiones de América del Sur nos sigue sorprendiendo en su sabor único, exótico y por su alto valor nutritivo para la alimentación humana (Zárate et al., 2022). La cosecha tiende a ser realizada de manera silvestre; esto quiere decir que generalmente caen de la palma cuando el fruto está maduro siendo innecesario tumbarlo. Una palmera de aguaje puede producir en el bosque un promedio de 4 hasta 10 racimos como máximo, cada racimo produce aproximadamente 800 frutos, dando una producción media aproximada de 150 kilos por palmera (Del Castillo et al., 2021).

Este cultivo se mantiene activo durante todo el año, produciendo frutos en cantidades significativas; las palmas hembras, que alcanzan una altura de 6 a 7 metros, comienzan a generar frutos, con un pico alto de producción en los meses de febrero y agosto, seguido de una disminución en septiembre y noviembre de cada año para obtener los frutos maduros de color marrón intenso (Sotero et al., 2013). La composición química en 100 gramos de Morete contiene: 256 calorías, 11.0 % de proteínas, 38.6 % de grasa, 46.0 % de carbohidratos, 41.95 % de fibra, 4.4 % de cenizas, 415.4mg, de calcio, 69.9mg de fósforo, 0.11mg de tiamina, 2.57mg de niacina y 0.85mg de riboflavina (Oña, 2015).

El consumo del Morete ofrece una gama de beneficios antioxidantes por su alto contenido de ácidos grasos insaturados como el ácido oleico y palmítico y carotenoides que indica su capacidad para combatir los radicales libres para una dieta saludable y prevenir el desarrollo de diversas enfermedades debido al cambio de la estructura celular. Esta propiedad antioxidante del Morete influye como un factor de valor nutricional en alimentos funcionales (Stefenon et al., 2021). Los alimentos funcionales son aquellos que, además de proporcionar nutrientes básicos, también tienen efectos positivos en la salud más allá de su valor nutritivo básico (Meléndez et al., 2020). En los últimos años, las propiedades nutricionales del Morete han llevado a cabo el consumo principal por las poblaciones rurales de la Amazonía a ser objeto de un proceso de desarrollo industrial. Esto se ha convertido en un producto cada vez más reconocido, incluso considerándose como un "súper alimento" que ha ganado aceptación en otros mercados nacionales (Alvarado et al., 2023).

El helado se define como un producto alimenticio, higienizado, edulcorado, obtenido a partir de una emulsión de grasas y proteínas, con la adición de otros ingredientes y aditivos NTE INEN 0706 2013; mediante el proceso de congelación y transformación ha estado sólido o semisólido, presentándose como un color y sabor agradable, además, no deben mostrar características del hielo visible en forma de cristales de lactosa y deben estar exentos de gránulos de grasa (Banguero y Navas, 2021).

El suero lácteo es un subproducto generado durante la producción del queso, de acuerdo con el Centro de la Industria Láctea del Ecuador la producción diaria de leche fue de 5,33 millones de litros a nivel nacional en el 2022 de la cual el 51,8 % fue destinada a la industria formal para la elaboración de toda la gama de productos lácteos (Restrepo et al., 2016). Dentro de la elaboración del queso, el suero lácteo representa entre el 85 % y el 90 % catalogándose como un residuo con un valor nutricional de proteínas, minerales y vitaminas sin darle un valor agregado. Está compuesto por lactosa originaria de la leche (4,6 %-5,2 %), proteínas (0,68 %-1 %), pequeñas cantidades de grasa (0,05 %-0,37 %), sales minerales (0,5 %) y en su mayoría agua (93,6 %); contiene vitaminas hidrosolubles, entre las que se destacan la riboflavina, el ácido pantoténico y la vitamina C (Asas et al., 2021).

Esta combinación de suero lácteo y pulpa de Morete en la elaboración de helado ofrecerá una serie de beneficios adicionales. Los aspectos nutricionales, sensoriales y la utilización de estas materias primas aportará a la reducción del desperdicio de suero lácteo, concientizando sobre el impacto ambiental y contribuyendo a una imagen sostenible de acuerdo con la ley de la economía circular (Da Costa, 2022).

La elaboración de un helado con la adición de Morete y suero lácteo (0 %, 25 %, 50 %, 75 % y 100 %) podría ser una alternativa para que las personas encuentren un atractivo sabor y al mismo tiempo se beneficien de su valor nutricional mejorado, en comparación con el helado convencional, y precisar una fórmula óptima que ofrezca beneficios funcionales a quienes lo consuman. El objetivo de este estudio fue desarrollar una fórmula de helado a partir

de suero lácteo y de Morete, como alimento funcional por las propiedades bioactivas de los componentes de esta especie nativa, para el consumo humano como subproducto agroindustrial.

### Materiales y Métodos

El presente estudio fue experimental y se llevó a cabo mediante una investigación mixta, que incluyó tanto métodos cuantitativos como cualitativos. Los diseños mixtos buscan integrar los beneficios de ambos enfoques con el objetivo de contrarrestar las limitaciones inherentes a cada uno, al tiempo que aprovechan sus fortalezas en un enfoque de investigación holístico; permiten un análisis exhaustivo de todas las variables que influyen en una investigación. El empleo de métodos cuantitativos, facilitan una mayor generalización y control en el proceso de investigación (Sáiz y Escolar, 2021).

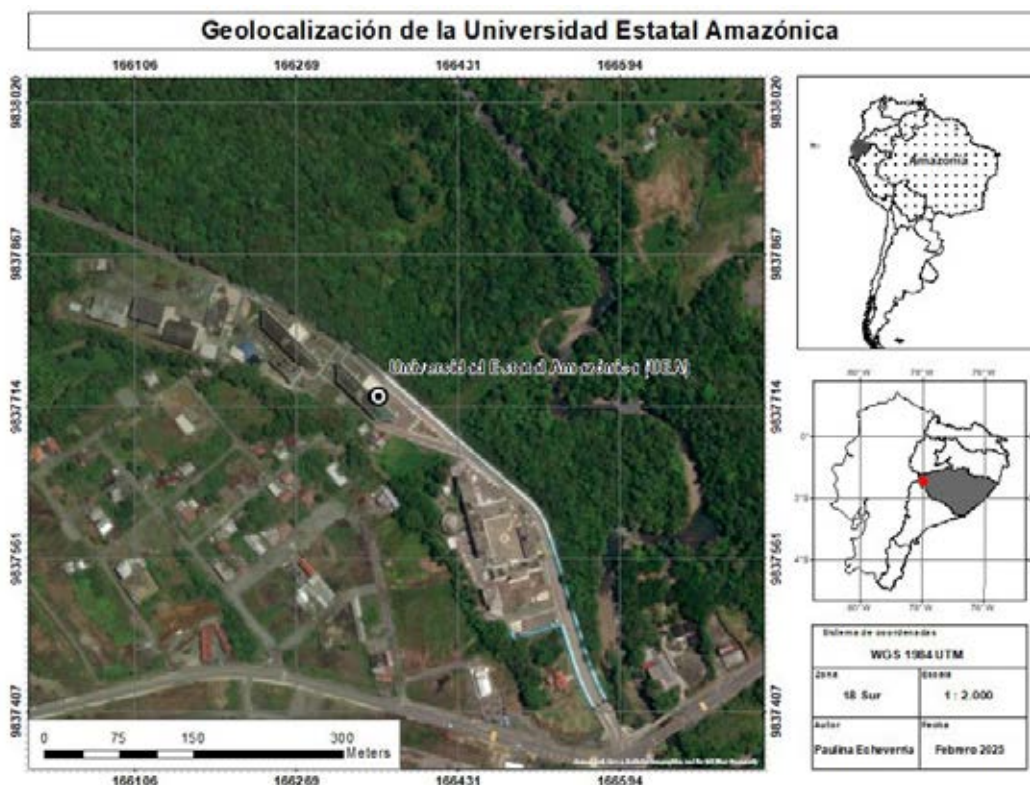
La línea investigativa de la Universidad Estatal Amazónica, en relación con el tema, es Desarrollo de Procesos Agroindustriales, dentro de la disciplina de Industrialización en temas de investigación como “Evaluación y aceptación de los alimentos funcionales a partir de subproductos agroindustriales”.

### Localización

La presente investigación se desarrolló en la Facultad de Ciencias de la Tierra en el Laboratorio de Química de la Universidad Estatal Amazónica ubicada en la provincia de Pastaza, cantón Pastaza, parroquia Puyo Vía Napo Km 2 ½, Paso Lateral S/N como se muestra en la Figura 1. Laboratorio de análisis químico TOX-CHEM ubicada en la ciudad de Riobamba Av. 21 de abril y Otto Arosemena Mz 9 Cs.

**Figura 1**

*Geolocalización de la Universidad Estatal Amazónica*



## Materia prima

Se utilizaron ingredientes como la pulpa de Morete de la marca Frutimas elaborado por la Asociación de Naranjilla y Frutales Amazónicas Murialdo, el suero lácteo adquirido en la Fábrica de Quesos en la Parroquia 10 de Agosto, la obtención y transporte del suero se llevó a cabo siguiendo estrictas condiciones de higiene para garantizar la calidad sanitaria del producto. La leche entera fue adquirida en el supermercado Gran Aki de la marca La Lechera, además de crema de leche, leche en polvo, sacarosa y carboximetilcelulosa (CMC).

En el análisis de varios estudios de los compuestos bioactivos, potencial nutricional, farmacéutico y el desarrollo económico del morete. Barboza et al. (2022) mencionan que esta fruta amazónica se puede destacar como un alimento saludable con propiedades funcionales presentes en sus partes comestibles y no comestibles. También destaca que el Morete es rico en nutrientes, como ácidos grasos y carotenoides. Estas características hacen que dicho fruto tenga un alto potencial para el desarrollo de formulaciones tanto alimentarias como farmacéuticas.

El morete (*Mauritia flexuosa*), es una fruta con un alto contenido nutricional, ya que contiene minerales, proteínas, grasas, vitaminas y carbohidratos, posee una gran reserva de betacaroteno, vitamina A. (Bernal, 1990).

**Tabla 1**

*Contenido de ácidos grasos (%)*

ÁCIDO GRASO	<i>Mauritia flexuosa</i> l.f. MUESTRA	<i>Mauritia flexuosa</i> l.f. VASQUEZ O., 2010
Ácido Mirístico C14:0	0.06 ± 0.01	ND
Ácido Palmítico C16:0	21.27 ± 0.80	19.61
Ácido Palmitoleico C16:1	0.29 ± 0.06	0.15
Ácido Esteárico C18:0	4.19 ± 0.04	1.57
Ácido Oleico C18:1	68.69 ± 1.60	75.63
Ácido Linoleico C18:2	2.05 ± 0.08	2.19
Ácido $\alpha$ -Linoleico C18:3	0.87 ± 0.03	0.82
Saturados	25.52	21.18
Insaturados	71.90	78.79

*Análisis proximal de la pulpa de morete (Mauritia flexuosa L.f.)*

DETERMINACIONES	CONTENIDO (g/100g peso fresco)
Humedad	10.00 ± 0.38
Cenizas	1.87 ± 0.04
Grasas	41.09 ± 0.00
Fibra cruda	2.83 ± 0.02
Proteína	2.30 ± 0.02
Azúcares reductores	2.70 ± 0.13

Fuente: (Restrepo, 2015)

## Procedimiento experimental

Para la formulación y diseño del prototipo del helado se empleó cuatro niveles de suero lácteo combinándolo con leche, en cuanto a los demás ingredientes utilizados en la producción de helados (Tabla 2).



**Tabla 2***Tratamientos del helado de Morete*

INGREDIENTES %	T0 0 %	T1 25 %	T2 50 %	T3 75 %	T4 100 %
Leche entera	38,2	28,65	19,1	9,55	...
Suero lácteo	...	9,55	19,1	28,65	38,2
Nata	7,6	7,6	7,6	7,6	7,6
Leche en polvo	6,3	6,3	6,3	6,3	6,3
Sacarosa	12,1	12,1	12,1	12,1	12,1
Estabilizante	0,15	0,15	0,15	0,15	0,15
Morete	35,65	35,65	35,65	35,65	35,65

Fuente: (Cajahuishca, 2024)

**Materiales para la elaboración del helado de Morete**

La Tabla 3 muestra una lista de los elementos esenciales que se utilizaron en la elaboración de las muestras de helado. Las herramientas necesarias para realizar los procesos de mezcla y homogeneización fueron proporcionadas por los utensilios de laboratorio, los equipos e instrumentos especializados que fueron esenciales para crear el helado.

