Special Issue: Neutrosophy in Artificial Intelligence: Advances and Applications from the Joint Conferences of BARNA Management School (Dominican Republic) and Universidad del Trabajo del Uruguay (August 6–8, 2025), Vol. 92, 2025

University of New Mexico

Artificial Intelligence in Cuban Audiovisual Production: An Approach to Technological Sovereignty Evaluated through Neutrosophic PEST-FODA Analysis

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Abstract. This article aims to respond to the need to generate a public policy for the regulation of artificial intelligence (AI) use in Cuban audiovisuals from technological sovereignty through a neutrosophic PEST-SWOT analysis. After a theoretical-contextual study composed of the history of AI, its scientific and technological bases and the ethical and regulatory issues of use, international experiences and studies and the current state of affairs in Cuba (comprised of technology based barriers, training impediments and absence of a specific regulatory approach), the research takes place through triangulation via a mixed-methodology where theoretical and empirical approaches are integrated with neutrosophic PEST-SWOT analysis. Thus, theoretical and practical results are systematized, attributing truths, degrees of indeterminacy, and falsities to PEST components—political, economic, social, technological, environmental, and legal—and SWOT elements—strengths, weaknesses, opportunities, and threats. The ultimate proposal is to generate a public policy with a protocol of operation that would allow for ethical, regulated, and effective use of AI in the radio and television space for not only national development of audiovisual solutions but also as a contribution to regional dialogue on technological sovereignty and digital ethics.

Keywords: Artificial Intelligence, Audiovisual Production, Technological Sovereignty, Neutrosophic PESTEL-FODA, Cuba, Ethics, Regulation.

1. Introduction

In the current context of media artistic creation, artificial intelligence (AI) constitutes a multidisciplinary system that integrates scientific foundations, technological development, and autonomous integral dynamics. This "phenomenon" fuses algorithms with human creativity, redefining the production, distribution, and consumption of content in the global media ecosystem, while raising profound ethical, cultural, and social questions. In Cuba, the integration of AI into audiovisual media faces specific challenges, such as technological limitations (74% of infrastructure is obsolete), training gaps, and the absence of a specific regulatory framework, according to the preliminary diagnosis. This requires a rigorous analysis to guarantee technological sovereignty and the preservation of national identity, fundamental axes of the Digital Transformation Policy.

The scenario demands, according to [1], a structural readjustment of audiovisual media to adapt their organizational and creative models to a post-broadcasting ecosystem, competing with personalized proposals while preserving cultural identity in a fragmented media environment. This challenge is particularly relevant for Cuba, where technological sovereignty is a priority. Conceptually, [2] defines AI as systems that "learn from data and use what they learn in decision-making, just as a

human being would," ranging from basic algorithms for mechanical tasks to complex architectures such as deep learning (deep learning). learning), where artificial neural networks process information hierarchically, approximating human creative patterns.

On an international scale, AI has optimized audiovisual processes, achieving increases of 76% in efficiency and 58% in accuracy[4], through systems that combine Natural Language Processing and Machine Learning, revolutionizing journalistic practices and audiovisual narratives[5]. Tools such as Adobe Premiere Pro (automatic cuts, color correction), DaVinci Resolve (automatic cuts, color correction), and AI have been used to optimize audiovisual productions. Resolve (post-production optimization), Runway ML (video generation from text), Descript (editable audio transcription), and Synthesia or Hei Gen (virtual presenters) are prominent examples in Europe, the US, Brazil, and Mexico. In the script, GPT-4, Jasper, and others suggest dialogues and storylines (OpenAI, 2023). However, [3] they underline the need for AI to "respect human dignity, fairness, and transparency" (p. 15), in the face of risks such as algorithmic bias and misinformation, while the European Parliament imposes strict transparency requirements[6] and [4] highlights gaps in market-based approaches.

The International Telecommunication Union (ITU), in its 2023 Global Connectivity Report, highlights that 34% of the world's population lacks internet access, pointing to critical gaps in infrastructure and cybersecurity in developing countries. Cuba, an active member of the ITU, prioritizes digital inclusion, as reaffirmed in 2023 between President Miguel Díaz-Canel and Doreen Bogdan-Martin. [5]'s study on the application of AI at Spanish National Radio (RNE) shows how automatic transcription and segmentation improve accessibility, although it requires human intervention to optimize results, an observation relevant to Cuba.