**Tabla 3***Elementos para la elaboración de helado de Morete*

MATERIAS PRIMAS	UTENSILIOS DE LABORATORIO	EQUIPOS E INSTRUMENTOS
Leche entera	Vasos de precipitación	Balanza analítica
Suero lácteo	Pipeta aforada	Emulsificador
Nata	Espátula de metal	Congelador
Leche en polvo	Caja Petri	
Sacarosa	Agitador	
Estabilizante	Probeta graduada	
Morete		

Fuente: (Cajahuishca, 2024)

**Análisis estadístico**

Para el análisis estadístico se empleó el Software IBM. SPSS. Se determinaron medias, mínimo, máximo y rango, desviación estándar, coeficiente de variación, prueba t-student, análisis de regresión y correlación, según el caso.

**Preparación del helado de Morete**

Se desarrollaron cinco formulaciones de helado siguiendo el diagrama de bloque como se describe en la Figura 2, calculando primero la cantidad requerida de suero lácteo, leche entera, pulpa de morete y otros ingredientes necesarios. Las muestras T1, T2, T3 y T4 se elaboraron con diferentes porcentajes de suero lácteo T1 (25 %), T2 (50 %), T3 (75 %), T4 (100 %), la muestra T0 es de control (sin adición de suero) como se describe en la Tabla 1.

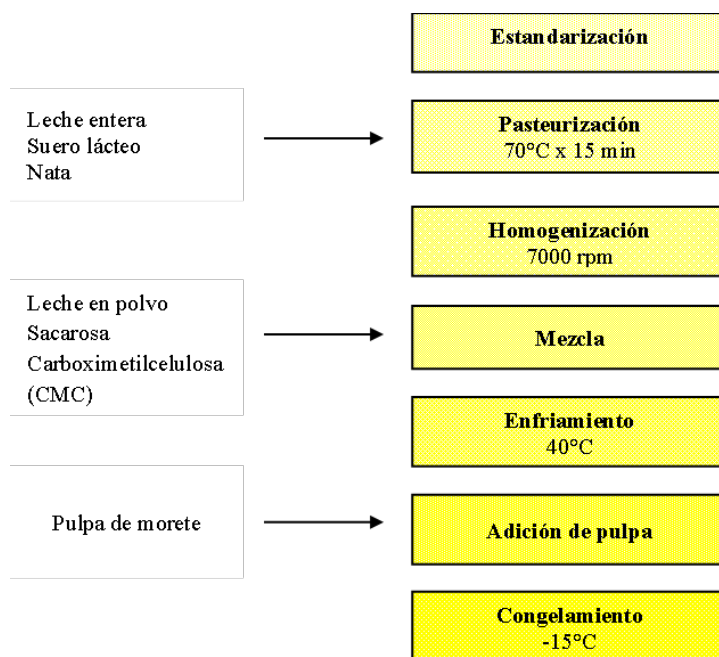
Para la preparación de las muestras se midieron con precisión en una balanza analítica marca santorius, la leche, el suero lácteo y la nata; se añadieron en diferentes vasos de precipitación de 100 ml, según cada tratamiento; se sometió a una pasteurización en el equipo marca Thermo precision, durante 15 min a 70°C; posteriormente se llevó a una máxima

agitación de 7000 rpm en un emulsificador marca Helidolph, se incorporó lentamente en forma dispersa la leche en polvo procurando de no formar grumos en las muestras.

A partir de los 40°C, se añadió la sacarosa y la carboximetilcelulosa (CMC) junto con la agitación continua para lograr una dispersión adecuada de la mezcla del estabilizador y dulzor, finalmente se añadió la pulpa de morete hasta completar la cantidad establecida en la formulación y se llevó a congelación.

**Figura 2**

*Diagrama de bloque del helado*



**Análisis de muestras experimentales**

*Análisis sensorial*

La medición se realizó utilizando una escala hedónica de cinco puntos, con una jerarquía definida (Molero-Méndez et al., 2017) Tabla 4.

**Tabla 4**

*Criterios de evaluación*

CRITERIO	VALORACIÓN
Me gusta mucho	1
Me gusta	2
Indiferente	3
Me disgusta	4
Me disgusta mucho	5

Fuente: Adaptado de Molero et al. (2017)

Las puntuaciones sensoriales fueron obtenidas mediante la participación de 50 panelistas no entrenados, conformados por 28 mujeres y 22 hombres, cuyas edades oscilaron entre 21 y 35 años. Los parámetros evaluados abarcaron aspectos fundamentales como el color, el sabor, la textura y el aroma del producto.

### Análisis fisicoquímicos

La cuantificación de la grasa total en los helados se llevó a cabo utilizando la metodología descrita en la AOAC 33.8.05 (952.06) (Association of Official Analytical Chemists); la determinación de la humedad Gravimetría-Método interno; cenizas NTE INEN 14; y proteínas se realizó siguiendo el método descrito en NTE INEN 016 (Reyna et al., 2020). La cantidad de carbohidratos se obtuvo mediante la diferencia entre los resultados de las pruebas mencionadas anteriormente, y el valor energético se calculó utilizando los coeficientes Atwater estándar para proteínas (4 kcal/g), grasas (9 kcal/g), y carbohidratos (4 kcal/g), conforme a las pautas de la FAO (Food and Agriculture Organization) de 2003 (Chire-Fajardo and Ureña-Peralta, 2023).

### Análisis microbiológicos

Con la interpretación de los resultados fisicoquímicos se seleccionó los mejores tratamientos y al tratamiento testigo para la evaluación microbiológica. Los métodos tradicionales para detectar los microorganismos presentes demanda una cantidad significativa de mano de obra, tiempo y costos en términos de equipo y preparación de medios de cultivo. Para ello, se aplicó técnicas y procedimientos basados en la norma oficial AOAC 110402 (Vásquez et al., 2020). Se utilizó el sistema de placas Compact Dry según los requisitos microbiológicos para helados que se describe en la Norma Técnica Ecuatoriana NTE INEN 0706 2013 como se muestra en la Tabla 5.

**Tabla 5**

#### Análisis microbiológicos

CRITERIO	n	m	M	C
Recuento de microorganismos mesófilos UFC/g)	5	10000	100000	2
Recuento de Coliformes	5	100	200	2
Recuento de <i>E. Coli</i>	5	<3	<10	0
Recuento de <i>Staphylococcus</i> , ufc/g	5	<10	<10	2
Detección de <i>Salmonella</i> /25g	5	Ausencia	Ausencia	0
Detección de <i>Listeria monocytogenes</i> /25g	5	Ausencia	Ausencia	0

Fuente: (NTE INEN 0706, 2013)

## Resultados y Discusión

### Análisis sensorial

Se procedió a la recolección de la información en el Software IBM. SPSS, según los resultados obtenidos de los 50 panelistas; para ello se utilizaron fichas de evaluación sensorial con una escala hedónica de 5 puntos. Las muestras de helado se calificaron entre “Me gusta mucho” y “Me disgusta mucho”.

**Tabla 6**

#### Resultado de análisis sensorial

TRATAMIENTO	COLOR /MEDIA	RANGO	MIN	MAX	SABOR/MEDIA	RANGO	MIN	MAX
T <sub>0</sub> : 0 %	2,56±0,159	4	1	5	1,94±0,890	4	1	5
T <sub>1</sub> :25 %	2,12±0,093	3	1	4	1,72±0,111	3	1	4
T <sub>2</sub> :50 %	1,86±0,103	3	1	4	1,98±0,126	3	1	4
T <sub>3</sub> :75 %	2,00±0,103	3	1	4	2,06±0,083	2	1	3
T <sub>4</sub> :100 %	1,78±0,080	2	1	3	1,84±0,92	3	1	4

TRATAMIENTO	TEXTURA/MEDIA	RANGO	MIN	MAX	AROMA/MEDIA	RANGO	MIN	MAX
T <sub>0</sub> : 0 %	2,42±0,118	4	1	5	2,30±0,138	3	1	4
T <sub>1</sub> :25 %	2,32±0,138	4	1	5	2,18±0,110	3	1	4
T <sub>2</sub> :50 %	1,96±0,124	4	1	5	2,30±0,096	3	1	4
T <sub>3</sub> :75 %	2,28±0,167	4	1	5	2,50±0,096	3	1	4
T <sub>4</sub> :100 %	2,10±0,125	4	1	5	2,40±0,103	3	1	4

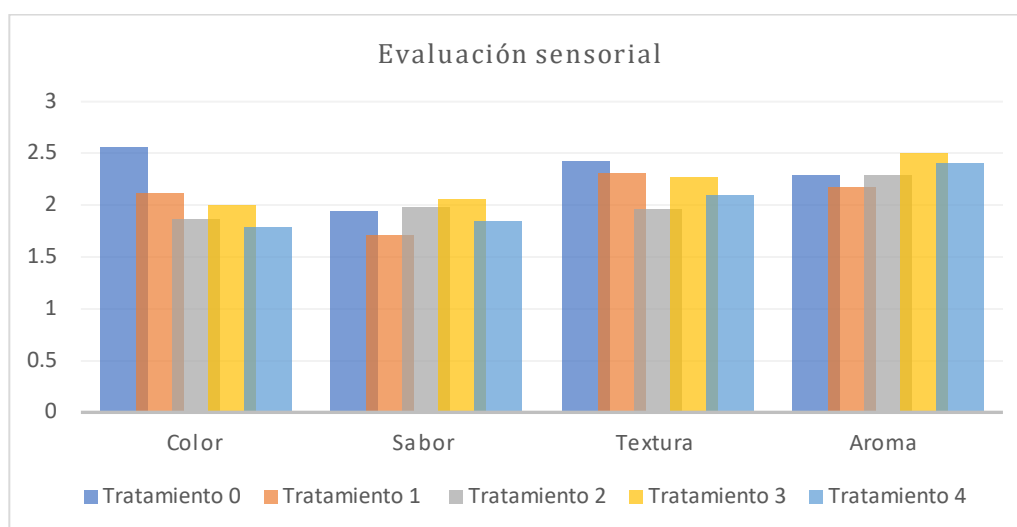
Fuente: (Cajahuishca, 2024)

Los resultados del análisis sensorial en el tratamiento testigo obtuvo la puntuación más alta en cuanto al color con una valoración de 4 (me disgusta). Los tratamientos T1, T2 y T3 obtuvo una puntuación promedio de 3 (indiferente), siendo el T4 con resultado de 2 (me gusta). Los resultados en cuanto al sabor se destaca el tratamiento T3, siendo el mejor al obtener una valoración de 2 (me gusta). Los tratamientos T1, T2 y T4 con resultados similares de 3 (indiferente), lo que indica una apreciación ligeramente menor que el T3, finalmente, el tratamiento testigo recibió un valor de 4 (me disgusta).

La evaluación de textura, en todos los tratamientos es la misma con una calificación de 4 (me disgusta) y del aroma todos coinciden con el resultado de 3 (indiferente) situándose en una posición intermedia.

**Figura 3**

*Aceptabilidad en el helado con niveles de suero lácteo*



Fuente: (Cajahuishca, 2024)

### Análisis fisicoquímicos

En la Tabla 7, los resultados de la caracterización del tratamiento testigo (T0) y los que obtuvieron mayor aceptación por los panelistas, tratamiento (T1) con la adición del 25 % de suero láctico y (T3) con la adición de 75 % de suero lácteo.

**Tabla 7**

*Resultados de análisis fisicoquímicos*

DETERMINACIONES	MÉTODO	UNIDAD	T0	T1	T3	NORMATIVA NTE INEN 0706 2013
Grasa	AOAC 33.8.05 (952.06)	(%) g/100g	7,40	6,71	5,32	6
Humedad	Gravimetría-Método interno	(%) g/100g	6,82	65,98	67,28	....
Ceniza	NTE INEN 14	(%) g/100g	0,83	0,83	0,81	....