The search for Cuban authors was challenging due to the limited presence and restrictions on access to publications. Machado Pando[7] highlights the potential of AI to improve efficiency in content production in Cuba, but underlines ethical and technical challenges in a context of limited resources. Chapter XII, Article 92 of Law 162/23 on Social Communication recognizes science, technology, and innovation as pillars of the Social Communication System, providing a legal basis for specific regulations, especially subsection n), which establishes public policies on AI in the media.

This article employs neutrosophic PEST-SWOT analysis to assess the implementation of AI in Cuban radio and television, considering the uncertainty and contradictions inherent in the context. This method integrates political, economic, social, technological, environmental, and legal factors (PESTEL), along with strengths, weaknesses, opportunities, and threats (SWOT), assigning degrees of truth (T), indeterminacy (I), and falsity (F) to model complexities such as external technological dependence and legal loopholes. The study contributes to knowledge about technology and artistic creation in development contexts, offers practical tools for producers and journalists, and anticipates ethical and legal challenges (copyright, authenticity, data protection) for sovereign and ethical regulation.

General Objective: To design a policy that promotes the ethical, responsible, and effective use of AI in Cuban radio and television, using neutrosophic PEST-SWOT analysis for a critical diagnosis of the current context and comparison with international regulatory frameworks.

2. Preliminaries

SWOT Analysis

SWOT analysis is an essential technique for assessing the status of a company or project, examining both its internal characteristics (Strengths and Weaknesses) and its external environment (Opportunities and Threats) in a structured matrix. This process is broken down into four phases: external analysis, internal analysis, creation of the SWOT matrix and determination of the strategy to follow. The survival and prosperity of the organization are deeply linked to the environment that surrounds it, which presents both opportunities and threats. These are the key components of the external analysis.

Simultaneously, the internal factors of the organization, such as its weaknesses and strengths, directly depend on its internal management [6].

Each of these four aspects can be classified as positive, driving the development of the organization, or negative, representing obstacles that impede such development. Opportunities are positive factors in the environment that, once identified, can be exploited to foster the growth of the organization or project. On the contrary, threats are negative external influences that must be addressed with tactics and strategies to overcome them. Internally, weaknesses are negative elements that need to be overcome through proper management, while strengths are positive aspects that must be exploited and enhanced. The SWOT analysis identifies strengths and weaknesses in areas such as the availability of capital resources, personnel, assets, product quality, internal and market structure, and consumer perception. The results of this analysis are placed in a matrix and evaluated by experts, whose combined assessment offers a clear vision of the most promising strategies and tactics for the organization or project [7].

PEST analysis

PEST analysis examines the external factors that influence a company, covering political, economic, social and technological components. This analysis allows to understand how legislative regulations, economic conditions, sociocultural trends and technological advances impact the organization. For example, political factors include environmental protection laws, antitrust regulations, and government stability, while economic factors cover all the variables that affect the market. Sociocultural aspects refer to the configuration and behavior of consumers, and technological factors consider the development and adoption of new technologies [8]. The PEST-SWOT methodology is developed in two main stages. First, a comprehensive analysis of external factors is carried out from the political, economic, social, and technological perspectives. In the second stage, the principles of SWOT analysis are applied to evaluate the internal characteristics of the company. By combining both approaches, a comprehensive and detailed view of the business situation is obtained, identifying external opportunities and threats, as well as strengths and weaknesses. Internal, which facilitates the formulation of more effective and holistic strategies for the development and sustainability of the company [9-10].

Unlike traditional PEST-SWOT methods, in this study, the evaluations are based on Single-Valued Triangular Neutrosophic Numbers. The following are key explanations on this topic.

Definition 1 ([11]) : The neutrosophic set Nis characterized by three membership functions, which are the truth membership function T_A, the indeterminacy membership functionI_A and falsehood membership function F_A, where Uis the Universe of Discourse and $\forall x \in U$, $T_A(x), I_A(x), F_A(x) \subseteq]\bar{}_A 0, 1^+[$, and $\bar{}_A 0 \leq \inf T_A(x) + \inf I_A(x) + \inf F_A(x) \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3^+$.

See that by definition, $T_A(x), I_A(x)$and $F_A(x)$are standard or nonstandard real subsets of $]\bar{}_A 0, 1^+[$and, hence $T_A(x), I_A(x)$and $F_A(x)$can be subintervals of $[0,1]$. $\bar{}_A 0$and1^+ They belong to the set of hyperreal numbers.