DETERMINACIONES	MÉTODO	UNIDAD	T0	T1	T3	NORMATIVA NTE INEN 0706 2013
Proteína Cruda	NTE INEN 016	(%) g/100g	4,98	4,59	3,73	1,5
Carbohidratos	Cálculo	(%) g/100g	21,79	21,72	21,44	30 (ST)
Energía	Cálculo	kcal/100g	174,04	165,63	153,9	....

Fuente: (Cajahuishca, 2024)

El análisis de grasa en los diferentes tratamientos arrojó variaciones significativas en su contenido. Se obtuvo 7,40 en el tratamiento T0; luego, al introducir el suero lácteo al 25 % en el tratamiento T1, el contenido de grasa disminuyó a 6,71. Esta reducción fue aún más notable en el tratamiento T3, donde el suero lácteo sustituyó el 75 % de la leche, obteniendo un contenido de grasa de 5,32.

Los resultados del análisis de humedad fueron de 64,82 en el tratamiento T0, en el tratamiento T1 el porcentaje de humedad se elevó a 65,98. Esta tendencia fue aún más pronunciada en el tratamiento T3, donde el contenido de humedad presentó 67,28. Los hallazgos del análisis de ceniza realizado en varios tratamientos de helado muestran una consistencia en los niveles de contenido mineral. En el tratamiento T0 y T1 se mantuvo constante con un valor de ceniza de 0,83; sin embargo, el contenido de ceniza disminuyó ligeramente en el tratamiento T3, alcanzando un valor de 0,82.

Los resultados del análisis de proteínas del helado muestran diferencias significativas en el contenido. Se registró un valor de proteína de 4,98 en el tratamiento T0. Este contenido de proteína disminuyó a 4,59 después de agregar suero lácteo con una proporción de 25 % en el tratamiento T1. Esta reducción fue aún más notable en el tratamiento T3, al agregar 73 % de suero lácteo con un valor de 3,73 en contenido proteico.

Los resultados del análisis de carbohidratos muestran una consistencia en los niveles de contenido de este macronutriente. Se registró un valor de 21,79 en el tratamiento T0. En el tratamiento T1, con un contenido de 21,72, esta cifra disminuyó ligeramente con un valor de 21,44 en el tratamiento T3.

Los resultados de análisis de energía de los tratamientos revelan una tendencia hacia la disminución en el valor calórico al aumentar la proporción de suero lácteo. Se registró un valor de 174,04 unidades energéticas en el tratamiento T0, al introducir el suero lácteo en el tratamiento T1, la energía disminuyó a 165,63 unidades. El tratamiento T3 mostró una reducción aún más significativa, ya que el suero lácteo reemplazó el 75 % de la leche, lo que resultó en un contenido energético de 153,9 unidades energéticas.

### Análisis microbiológico

Los análisis realizados a los tratamientos (T0, T1 y T3) del helado de morete manifestaron diferencia en sus parámetros Tabla 8. Los resultados obtenidos demostraron que estuvieron aptos para el consumo, ya que presentaron valores inferiores a los límites establecidos por la Norma Técnica Ecuatoriana NTE INEN 0706 2013.

**Tabla 8**

*Resultado de análisis microbiológicos*

CRITERIO	TRATAMIENTOS			NORMATIVA NTE INEN 0706 2013
	T <sub>0</sub>	T <sub>1</sub>	T <sub>3</sub>	NIVEL DE ACEPTACIÓN m
Recuento de microorganismos mesófilos UFC/g)	1,41x10 <sup>3</sup>	1,41x10 <sup>3</sup>	6,2x10 <sup>2</sup>	10000

CRITERIO	TRATAMIENTOS			NORMATIVA NTE INEN 0706 2013
	T <sub>0</sub>	T <sub>1</sub>	T <sub>3</sub>	NIVEL DE ACEPTACIÓN m
Recuento de Coliformes	1x10 <sup>1</sup>	1x10 <sup>1</sup>	1x10 <sup>1</sup>	100
Recuento de <i>E. Coli</i>	< 1	< 1	< 1	< 3
Recuento de <i>Staphylococcus</i> , ufc/g	< 1	< 1	< 1	< 10
Detección de <i>Salmonella</i> /25g	Ausencia	Ausencia	Ausencia	Ausencia
Detección de <i>Listeria monocytogenes</i> /25g	Ausencia	Ausencia	Ausencia	Ausencia

Fuente: (Cajahuishca, 2024)

## Discusión

### *Análisis sensorial*

Al reformular el helado de Morete, se requirió de una evaluación sensorial que permitió discernir los cambios en el producto en comparación a la formulación testigo T<sub>0</sub>, al realizar los análisis estadísticos de las calificaciones asignadas por los 50 panelistas, evaluando los parámetros de color, sabor, textura y aroma (Figura 3). Al igual que Guillen et al. (2019) evaluó el efecto de la sustitución parcial de leche por suero, en el helado de quinua, con cuatro formulaciones y concentraciones, similares en 31 panelistas con una escala hedónica de 5 puntos.

Dentro de la evaluación organoléptica se analizaron los resultados del color, encontrando los mejores tratamientos; los puntajes de aceptabilidad fueron del tratamiento testigo T<sub>0</sub> con una calificación de 4 seguido del T<sub>1</sub> que contiene el 25 % de suero lácteo, en relación con Saentaweek & Chaikham (2023) donde el helado de control resultó con el mayor valor y dicho valor fue significativamente superior a las otras formulaciones, además, Barros et al. (2021) menciona que los valores negativos indican que los helados tienden al color verde o amarillo por la adición de suero lácteo. Los helados con mayor concentración de suero fueron los más afectados, ya que el sustituir la leche por el suero lácteo en los niveles de 50 %, 75 % y 100 % fue visible al ojo humano.

Los resultados en cuanto a la aceptación en la variable del sabor no presentaron diferencias significativas, teniendo variaciones consistentes, lo que sugiere cierta estabilidad en las mediciones, esto se debe a los ingredientes adicionales presentes en la formulación con la misma cantidad sin tener un efecto a las propiedades del sabor. El tratamiento T<sub>3</sub> presentó la mejor puntuación de 2, seguido del tratamiento T<sub>1</sub>, T<sub>2</sub> y T<sub>4</sub> con una valoración de 3 con criterio de indiferente. En relación con Muñoz et al. (2017) el sabor no presentó diferencias estadísticas a pesar de tener un 35 % de suero lácteo con un criterio de “Me disgusta” y el 15 % tiende a un criterio de “Me gusta” ligeramente.

En la textura se obtuvo un efecto similar en todos los tratamientos, con el puntaje de 4 con criterio de “Me disgusta” a pesar de tener diferentes porcentajes de suero lácteo. Este efecto puede deberse a la disminución del contenido de grasa, como sostiene Silantjeva et al. (2022) que en los helados bajos en grasa, o sin grasa, podría afectarse seriamente a la textura del producto; la dureza por la formulación de contenido de sólidos, azúcares, grasas, proteínas, cantidad y característica del estabilizante y emulsionante utilizado afectaría así mismo, tanto a la cantidad de agua libre, como a la temperatura de congelación del helado.

Los resultados de Meneses et al. (2020) que utiliza un medidor de textura TA.XT Express para determinar la dureza (fuerza máxima durante la penetración (N)), concluyó que existe una relación directa entre la concentración de suero de queso Ricotta (RCW) y la firmeza de los helados, dado que a mayor concentración mayor fuerza de deformación.

En el análisis del aroma se presentó puntuaciones de 3 con criterio de indiferente entre todos los tratamientos; sin embargo, esto puede deberse a la disminución del olor característico de la leche entera en reemplazo del suero lácteo; una mayor fijación del aroma propio del Morete a medida que aumenta el porcentaje de suero lácteo siendo un aroma agradable para los panelistas. Guillen et al. (2019) mencionan que, al sustituir parcialmente la leche por suero en el helado, puede tener un efecto en la percepción del aroma en comparación con la fórmula de control. En el estudio de Meneses et al. (2021) demuestran que el adicionar suero de Ricotta, suero de queso y suero de mantequilla no afectó significativamente el gusto general por el helado de chocolate, pero sí aumentó la percepción en el aroma del chocolate.

### **Análisis fisicoquímicos**

Se realizaron análisis fisicoquímicos y microbiológicos sólo a los tratamientos con mayor aceptación sensorial T3 y T1 incluyendo el T0 como tratamiento testigo.

En la determinación de grasa, mostró diferencias significativas por el efecto del sustituto, presentó un mayor contenido graso de 7,40 % sin la adición de suero lácteo T0, seguidamente del T1 y T3 con 6,71 % y 5,32 % respectivamente; como se ilustra en el Cuadro 3, las muestras analizadas y comparadas con los requisitos nutricionales de la NTE INEN 0706 2013 para helados, se observó que es aceptable los valores obtenidos. Un estudio realizado por Meneses et al. (2020) indicó que la adición de suero lácteo influye significativamente en la composición nutricional del helado, aumentando la humedad y reduciendo las cenizas, lípidos, proteínas carbohidratos y valor energético, la grasa presentó una reducción de más del 25 % en comparación con el helado elaborado únicamente con leche entera. La sustitución de la leche por subproductos lácteos tuvo una influencia significativa sobre la composición lipídica, con una reducción de entre el 35,71 % (suero de queso) y el 43,97 % (suero de Ricotta) (Meneses et al., 2023).

En el contenido de humedad, se reportaron diferencias notorias en el porcentaje del helado que se utilizó 75 % de suero lácteo T3, presentando un 67,20 % de humedad que decrece a 65,98 % en el helado con 25 % de suero lácteo T1 y el porcentaje más bajo fue en el helado testigo con 0 % de suero lácteo T0 con un 64,82 % de humedad; esto se debe a que el suero lácteo contiene de entre 91,01 % y 95,70 % de humedad a comparación de la leche entera con 88,1 % por cada 100g (Ramírez and Puente, 2011), además, Meneses et al. (2020) demuestran que, a medida que aumenta la concentración, también aumenta la formación de cristales debido a la reducción de sólidos y al aumento de la humedad, que pueden generar mayor dureza en los helados bajos en grasa.

La valoración de contenido de cenizas de helado en los tres tratamientos no reportó diferencias porcentuales significativamente, sin embargo, numéricamente se registra superioridad en el helado en el que se aplicó 100 % y 25 % de suero lácteo con un 0,83 %, descendiendo a 0,81 % de ceniza en el helado con 75 % de suero lácteo, de tal manera que la ceniza disminuye a medida que se aumenta la cantidad de suero lácteo como sustituto de la leche entera, tal como lo reporta Meneses et al. (2020) donde el helado de chocolate con 0% de suero lácteo poseía el 1,40% de ceniza, teniendo un efecto decreciente hasta el helado con 100% de suero lácteo con 1,20% de ceniza.

Al evaluar los diferentes porcentajes de proteína cruda, se registraron diferencias significativas, el porcentaje de proteína más alta fue en el helado T0 con 4,98 %, el helado T1 presentó un 4,59 %, y finalmente el T3 disminuyó hasta 3,73 % de proteína. La inclusión de proteína de suero en la mezcla de helado resultó en un helado con una mayor consistencia, capacidad de resistir la fusión y la textura viscosa, en comparación con los helados

tradicionales (Correa y Mosquera, 2015); sin embargo, debido a su tendencia a desnaturalizarse a altas temperaturas (alrededor de 80 °C), este fenómeno conduce a la precipitación y la separación de fases (Pintor-Jardines and Totosa-Sánchez, 2013).

En la determinación de carbohidratos, los resultados porcentuales no reflejan un cambio significativo, pero el helado que tuvo mayor porcentaje de carbohidratos fue el T0 con 21,79 % seguido del T1 y T3 con 21,72 % y 21,44 % respectivamente. En el estudio de Meneses et al. (2020) reflejó menos contenido de proteínas en comparación del helado con leche entera; sin embargo, se encontraron valores similares para los carbohidratos.

Por último, en la valoración del contenido de energía se puede observar los valores de los tratamientos ubicados en el siguiente orden: T0 (0 % suero lácteo) con 174,04 %, T1 (25 % suero lácteo) con 165,63 y finalmente el T3 (75 % de suero lácteo) con 163,9 % de energía. Un estudio realizado por Meneses et al. (2020) demostró que, al sustituir la leche entera por el suero lácteo, su valor energético disminuía de 164,8 % a 133,83 % debido a la reducción del contenido graso y proteína.

### **Análisis microbiológicos**

Un medio ambiente descuidado puede tener un impacto adverso en la calidad de los helados, donde el aire, el agua y el suelo pueden ser fuentes significativas de microorganismos no deseados, y representar un riesgo para la calidad e inocuidad del producto; por ello se debe utilizar agua envasada (Rosales y Díaz, 2006). Para garantizar la seguridad y calidad del helado, se realizó un análisis microbiológico completo, según los estándares establecidos por la norma INEN 076 (Tabla 3) presentando valores inferiores a los límites establecidos.

Los resultados del tratamiento T0 tuvo un mayor recuento de microorganismos mesófilos con  $1,41 \times 10^3$  UFC/g a comparación del T3 con  $6,2 \times 10^2$  UFC/g, en análisis de Coliformes presentó  $1 \times 10^1$  UFC/g, en los tratamientos, al igual que *E. Coli*, y *Staphylococcus* con valores menores a 1 UFC/g, *Salmonella* y *Listeria monocytogenes* estuvieron ausentes. En la investigación de Tsuchiya et al. (2017) los valores, en el helado enriquecido con suero en polvo, reportaron un recuento de Coliformes que osciló entre  $2,4 \times 10^1$  -  $2,4 \times 10^2$  UFC/g, *Staphylococcus* estuvo presente en  $< 10^2$  UFC/g, en el recuento de bacterias mesófilas entre  $3,9 \times 10^3$  UFC/g en las formulaciones de helado. Este fue inferior al reportado previamente en los helados caseros donde los resultados fueron mayores a los rangos permisibles, las bacterias aerobias mesófilas presentaron un promedio de  $5,7 \times 10^4$  UFC/g, Coliformes 803 UFC/g, *Estafilococos*  $< 1,0 \times 10^2$  UFC/g, (Rosales y Díaz, 2006). Esta variación de resultados permite corroborar que se tuvo control durante todo el proceso en el manejo de materias primas y personal encargado de la preparación, teniendo un impacto directo en la calidad microbiológica.

La Norma NTE INEN 0706 2013 para helados en los requisitos para microorganismos específicos se establecen para asegurar la calidad del producto final, ya que se basan en la evaluación de los riesgos, es decir, microorganismos que pueden causar enfermedades transmitidas por alimentos (ETA) (Párraga et al., 2023).

### **Conclusiones**

Los resultados de este estudio validan que es posible el uso de un residuo de la industria láctea para la elaboración de helado con frutas exóticas como el morete, utilizando suero lácteo por su contenido nutricional como sustituto de la leche entera y obteniendo una nueva propuesta tecnológica. El tratamiento T3 con un 75 % de suero lácteo, en particular, demostró una alta aceptación en términos de sabor y aroma, y obtuvo una calificación competitiva en



textura y color. Este hallazgo demuestra que la inclusión de suero lácteo, en la formulación del helado de morete, puede ser una opción viable para mejorar las características organolépticas del producto final y podría ser considerado como una alternativa para evitar el desecho de este residuo en la industria. Al reutilizar el suero lácteo, se maximiza la eficiencia del proceso de producción y se reduce el impacto ambiental.

La calidad fisicoquímica del helado de morete con suero lácteo se vio claramente afectada, con la adición de diferentes porcentajes a la formulación, lo que redujo el porcentaje de grasa, ceniza, proteína cruda, carbohidratos y energía. Estos resultados indican que la composición nutricional y las propiedades físicas del helado de morete pueden verse modificadas por la incorporación de este residuo; sin embargo, el uso de la pulpa de morete ofrece una mixtura única de beneficios al combinarlo, y compensaría la disminución en el valor nutricional causada por la inclusión del lactosuero.

Los resultados de los análisis microbiológicos del helado de Morete fueron satisfactorios porque se encontraron dentro de los límites permitidos por las normas actuales, sin importar la cantidad de suero lácteo presente en la formulación. Este hallazgo es importante porque demuestra que el producto cumple con los estándares de seguridad e higiene microbiológica requeridos para su consumo. Estos resultados destacan la importancia de llevar a cabo prácticas adecuadas de higiene y seguridad alimentaria, lo que reduce el riesgo de contaminación microbiológica y garantiza la calidad del producto final.

### Reconocimientos

Los autores declaran la contribución y participación equitativa de roles de autoría para esta publicación.

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## Variación espacial de la contaminación por coliformes fecales en el Río Portoviejo, Provincia de Manabí

### Spatial Variation of Fecal Coliform Contamination in the Portoviejo River, Manabí Province

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Enviado: 2024/12/26  
Aceptado: 2025/06/13  
Publicado: 2025/06/30

#### Resumen

El presente estudio evalúa la calidad microbiológica y fisicoquímica del río Portoviejo, ubicado en la provincia de Manabí (Ecuador), mediante el análisis de coliformes fecales y parámetros como pH, temperatura, conductividad eléctrica, sólidos totales disueltos y salinidad. Para este propósito, se establecieron ocho estaciones de muestreo a lo largo del cauce principal, desde su nacimiento hasta la desembocadura, abarcando los cantones de Santa Ana, Portoviejo, Rocafuerte y Sucre. Se recolectaron 48 muestras de agua en junio de 2023 y los análisis se realizaron in situ y en laboratorio, conforme a la norma INEN 2176:2013 y el método 1060 de la Standard Methods for the Examination of Water and Wastewater. Los resultados mostraron concentraciones de coliformes fecales que oscilaron entre 1 600 y 160 000 NMP/100 mL, con promedios por estación que superaron en su totalidad los límites máximos permisibles establecidos por la normativa ecuatoriana para usos recreativos y agrícolas. La estación más contaminada fue la ubicada en la ciudadela El Comercio (Portoviejo), con  $137\,333.33 \pm 39\,259.82$  NMP/100 mL. El análisis estadístico reveló diferencias significativas entre estaciones (ANOVA,  $p < 0.05$ ), y la correlación de Spearman indicó una relación positiva entre

**Sumario:** Introducción, Metodología, Resultados, Discusión, Conclusiones.

**Como citar:** Cedeño, V., Arévalo, O., López, K., Álava, I. & Macas, V. (2025). Variación espacial de la contaminación por coliformes fecales en el Río Portoviejo, Provincia de Manabí. *Revista Tecnológica - Espol*, 37(1), 348-364. <https://rte.espol.edu.ec/index.php/tecnologica/article/view/1271>

la concentración de coliformes y el número de habitantes. Los valores de conductividad, salinidad y sólidos disueltos también alcanzaron niveles que implican restricciones para el uso agrícola en algunos tramos. Se identificó una mayor contaminación en zonas urbanas densamente pobladas, y se propuso un plan de acción con estrategias por cantón para mitigar los impactos detectados. Finalmente, se planteó una propuesta de acción con la finalidad de mitigar la contaminación microbiológica.

**Palabras clave:** bacteria, coliformes fecales, contaminación fluvial, microbiológica, variación espacial.

### Abstract

This study evaluates the microbiological and physicochemical quality of the Portoviejo River, located in the Manabí province (Ecuador), through the analysis of fecal coliforms and parameters such as pH, temperature, electrical conductivity, total dissolved solids (TDS), and salinity. For this purpose, eight sampling stations were established along the main river course, from its source to its mouth, covering the cantons of Santa Ana, Portoviejo, Rocafuerte, and Sucre. A total of 48 water samples were collected in June 2023, and analyses were conducted both in situ and in the laboratory, following the Ecuadorian Technical Standard INEN 2176:2013 and Method 1060 of the Standard Methods for the Examination of Water and Wastewater. The results showed fecal coliform concentrations ranging from 1,600 to 160,000 MPN/100 mL, with station averages exceeding the maximum permissible limits established by Ecuadorian regulations for recreational and agricultural uses. The most contaminated station was located in the El Comercio neighborhood (Portoviejo), with  $137,333.33 \pm 39,259.82$  MPN/100 mL. Statistical analysis revealed significant differences between stations (ANOVA,  $p < 0.05$ ), and Spearman's correlation showed a positive relationship between fecal coliform concentration and population size. Conductivity, salinity, and TDS values also reached levels that indicate restrictions for agricultural use in some sections. Higher contamination was identified in densely populated urban areas, and an action plan was proposed with strategies by canton to mitigate the observed impacts. Finally, a proposal was presented to reduce microbiological pollution.

**Keywords:** bacteria, fecal coliforms, river contamination, microbiological, spatial variation.

### Introducción

El agua es un recurso esencial para la vida y el desarrollo humano. Su calidad y disponibilidad están directamente relacionadas con la salud pública y la sostenibilidad ambiental; sin embargo, a nivel global, las fuentes hídricas están siendo gravemente afectadas por la contaminación, tanto de origen natural como antrópico, comprometiendo su capacidad de abastecimiento y aumentando los riesgos sanitarios (López-Gálvez & Gil, 2020; Arévalo Lata, 2017).

En las últimas décadas, el crecimiento poblacional y la descarga de aguas residuales no tratadas han incrementado la carga microbiológica en cuerpos de agua superficiales (Olivas-Enríquez et al., 2011). Una de las formas más comunes de contaminación es la presencia de coliformes fecales, microorganismos indicativos de residuos fecales humanos o animales, que pueden albergar patógenos como *E. coli*, *Salmonella* y *Vibrio cholerae* (Cabral et al., 2018; Arias et al., 2022). Estos patógenos representan un riesgo considerable de enfermedades entéricas, especialmente en zonas donde las aguas contaminadas se utilizan con fines recreativos, agrícolas o para consumo humano (Guambo et al., 2022; Dorevitch et al., 2015).

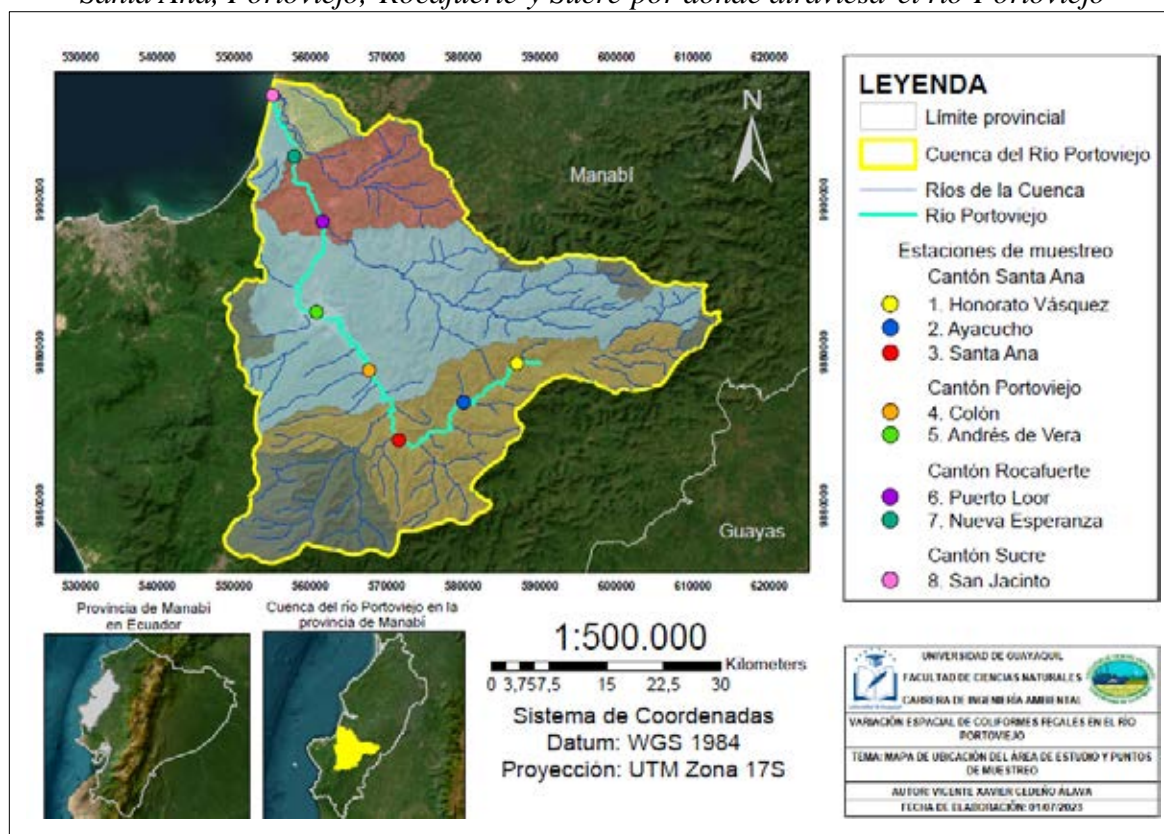
En Ecuador, aunque el país dispone de abundantes recursos hídricos, se estima que más del 70% de sus ríos presentan niveles de contaminación superiores a los permitidos (Palacios, 2013). Estudios realizados en cuerpos de agua de la región costera, como los ríos Chone, Jama, Esmeraldas y estuarios urbanos, han reportado niveles preocupantes de coliformes fecales, reflejando una tendencia creciente en la degradación de la calidad del agua (Real Goya et al., 2025; Frena et al., 2019; Mitra et al., 2018).