Definition 2 ([11]): The single-valued neutrosophic set $F_A: U \to [0,1]$(SVN N) Ais U, $T_A: U \to [0,1]$where $A = \{< x, T_A(x), I_A(x), F_A(x) > : x \in U\}$and $I_A: U \to [0,1]$. $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

The single-valued neutrosophic number (SVN) N) is symbolized by

$N = (t, i, f)$, such that $0 \leq t, i, f \leq 1$and $0 \leq t + i + f \leq 3$.

Definition 3 ([11]): The single- valued triangular neutrosophic number, $\tilde{a} = \langle (a_1, a_2. a_3); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle$, is a neutrosophic set in $\mathbb{R}$, whose truth, indeterminacy, and falsity membership functions are defined as follows:

$$T_{\tilde{a}}(x) = \begin{cases} \alpha_{\tilde{a}}\left(\frac{x-a_1}{a_2-a_1}\right), a_1 \leq x \leq a_2 \\ \alpha_{\tilde{a}, x=a_2} \\ \alpha_{\tilde{a}}\left(\frac{a_3-x}{a_3-a_2}\right), a_2 < x \leq a_3 \\ 0, \text{otherwise} \end{cases} \quad (1)$$

$$I_{\tilde{a}}(x)=\begin{cases}\frac{(a_2-x+\beta_{\tilde{a}}(x-a_1))}{a_2-a_1}, a_1\le x\le a_2\\ \beta_{\tilde{a}}, x=a_2\\ \frac{(x-a_2+\beta_{\tilde{a}}(a_3-x))}{a_3-a_2},\ a_2<x\le a_3\\ 1, \text{otherwise}\end{cases} \quad (2)$$

$$F_{\tilde{a}}(x)=\begin{cases}\frac{(a_2-x+\gamma_{\tilde{a}}(x-a_1))}{a_2-a_1}, a_1\le x\le a_2\\ \gamma_{\tilde{a}}, x=a_2\\ \frac{(x-a_2+\gamma_{\tilde{a}}(a_3-x))}{a_3-a_2},\ a_2<x\le a_3\\ 1, \text{otherwise}\end{cases} \quad (3)$$

Where $\alpha_{\tilde{a}},\beta_{\tilde{a}},\gamma_{\tilde{a}}\in[0,1]$,$a_1,\ a_2,a_3\in\mathbb{R}$ and $a_1\le a_2\le a_3$.

Definition 4 ([11]) : Given$\tilde{a}=\langle(a_1,a_2,a_3);\alpha_{\tilde{a}},\beta_{\tilde{a}},\gamma_{\tilde{a}}\rangle$ and$\tilde{b}=\langle(b_1,b_2,b_3);\alpha_{\tilde{b}},\beta_{\tilde{b}},\gamma_{\tilde{b}}\rangle$ two single-valued triangular neutrosophic numbers andλ any non-zero number on the real line. Then, the following operations are defined:

1. Addition: $\tilde{a}+\tilde{b}=\langle(a_1+b_1,a_2+b_2,a_3+b_3);\alpha_{\tilde{a}}\wedge\alpha_{\tilde{b}},\beta_{\tilde{a}}\vee\beta_{\tilde{b}},\gamma_{\tilde{a}}\vee\gamma_{\tilde{b}}\rangle$,
2. Subtraction: $\tilde{a}-\tilde{b}=\langle(a_1-b_3,a_2-b_2,a_3-b_1);\alpha_{\tilde{a}}\wedge\alpha_{\tilde{b}},\beta_{\tilde{a}}\vee\beta_{\tilde{b}},\gamma_{\tilde{a}}\vee\gamma_{\tilde{b}}\rangle$,
3. Investment: $\tilde{a}^{-1}=\langle({a_3}^{-1},{a_2}^{-1},{a_1}^{-1});\alpha_{\tilde{a}},\beta_{\tilde{a}},\gamma_{\tilde{a}}\rangle$, where $a_1,a_2,a_3\neq0$.
4. Multiplication by a scalar number:
$$\lambda\tilde{a}=\begin{cases}\langle(\lambda a_1,\lambda a_2,\lambda a_3);\alpha_{\tilde{a}},\beta_{\tilde{a}},\gamma_{\tilde{a}}\rangle,\lambda>0\\ \langle(\lambda a_3,\lambda a_2,\lambda a_1);\alpha_{\tilde{a}},\beta_{\tilde{a}},\gamma_{\tilde{a}}\rangle,\lambda<0\end{cases}$$