Pese a estos antecedentes, la calidad microbiológica del cauce principal del río Portoviejo, uno de los más importantes de la vertiente del Pacífico ecuatoriano, ha sido poco estudiada. Este río recorre aproximadamente 106 km y su cuenca abarca 2134 km<sup>2</sup>, abasteciendo de agua potable a más de 600.000 habitantes e incluyendo zonas de uso recreativo y agrícola. La intensificación de las actividades humanas y el vertido de aguas residuales en los cantones de Santa Ana, Portoviejo, Rocafuerte y Sucre generan una presión creciente sobre este recurso (Intriago-Flores & Quiroz-Fernández, 2021; Quiroz et al., 2017; Cedeño-Loor, 2019).

Dado que la contaminación fecal constituye una amenaza directa a la salud y al ambiente, este estudio propone evaluar la presencia y concentración de coliformes fecales en el río Portoviejo desde su nacimiento hasta su desembocadura, abarcando puntos distribuidos en los cantones de Santa Ana, Portoviejo, Rocafuerte y Sucre. En la Figura 1 se muestra la ubicación geográfica del área de estudio y la localización precisa de las estaciones de muestreo dentro de la cuenca del río Portoviejo. A partir de los resultados obtenidos, se busca presentar estrategias de mitigación y gestión ambiental que contribuyan a la conservación del recurso hídrico y la protección de las comunidades ribereñas.

**Figura 1**

*Mapa de ubicación del área de estudio y puntos de muestreo en localidades de los cantones Santa Ana, Portoviejo, Rocafuerte y Sucre por donde atraviesa el río Portoviejo*



## Metodología

La presente investigación adoptó un enfoque cuantitativo, descriptivo y transversal, cuyo propósito fue caracterizar la contaminación por coliformes fecales en el río Portoviejo a lo largo de su recorrido por diversos cantones de la provincia de Manabí. La metodología empleada abarcó el diseño del muestreo, la descripción de los procedimientos analíticos tanto fisicoquímicos como microbiológicos, así como el tratamiento estadístico de los datos recolectados. Este enfoque integral permitió establecer comparaciones espaciales entre distintos tramos del río y vincular los niveles de contaminación con las actividades humanas circundantes, respetando los protocolos técnicos normativos vigentes en Ecuador y estándares internacionales.

### Diseño del muestreo para microbiología y parámetros fisicoquímicos

En campo se realizaron visitas in situ a la zona de estudio con el objetivo de observar y registrar los puntos tentativos de muestreo. Se consideraron criterios como localización, accesibilidad y seguridad, seleccionando ubicaciones cercanas a poblados o comunas, y con distancias promedio de 10 km entre estaciones. En total se definieron 8 estaciones, con un total de 48 muestras de agua para análisis microbiológico y fisicoquímico, siguiendo los lineamientos de la Norma Técnica Ecuatoriana INEN 2176:2013 (Instituto Ecuatoriano de Normalización, 2013). La norma establece los procedimientos adecuados para obtener muestras representativas en cuerpos de agua naturales.

En cada una de las ocho estaciones definidas a lo largo del río Portoviejo, se efectuaron tres tomas puntuales dispuestas a lo largo de una línea transversal que cruza de margen a margen del cauce, garantizando la representatividad espacial del flujo. Cada uno de estos tres puntos fue muestreado por duplicado, de manera inmediata al finalizar las tres primeras, lo cual totaliza seis muestras por estación para el análisis microbiológico y una en cada estación para el análisis fisicoquímico, ver Tabla 1. Las muestras se recolectaron en botellas de polietileno estériles, sumergidas aproximadamente a 20 cm bajo la superficie, evitando la agitación del sedimento o contacto con la orilla.

**Tabla 1**

*Ubicación y cantidad de muestras por estación para análisis de microbiología y fisicoquímico*

Cantón	Estación	Ubicación	Muestras Microbiología	Muestras Fisicoquímico
Santa Ana	E1	El Tamarindo, 1 km después de la parroquia Honorato Vásquez, cercano a la represa Poza Honda	6	1
	E2	Km. 13 vía Santa Ana – Poza Honda, entrada al sitio Agua Fría	6	1
	E3	Cabecera cantonal, zona urbana	6	1
Portoviejo	E4	El Cady, parroquia Colón	6	1
	E5	Ciudadela El Comercio, parroquia Andrés de Vera, Portoviejo	6	1
Rocafuerte	E6	Comunidad Puerto Loor	6	1
	E7	Comunidad Nueva Esperanza	6	1

Cantón	Estación	Ubicación	Muestras	Muestras
			Microbiología	Fisicoquímico
Sucre	E8	Sendero ecológico del manglar La Boca, comuna San Jacinto	6	1

*Nota:* Frascos de 125 ml para muestras de ensayos de microbiología y frascos de 1 litro para ensayos de parámetros fisicoquímicos. Tomas realizadas en el mes de junio 2023.

Los recipientes utilizados fueron de 125 mL para análisis microbiológicos y de 1 L para parámetros fisicoquímicos. Una vez recolectadas, las muestras fueron etiquetadas, almacenadas a 4 °C en cajas térmicas, y transportadas inmediatamente al laboratorio Lazo ubicado en el cantón Durán, conforme a las recomendaciones de conservación y preservación establecidas por la norma (Standard Methods Committee of the American Public Health Association, 2023a) en el 1060 Recolección y Conservación de Muestras de Standard Methods para el análisis de agua y aguas residuales (SMWW). El análisis microbiológico empleó la técnica de fermentación en tubos múltiples para coliformes fecales, conforme al método 9221E (Standard Methods Committee, 2023b).

Este diseño de muestreo garantizó una cobertura horizontal representativa del río en cada estación y la integridad de las muestras para su análisis posterior. La fecha de realización fue durante las cuatro semanas del mes de junio de 2023.

En cada estación de muestreo y para cada una de las muestras recolectadas, se realizaron mediciones in situ de los parámetros fisicoquímicos: pH, conductividad eléctrica, sólidos totales disueltos (TDS), salinidad y temperatura. Estas mediciones se efectuaron utilizando un equipo multiparámetro PC60 Premium de Apera, previamente calibrado según las especificaciones del fabricante. Los valores obtenidos fueron registrados de forma inmediata en una bitácora de campo, conforme a las recomendaciones del protocolo 1060 de la Standard Methods for the Examination of Water and Wastewater (Standard Methods Committee, 2023a), el cual establece la necesidad de realizar ciertos análisis directamente en campo para garantizar la precisión y representatividad de los datos.

### Tratamiento estadístico

Los datos fisicoquímicos y microbiológicos fueron analizados para verificar su normalidad mediante la prueba de Anderson-Darling. La homogeneidad de varianzas fue evaluada con la prueba de Levene. Para comparar las concentraciones de coliformes fecales entre estaciones, se aplicó ANOVA y la prueba a posteriori de Tukey. Además, se empleó la correlación de Pearson para analizar relaciones entre variables. Todo el procesamiento estadístico se realizó con el software R Studio versión 4.0.2.

### Representación Espacial de la Contaminación Microbiológica y número de habitantes

Para la elaboración del mapa de variación espacial de coliformes fecales en el río Portoviejo, se utilizaron los datos obtenidos de las ocho estaciones de muestreo. Cada estación fue georreferenciada en coordenadas UTM a través de un GPS de mano, y luego procesada en el software QGIS versión 3.28. Los niveles de concentración fueron representados mediante esferas de distintos tamaños de acuerdo a la concentración de coliformes fecales en NMP/100 ml.

Los valores fueron clasificados en rangos conforme a los niveles de contaminación establecidos por Bermúdez-Medrandá et al. (2022) y contrastados con los límites máximos permisibles del MAATE (2015). A su vez, se incorporaron los polígonos de las zonas urbanas



ubicadas en las riberas del río (Instituto Nacional de Estadísticas y Censos, 2011), y se cuantificó el número de habitantes por cada localidad (Tabla 2). Esto permitió observar visualmente la relación entre el nivel de contaminación y la concentración demográfica en las zonas aledañas al cauce del afluente (véase las Figura 3 y 4).

## Resultados

### Nivel de contaminación microbiológica

El análisis de la contaminación microbiológica del río Portoviejo se basó en la escala conceptual propuesta por Bermúdez-Medranda et al. (2022), que permite clasificar la intensidad de la contaminación según el porcentaje de muestras que superan el umbral de 200 NMP/100 mL de coliformes fecales. Esta clasificación considera tres niveles:

- Contaminación baja: hasta el 20 % de las muestras supera los 200 NMP/100 mL.
- Contaminación media: entre el 21 % y 60 % de las muestras superan el umbral.
- Contaminación alta: entre el 61 % y el 100 % de las muestras superan los 200 NMP/100 mL.

Esta escala es útil para describir tendencias generales en el estado microbiológico del agua; sin embargo, con el fin de verificar el cumplimiento legal en cada estación, se contrastaron también los resultados con los Límites Máximos Permisibles (LMP) establecidos por la normativa ambiental ecuatoriana (MAATE, 2015), en la cual los valores de coliformes fecales no deben exceder los 1000 NMP/100 mL para riego y uso pecuario, y 200 NMP/100 mL para fines recreativos.

**Tabla 2**

*Valores NMP/100 mL para cada una de las estaciones y el promedio por estación medida en el río Portoviejo*

Cantón	Estación	Punto	Habitantes	NMP/100ml	Promedio (NMP/100ml)
Santa Ana	E1	1	385	1600	4133.33 ± 4387.86
		2		1600	
		3		9200	
	E2	1	1.151	16000	28666.67 ± 21939.31
		2		16000	
		3		54000	
	E3	1	9.681	92000	41.333.33 ± 39259.82
		2		160000	
		3		92000	
Portoviejo	E4	1	5.665	54000	37666.67 ± 15176.74
		2		35000	
		3		24000	
	E5	1	201.017	160000	137333.33 ± 39259.82
		2		160000	
		3		92000	
Rocafuerte	E6	1	2.712	1700	9366.67 ± 12677.67
		2		24000	
		3		2400	
	E7	1	1.86	16000	13733.33 ± 3925.98
		2		16000	
		3		9200	
Sucre	E8	1	10.657	24000	14066.67 ± 11027.84
		2		16000	
		3		2200	

La Tabla 2 muestra los valores obtenidos en cada uno de los puntos de muestreo. Se observó que el 100 % de las muestras superaron el umbral de 200 NMP/100 mL, lo que ubica al río Portoviejo en el nivel de contaminación alta, según Bermúdez-Medranda et al. (2022). Además, el 92 % de los valores promedio por estación también superaron los límites establecidos por la normativa ecuatoriana para riego y contacto recreativo. Esto evidencia una situación crítica de calidad microbiológica en todo el cauce del río, como en otros del país, así lo indican Richiardi et al., (2023); Silva et al., (2024); Vinueza et al., (2021).

### Parámetros fisicoquímicos

Con el propósito de evaluar la calidad del agua en distintas localidades de la cuenca del río Portoviejo, se analizaron los parámetros fisicoquímicos obtenidos a partir de tres puntos de muestreo por estación, considerando un total de 24 puntos distribuidos en los cantones de Santa Ana, Portoviejo, Rocafuerte y Sucre (ver Tabla 3 y Figura 2).

El pH promedio registrado fue de  $7.76 \pm 0.13$ , dentro del rango permitido por la normativa ecuatoriana (6.5 a 9.5). El valor más elevado (8.19) se observó en la muestra 1 de la Estación 4 (cantón Portoviejo), mientras que el valor más bajo (7.47) correspondió a la muestra 2 de la Estación 2 (Santa Ana). La estación con el promedio más alto fue la E4 ( $8.01 \pm 0.17$ ), y la más baja fue la E2 ( $7.56 \pm 0.12$ ).

Respecto a la conductividad eléctrica, se obtuvo un promedio general de  $1286.33 \pm 803.33 \mu\text{S/cm}$ , lo cual representa una restricción moderada para uso agrícola (700–3000  $\mu\text{S/cm}$ ), según el Anexo 1 del Libro VI del TULSMA. La mayor conductividad (3100  $\mu\text{S/cm}$ ) se registró en la muestra 3 de la Estación 8 (Sucre), clasificándose como de restricción severa ( $>3000 \mu\text{S/cm}$ ), mientras que el valor mínimo (263  $\mu\text{S/cm}$ ) se observó en la muestra 2 de la Estación 1 (Santa Ana), considerada apta para riego.

**Tabla 3**

*Parámetros fisicoquímicos de las estaciones medidas en el río Portoviejo*

Cantón	Estación	Punto	pH	Media	Temperatura (°C)	Media	Conductividad ( $\mu\text{S/cm}$ )	Media	TDS (ppm)	Media	Salinidad (g/L)	Media
Santa Ana	E1	1	7.61	<b>7.69</b>	28.90	<b>28.63</b>	268	<b>279</b>	190	<b>192</b>	0.14	<b>0.13</b>
		2	7.65		28.40		263		192		0.13	
		3	7.81		28.60		306		195		0.13	
	E2	1	7.70	<b>7.56</b>	29.00	<b>29.07</b>	326	<b>344</b>	247	<b>248</b>	0.17	<b>0.18</b>
		2	7.47		29.20		342		246		0.18	
		3	7.52		29.00		365		252		0.18	
E3	1	7.71	<b>7.71</b>	29.20	<b>29.07</b>	573	<b>587</b>	387	<b>408</b>	0.27	<b>0.29</b>	
	2	7.77		28.80		575		406		0.29		
	3	7.64		29.20		612		430		0.3		
Portoviejo	E4	1	8.19	<b>8.01</b>	28.50	<b>28.43</b>	1616	<b>1512</b>	1150	<b>1080</b>	0.81	<b>0.76</b>
		2	7.99		28.40		1466		1040		0.74	
		3	7.85		28.40		1455		1050		0.74	
	E5	1	7.74	<b>7.77</b>	29.20	<b>28.97</b>	1635	<b>1657</b>	1160	<b>1177</b>	0.82	<b>0.81</b>
		2	7.74		28.80		1677		1190		0.78	
		3	7.83		28.90		1660		1180		0.83	
Rocafuerte	E6	1	7.72	<b>7.78</b>	29.10	<b>29.27</b>	1664	<b>1675</b>	1180	<b>1190</b>	0.83	<b>0.84</b>
		2	7.81		29.50		1672		1190		0.84	
		3	7.81		29.20		1689		1200		0.85	
	E7	1	7.79	<b>7.81</b>	28.90	<b>29.27</b>	1682	<b>1669</b>	1200	<b>1193</b>	0.84	<b>0.84</b>
		2	7.90		29.70		1659		1190		0.84	
		3	7.74		29.20		1667		1190		0.83	
Sucre	E8	1	7.74	<b>7.73</b>	29.40	<b>28.97</b>	2460	<b>2567</b>	1740	<b>1813</b>	1.23	<b>1.28</b>
		2	7.72		28.80		2140		1520		1.07	
		3	7.74		28.70		3100		2180		1.53	
			<b>7.76</b>		<b>28.96</b>		<b>1286.33</b>		<b>912.71</b>		<b>0.64</b>	

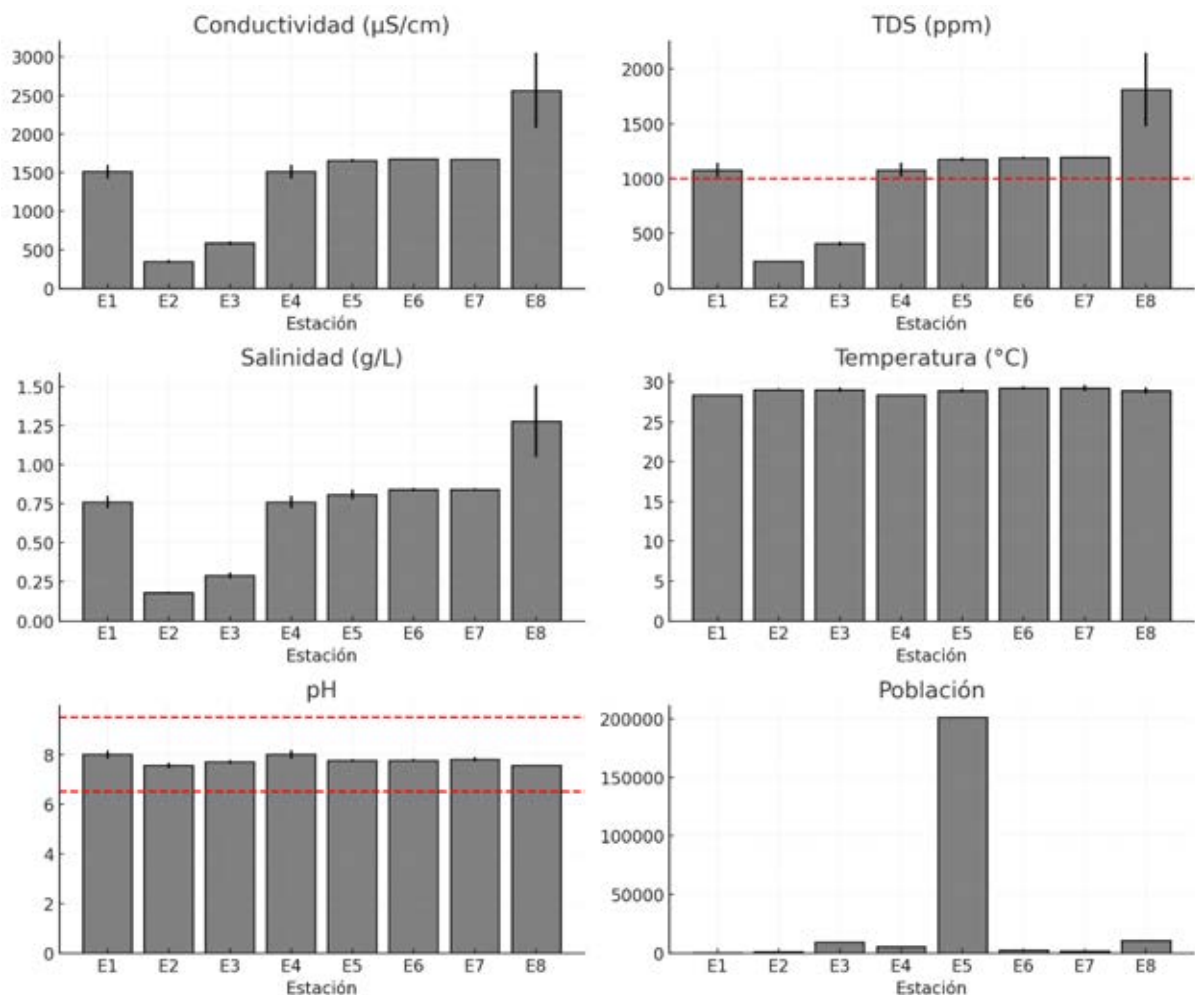
El análisis de sólidos totales disueltos (TDS) evidenció un promedio de  $912.71 \pm 570.69$  mg/L, situándose en el rango de restricción moderada para riego agrícola. La concentración más alta fue de 2180 mg/L en la muestra 3 de la Estación 8, lo que indica una restricción severa ( $>2000$  mg/L), mientras que el valor más bajo fue de 190 mg/L en la muestra 1 de la Estación 1. El promedio más alto por estación se observó en E8 ( $1813.33 \pm 336.06$  mg/L).

En cuanto a la salinidad, los valores oscilaron entre 0.13 y 1.53 g/L, con un promedio global de  $0.64 \pm 0.40$  g/L. La Estación 8 evidenció el promedio más alto ( $1.28 \pm 0.23$  g/L) y la muestra 3 es la más salina (1.53 g/L), mientras que el promedio más bajo fue reportado en la Estación 1 ( $0.13 \pm 0.006$  g/L).

Por último, la temperatura del agua en las distintas estaciones promedió  $28.96 \pm 0.29$  °C. El valor más elevado ( $29.7$  °C) se presentó en la muestra 2 de la Estación 7 (Rocafuerte), mientras que los valores más bajos ( $28.4$  °C) se observaron en la muestra 2 de la Estación 1 y en las muestras 2 y 3 de la Estación 4. El promedio más alto fue el de la Estación 7 ( $29.27 \pm 0.40$  °C) y el más bajo en la Estación 4 ( $28.43 \pm 0.06$  °C).

**Figura 2**

*Parámetros fisicoquímicos y población por estación de muestreo en el río Portoviejo*



Nota: Se muestran los valores promedio de conductividad eléctrica ( $\mu\text{S}/\text{cm}$ ), sólidos totales disueltos (TDS, ppm), salinidad (g/L), temperatura ( $^{\circ}\text{C}$ ) y pH con sus respectivas barras de error ( $\pm$  desviación estándar). Se incluyen las líneas de referencia normativas para TDS (1000 ppm) y pH (6.5–9.5), según el MAATE (2015). En la última gráfica se presenta la población estimada en cada estación. Estos datos permiten contextualizar la presión antropogénica sobre la calidad del agua en las zonas evaluadas.

### Comparación con Normativas Ambientales nacional e internacional

Los datos obtenidos de la concentración de coliformes fecales se contrastaron con los límites máximos permisibles (LMP) decretados en la normativa ambiental ecuatoriana, uruguaya y mexicana (Tabla 4).

**Tabla 4**

*Valores límites máximos permisibles (LMP) de coliformes fecales, según normas de los países Ecuador, Uruguay, Colombia, EEUU, Chile y la OMS*

Uso del Agua	Ecuador	Uruguay	Colombia	OMS	EE. UU. (EPA)	Chile
Riego agrícola (cultivos comestibles)	1000	≤2000 (prom. <1000)	1000	<1000	≤126 E. coli	≤1000
Uso pecuario	1000	≤2000 (prom. <1000)	1000	<1000	≤126 E. coli	≤1000
Recreación (contacto primario)	200	≤1000 (prom. <500)	200	0–200	≤126 E. coli	≤500
Descarga a cuerpos de agua dulce o marino	2000	≤5000 (80% muestras)	≤1000	N/A	≤200 E. coli	≤1000
Conservación (flora/fauna, cultivos no comestibles)	2000	≤2000 (prom. <1000)	≤1000	N/A	≤200 E. coli	≤1000

*Nota:* OMS = Organización Mundial de la Salud; EPA = Environmental Protection Agency (EE. UU.). Los valores indican el límite máximo permisible de coliformes fecales en agua, expresado como número más probable (NMP) por cada 100 mL.

*Fuente:* MAATE (2015) antes MAE, Decreto 253/1979, NOM-127-SSA1-1994, Resolución 2115 de 2007, WHO (2011), EPA (2012), NCh409/1.Of2005.