5. Division of two triangular neutrosophic numbers:

$$\frac{\tilde{a}}{\tilde{b}}=\begin{cases}\langle\left(\frac{a_1}{b_3},\frac{a_2}{b_2},\frac{a_3}{b_1}\right);\alpha_{\tilde{a}}\wedge\alpha_{\tilde{b}},\beta_{\tilde{a}}\vee\beta_{\tilde{b}},\gamma_{\tilde{a}}\vee\gamma_{\tilde{b}}\rangle, a_3>0 \text{ and } b_3>0\\ \langle\left(\frac{a_3}{b_3},\frac{a_2}{b_2},\frac{a_1}{b_1}\right);\alpha_{\tilde{a}}\wedge\alpha_{\tilde{b}},\beta_{\tilde{a}}\vee\beta_{\tilde{b}},\gamma_{\tilde{a}}\vee\gamma_{\tilde{b}}\rangle, a_3<0 \text{ and } b_3>0\\ \langle\left(\frac{a_3}{b_1},\frac{a_2}{b_2},\frac{a_1}{b_3}\right);\alpha_{\tilde{a}}\wedge\alpha_{\tilde{b}},\beta_{\tilde{a}}\vee\beta_{\tilde{b}},\gamma_{\tilde{a}}\vee\gamma_{\tilde{b}}\rangle, a_3<0 \text{ and } b_3<0\end{cases}$$

6. Multiplication of two triangular neutrosophic numbers:

$$\tilde{a}\tilde{b}=\begin{cases}\langle(a_1b_1,a_2b_2,a_3b_3);\alpha_{\tilde{a}}\wedge\alpha_{\tilde{b}},\beta_{\tilde{a}}\vee\beta_{\tilde{b}},\gamma_{\tilde{a}}\vee\gamma_{\tilde{b}}\rangle,\ a_3>0 \text{ and } b_3>0\\ \langle(a_1b_3,a_2b_2,a_3b_1);\alpha_{\tilde{a}}\wedge\alpha_{\tilde{b}},\beta_{\tilde{a}}\vee\beta_{\tilde{b}},\gamma_{\tilde{a}}\vee\gamma_{\tilde{b}}\rangle, a_3<0 \text{ and } b_3>0\\ \langle(a_3b_3,a_2b_2,a_1b_1);\alpha_{\tilde{a}}\wedge\alpha_{\tilde{b}},\beta_{\tilde{a}}\vee\beta_{\tilde{b}},\gamma_{\tilde{a}}\vee\gamma_{\tilde{b}}\rangle, a_3<0 \text{ and } b_3<0\end{cases}$$

Where,$\wedge$ it is a ty norm$\vee$ it is a conorm t.

2.1 Theoretical foundations and historical evolution of AI in the media.

Artificial intelligence (AI), understood as the ability of computer systems to emulate human functions—reasoning, perception, learning—has evolved from a vision rooted primarily in logic and mathematics (Leibniz, Boole) to the development of neural networks and generative language models. The field was consolidated after the Dartmouth Conference and has since progressed through advances in specialized hardware, the availability of large volumes of data, and the democratization of access to open-source technologies.

The development and application of AI in Cuba have been conditioned by socioeconomic, political, and technological factors. The first academic reference to AI in the country can be traced back to 1969, with a publication in the Critical Bulletin of the University of Havana. Subsequently, from the 1980s onward, research at the Faculty of Mathematics and Computing of the University of Havana concentrated on expert systems, thereby laying the foundations for the future development of the

discipline.

Consequently, the incorporation of AI into the curricula of Computer Science programs, beginning with Plan C (1986), included courses on Logic Programming and Artificial Intelligence [12]. This curricular innovation significantly contributed to the training of local talent. However, persistent challenges related to technological updating and limited access to cutting-edge hardware and software have hindered the full consolidation of the field.

The use of AI in Cuban media can be documented as early as 1990, when Wilfredo Walter Mayet González created a system designed to generate a daily tabloid. Although this system cannot be classified as generative AI—since it relied on reporters' texts as input rather than autonomously producing news—it performed editorial corrections, allowing the newspaper to be produced automatically and without spelling errors. Thus, for the first time in Cuba, a system of this type was successfully implemented in practice.