### Análisis Estadístico

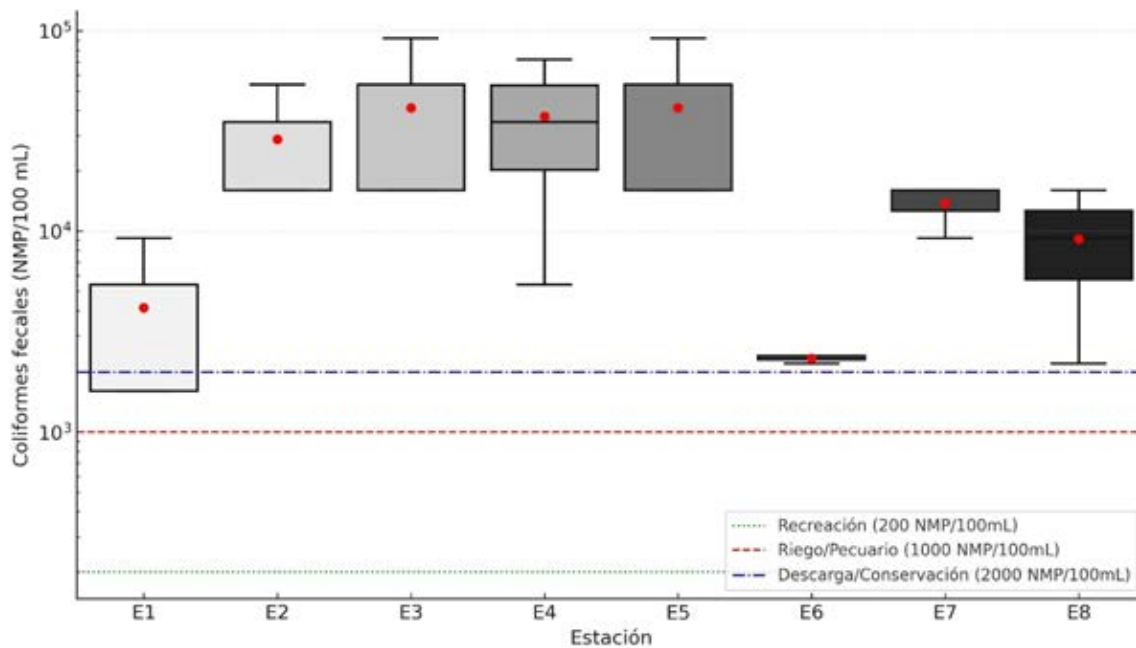
Una vez obtenidos los datos microbiológicos y fisicoquímicos, se procedió con el análisis estadístico. Para determinar si se debían aplicar pruebas paramétricas o no paramétricas, se evaluó la normalidad de los datos mediante la prueba de Anderson-Darling. Esta prueba estadística permite verificar si los datos siguen una distribución normal. Se utilizó un nivel de significancia de 0.05; cuando el valor-p fue menor a este umbral, se rechazó la normalidad, por lo que se optó por utilizar pruebas no paramétricas.

En continuidad, se aplicó la prueba de Levene para comprobar la homogeneidad de varianzas entre estaciones. Con base en estos resultados, se utilizó un análisis de varianza (ANOVA) de una vía, seguido de una prueba post hoc de Tukey, para identificar diferencias significativas entre las ocho estaciones de muestreo respecto a los niveles de coliformes fecales y sus relaciones con los parámetros fisicoquímicos medidos. Además, se realizó una prueba de correlación de Pearson para explorar las asociaciones entre las variables analizadas.

Los resultados de la variabilidad de coliformes fecales entre estaciones se visualizan en la Figura 3, mediante un gráfico boxplot con escala logarítmica ( $\log_{10}$ ) que incluye las líneas guía correspondientes a los límites normativos establecidos por la normativa ambiental ecuatoriana (MAE, 2015). Esta representación gráfica permitió identificar de forma clara las estaciones que exceden los valores permitidos y la dispersión de los datos entre réplicas. Todos los análisis estadísticos y visualizaciones fueron realizados utilizando el software R Studio versión 4.0.2.

**Figura 3**

*Distribución de coliformes fecales por estación de muestreo en el río Portoviejo, provincia de Manabí*



*Nota:* Se presentan los valores de coliformes fecales (NMP/100 mL) en escala logarítmica para cada estación (E1–E8), con la media indicada por círculos rojos. Las líneas horizontales corresponden a los límites máximos permisibles establecidos por la normativa ecuatoriana: 200 NMP/100 mL para recreación con contacto primario (línea verde punteada), 1000 NMP/100 mL para riego agrícola y uso pecuario (línea roja discontinua), y 2000 NMP/100 mL para descarga en cuerpos de agua dulce o conservación de flora/fauna (línea azul punteada). Fuente: elaboración propia con base en MAATE (2015), antes MAE.

### Discusión

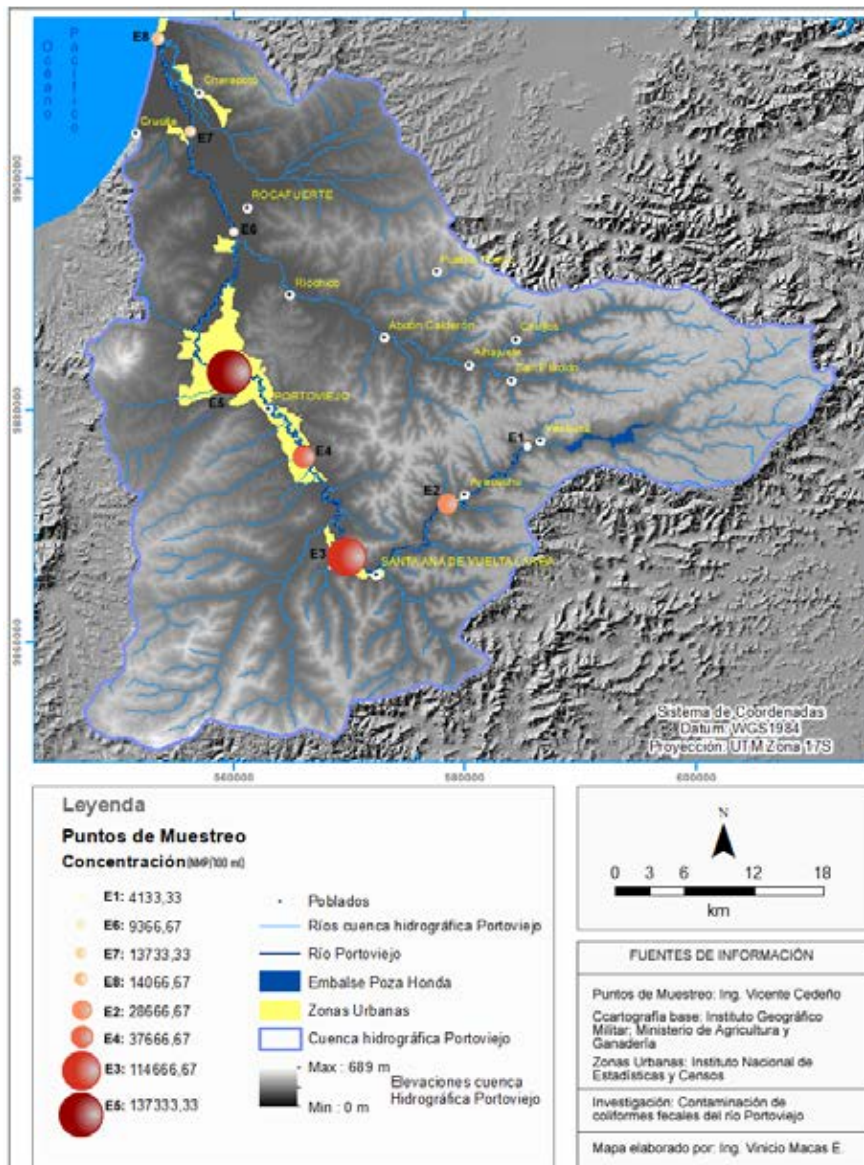
Se detectó la presencia de coliformes fecales en todas las estaciones de muestreo del río Portoviejo, con un promedio general de  $44,954.17 \pm 52,727.29$  NMP/100 mL. El valor promedio más alto se registró en la Estación 5 (Portoviejo urbano), con  $137,333.33 \pm 39,259.82$  NMP/100 mL, coincidiendo con la localidad de mayor número de habitantes entre los sitios evaluados (Figura 4); en contraste, el valor promedio más bajo se obtuvo en la Estación 1 (E1), ubicada aguas arriba del río en una zona rural, con  $4,133.33 \pm 4,387.86$  NMP/100 mL.

Asimismo, los valores máximos individuales fueron observados en las muestras 2 de la Estación 3 y muestras 1 y 2 de la Estación 5, con valores de hasta 160,000 NMP/100 mL. Los valores mínimos fueron reportados en las muestras 1 y 2 de la Estación 1, con 1,600 NMP/100 mL, lo que refleja un claro gradiente de contaminación creciente desde la Estación 2 hacia la ciudad de Portoviejo, seguido por una leve disminución en la zona de desembocadura hacia el Océano Pacífico.

La leve disminución de coliformes fecales observada en la Estación 8 (zona de desembocadura) puede atribuirse a procesos naturales de dilución, sedimentación y autodepuración del ecosistema fluvial; además, la intrusión salina del estuario del manglar La Boca podría generar un ambiente menos favorable para la supervivencia de coliformes fecales, lo que explicaría la atenuación relativa de la carga microbiana en comparación con estaciones altamente urbanizadas aguas arriba.

**Figura 4**

*Mapa de variación espacial de coliformes fecales en NMP/100 ml en el río Portoviejo*



*Nota:* Los puntos de muestreo (E1 a E8) están representados mediante símbolos proporcionales que indican la concentración promedio de coliformes fecales (NMP/100 mL) en cada estación. El mapa incluye límites hidrográficos, zonas urbanas, red hidrográfica y elevaciones dentro de la cuenca. Elaborado con base en información cartográfica del Instituto Geográfico Militar, MAATE (2015), INEC y trabajo de campo de la presente investigación. Proyección UTM zona 17S, Datum WGS84.

### **Comparación de los resultados por cantón con Normativa Ambiental**

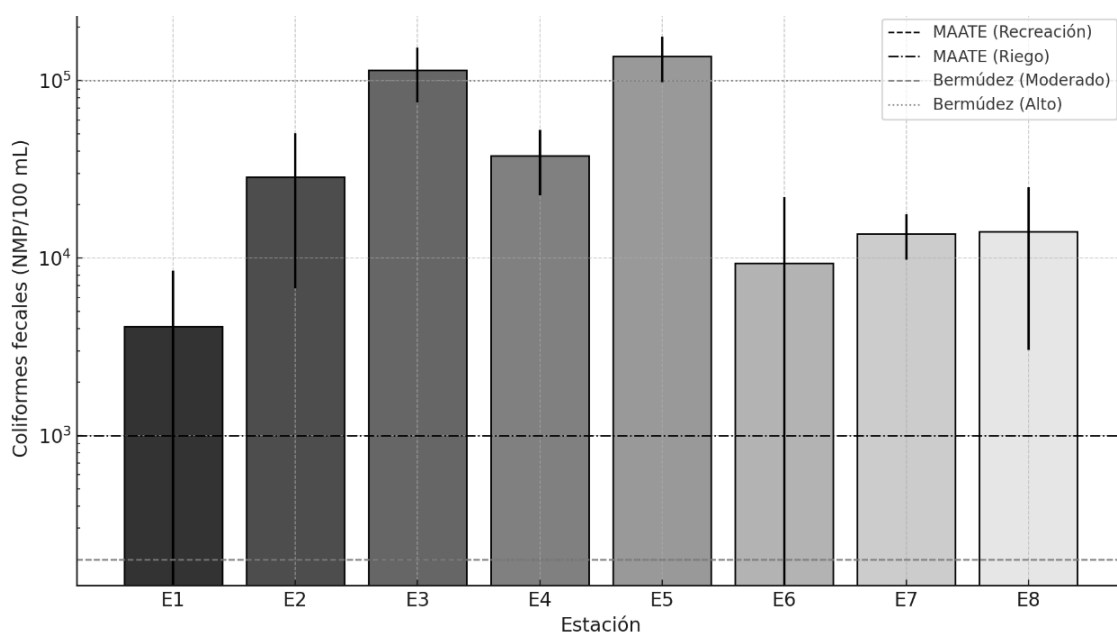
En la Figura 5 al comparar los niveles promedio de coliformes fecales obtenidos en las estaciones del río Portoviejo con las normativas ambientales, se evidencia que la mayoría de las estaciones superan los límites establecidos para riego agrícola (1000 NMP/100 mL) y recreación con contacto primario (200 NMP/100 mL), según el MAATE (2015). Incluso los valores más bajos, como el de la estación E1 (4133,33 NMP/100 mL), se encuentran por encima del límite ecuatoriano para uso recreativo. Estos resultados reflejan una condición de contaminación microbiológica generalizada en el cauce del río.

La Tabla 4, vista arriba, resume los límites máximos permisibles establecidos por Ecuador y otros países (Uruguay, Colombia, EE. UU., Chile) y organismos internacionales, como la OMS, permitiendo contextualizar los niveles encontrados en este estudio. En este sentido, se destaca que los valores registrados en estaciones como E3, E5 y E8 exceden los estándares para descarga en cuerpos de agua dulce e incluso los límites recomendados por la EPA para *E. coli* ( $\leq 126$  NMP/100 mL), sugiriendo un riesgo significativo para usos recreativos o agrícolas sin tratamiento previo.

Los resultados obtenidos muestran una presencia generalizada de coliformes fecales en todas las estaciones de muestreo del río Portoviejo. El promedio global fue de  $44954.17 \pm 52727.29$  NMP/100 mL, superando ampliamente los límites máximos permisibles (LMP) establecidos para fines recreativos y riego agrícola, tanto en la normativa ecuatoriana (MAATE, 2015) como en normas internacionales.

**Figura 5**

*Comparación de niveles de coliformes fecales con escalas MAATE y Bermúdez-Medrandá*

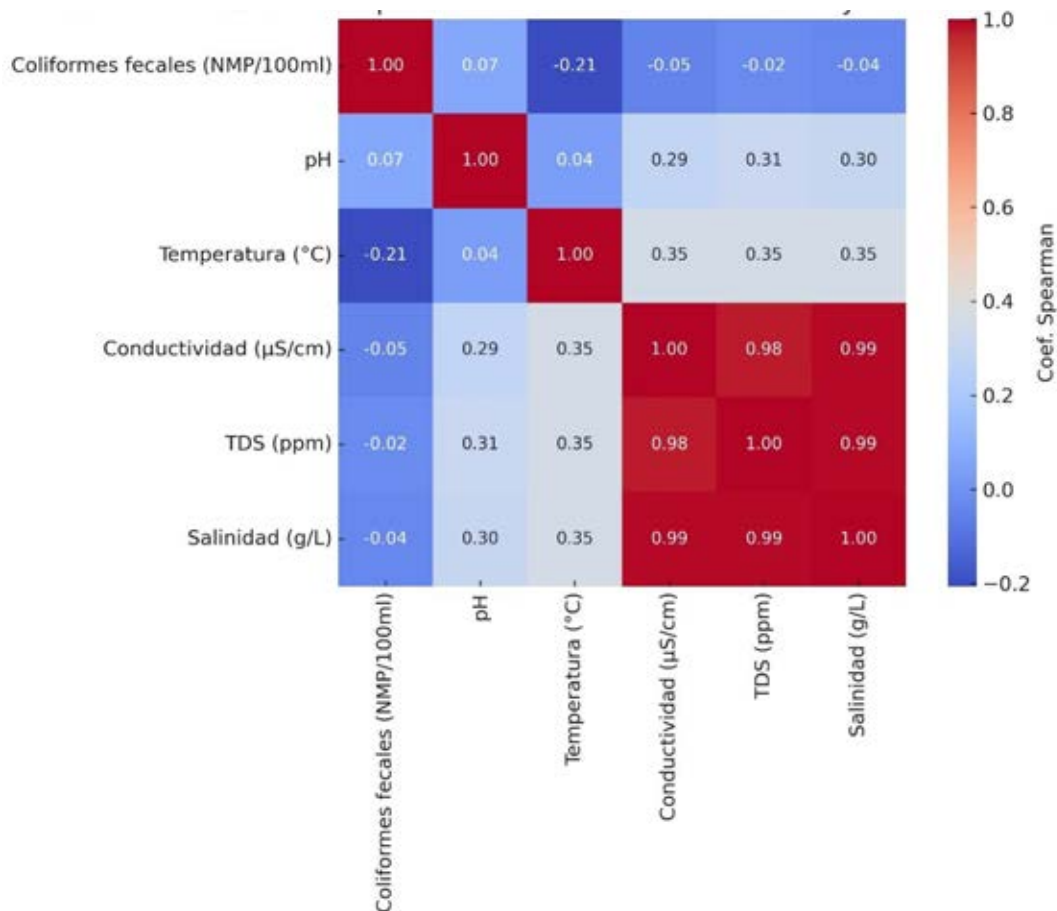


### Análisis de Correlación

La Figura 6 presenta la matriz de correlación de Spearman entre la concentración de coliformes fecales y los parámetros fisicoquímicos evaluados en las ocho estaciones de muestreo del río Portoviejo. Se observa que la concentración de coliformes presenta correlaciones negativas débiles con el pH ( $\rho = -0.14$ ), temperatura ( $\rho = -0.14$ ), conductividad eléctrica ( $\rho = -0.07$ ), TDS ( $\rho = -0.07$ ) y salinidad ( $\rho = -0.07$ ), indicando que el aumento de estos parámetros no necesariamente está asociado con un incremento de la contaminación microbiológica; en contraste, se evidencian correlaciones positivas fuertes entre conductividad, TDS y salinidad ( $\rho > 0.98$ ), lo que sugiere un origen común o comportamiento similar en el sistema hídrico. Estos resultados permiten interpretar que los niveles de coliformes fecales están más influenciados por fuentes puntuales de contaminación fecal que por las variaciones fisicoquímicas del agua.

**Figura 6**

*Matriz de correlación de Spearman entre la concentración de coliformes fecales y los parámetros fisicoquímicos*



*Nota:* Matriz de correlación de Spearman entre la concentración de coliformes fecales (NMP/100 mL) y los parámetros fisicoquímicos del agua en ocho estaciones del río Portoviejo. Se incluyen pH, temperatura, conductividad eléctrica, sólidos totales disueltos (TDS) y salinidad. Las tonalidades representan la fuerza y dirección de la correlación. Los coeficientes fueron calculados a partir de los valores medios por estación. El análisis fue realizado en RStudio 4.0.2.

### **Aplicabilidad de los resultados y propuesta de Plan de Acción Territorial**

Los resultados obtenidos en este estudio evidencian niveles preocupantes de contaminación microbiológica por coliformes fecales en el río Portoviejo, especialmente en las zonas urbanas de los cantones de Portoviejo, Santa Ana y Sucre. Estos hallazgos no solo permiten caracterizar la calidad del agua en términos cuantitativos, sino que también proporcionan insumos críticos para el diseño de estrategias de gestión ambiental a nivel local y cantonal.

En este contexto, se propone un plan de acción orientado a mitigar los impactos detectados, considerando tanto el diagnóstico por cantón como la identificación de puntos estratégicos y las instituciones responsables de su ejecución. La propuesta fue diseñada con base en los niveles promedio de coliformes fecales por estación, la distribución poblacional cercana y el uso de suelo predominante (urbano, agrícola, pecuario o camaronero). La Tabla 5 presenta una síntesis del plan de acciones claves.

Se destaca la necesidad de establecer comités intermunicipales para coordinar acciones, fortalecer la inspección de fuentes de contaminación (alcantarillado, descargas industriales,



drenaje pluvial), promover prácticas sostenibles en el manejo agropecuario, y fomentar la educación ambiental en comunidades aledañas al cauce; asimismo, se recomienda implementar un monitoreo semestral del agua en cada cantón, diferenciando entre época seca y lluviosa.

Este plan de acción constituye una herramienta técnica que permite vincular la evidencia científica con la planificación territorial, y representa una oportunidad para fortalecer la gobernanza del recurso hídrico en la cuenca del río Portoviejo.

**Tabla 5**

*Plan Estratégico para la Mitigación de la Contaminación por coliformes fecales en la cuenca del río Portoviejo*

Cantón	Objetivo Estratégico	Acciones Clave	Actores Involucrados	
Santa Ana	Reducir la contaminación bacteriológica en el río Portoviejo  Educar y sensibilizar a la población sobre el cuidado del agua	Mejorar el sistema de alcantarillado y tratamiento de aguas residuales Desarrollar campañas educativas en escuelas y comunidades	Municipio, GAD Parroquial, MAATE Ministerio de Educación, ONG, universidades locales	2025-2027
Portoviejo		Controlar descargas ilegales y fortalecer monitoreo ambiental Implementar programas radiales y talleres comunitarios	Municipio, ARCSA, MAATE Medios de comunicación, líderes barriales	2025-2026
Rocafuerte		Implementar soluciones individuales en zonas rurales sin alcantarillado Organizar brigadas comunitarias de monitoreo y limpieza	GAD cantonal, organizaciones comunitarias Voluntarios locales, universidades	2025-2028
Sucre		Mejorar el acceso a servicios sanitarios en comunidades vulnerables Incluir temas de educación ambiental en actividades turísticas	Municipio, MIES, MAATE Ministerio de Turismo, operadores turísticos	2025-2026

Los niveles de coliformes fecales detectados en el río Portoviejo guardan correspondencia con los hallazgos reportados por Real Goya et al. (2025) en el río Jama, donde también se identificaron concentraciones que exceden los límites permisibles establecidos por la normativa ecuatoriana. Esta tendencia de acumulación de coliformes en sectores medios y bajos de la cuenca ha sido documentada igualmente en el río Milagro (Cevallos Cabrera, 2022). En este contexto, resulta pertinente considerar experiencias exitosas como la del río Chambo, donde la implementación de estrategias participativas fortaleció la gobernanza hídrica y el control de vertidos (Herrera-Morales et al., 2022). Estos antecedentes respaldan la necesidad de una intervención estructurada y coordinada en la cuenca del río Portoviejo, articulando acciones comunitarias, institucionales y técnicas para reducir la carga microbiológica y proteger la salud pública.

### Conclusiones

El río Portoviejo presenta contaminación microbiológica a lo largo de todo su curso, con concentraciones de coliformes fecales que van desde 1,600 hasta 160,000 NMP/100 ml. Los promedios por estación superan los límites establecidos por la normativa ecuatoriana (Acuerdo Ministerial 097-A) y uruguayo (Decreto N.º 253/979), evidenciando un riesgo para la salud y el ambiente.

Comparado con estudios de 2017 y 2020, los niveles de coliformes se incrementaron un 206 % y 1,772 % respectivamente, indicando un aumento exponencial de la contaminación en los últimos seis años.

Las estaciones con mayor contaminación corresponden a áreas densamente pobladas como Santa Ana y Portoviejo, donde el sistema de alcantarillado es deficiente y existen descargas clandestinas. Parámetros como pH, temperatura y salinidad estuvieron dentro de rangos aceptables; sin embargo, la conductividad eléctrica (279–2,566.67  $\mu\text{S}/\text{cm}$ ) y los sólidos totales disueltos (192.33–1,813.33 mg/l) presentaron restricciones severas para el uso agrícola.

Estudios en los ríos Jama, Milagro, Chambo, Piñas y estero Salado muestran niveles similares o menores, confirmando que la contaminación observada en el río Portoviejo es crítica, especialmente en época seca.

La alta presencia de coliformes fecales incrementa el riesgo de enfermedades como gastroenteritis, disentería, tifoidea y hepatitis, además de potenciales pérdidas económicas por afectación al turismo y productividad.

Es urgente implementar acciones integradas que incluyan vigilancia sanitaria, tratamiento de aguas residuales, educación ambiental y mejora de infraestructura sanitaria para mitigar la contaminación del río.

### Reconocimientos

Los autores declaran la contribución y participación equitativa de roles de autoría para esta publicación.

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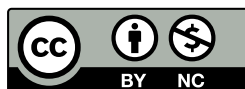
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