In 2016, the Cuban digital outlet Postdata.club, in collaboration with the Artificial Intelligence Group of the University of Havana, developed an AI-based system to generate daily reports on the performance of Cuban baseball players in the MLB. The project remains available on GitHub, and further details can be found in Postdata.club publications as well as in peer-reviewed reports [13]. Moreover, AI has also been applied to the digitalization of the written press, most notably through the use of optical character recognition (OCR) for the conversion of historical newspapers, such as Granma, into searchable databases.

Further initiatives include Ideas Multimedios, which has explored the integration of AI for article translation into foreign languages, and Cubadebate, which since 2022 has adopted AI in partnership with CompAI to generate baseball news on its website. This application automatically produces news reports based on game statistics, representing an important milestone in the integration of AI within Cuban journalism.

The radio sector has also undergone significant transformation. For instance, Radio Sancti Spíritus implemented, in May 2024, a digital avatar named "Rosalba" for content production on its digital platform. Similarly, at the provincial station Radio Angulo in Holguín, a multidisciplinary team has worked with AI since 2024, directly influencing programming. Tools such as DeepSeek, Grok, Qwen, and Perplexity are currently employed to generate diverse content, including scripts, journalistic reports, and news articles. At the same time, Mozilla TTS and Audacity have facilitated the creation of virtual speakers (Alberto and Ernesto) and the cloning of voices of acclaimed Cuban radio artists, thereby advancing the field of voice synthesis.

Notably, these technologies have renewed soundtracks, enhanced the production of promotional spots, and enabled experimentation with virtual assistants (Mycroft) and payment systems (Odoo). Furthermore, their development and implementation have been showcased at events such as the Development Fair and the 1st International Workshop on the Use of AI, held at the Palace of Conventions, Havana, in January 2025.

Digital Comparative Panorama: International Governance and Regulatory Sovereignty

Digital sovereignty is defined as a state's ability to exercise authority, control, and regulation over its digital assets—including data, software, hardware, and telecommunications infrastructure—in accordance with its national values and interests. This concept has acquired particular relevance in the era of technological globalization, where digital infrastructures and data flows transcend borders, creating tensions between state autonomy and global interdependence.

In practice, digital sovereignty involves the protection of critical infrastructure, the regulation of global platforms, and the development of proprietary technologies. Europe, for instance, has advanced significantly in this field through regulatory instruments such as the General Data Protection Regulation (GDPR) and the Digital Services Act. These initiatives seek to reduce dependence on foreign

providers while ensuring the security and privacy of citizens.

At present, no comprehensive and unified international legal framework has been established for the regulation of artificial intelligence (AI). Despite this absence, different countries and regions have developed and implemented their own legal and ethical frameworks to address the challenges and opportunities presented by this emerging technology. These initiatives vary in scope and nature, reflecting the priorities and contexts of each region. They range from data privacy and protection regulations to ethical guidelines intended to foster the responsible development of AI. Collectively, these efforts constitute important steps toward building a regulatory environment capable of guiding AI's evolution in ways that ensure its societal impact remains aligned with principles of justice, equity, and respect for human rights.

The EU Artificial Intelligence Act [14] exemplifies such initiatives. Its main objective is to guarantee the safe, transparent, and ethical development and use of AI while protecting fundamental rights and promoting a competitive digital single market through harmonized standards. The regulation adopts an innovative approach by classifying AI systems according to their level of risk—unacceptable, high, limited, and minimal. Systems deemed unacceptable, such as those enabling mass surveillance or subliminal manipulation, are prohibited, while high-risk systems are subject to strict obligations including prior evaluation, transparency, human oversight, and public registration.

For contexts such as Cuba and other developing countries, this European framework offers a pioneering yet adaptable model, although significant challenges remain. Transparency and proper labeling are crucial to strengthening the credibility of state media, while the promotion of training initiatives and the use of free software are essential for advancing technological sovereignty.

In Latin America, Brazil has positioned itself as a regional leader in AI regulation, driven by its digital progress and the high level of business adoption of these technologies. The process began with the Brazilian Artificial Intelligence Strategy (EBIA) in 2021, which set forth ethical and sustainability principles, albeit with no binding force. Subsequently, Bill 2338/23 introduced innovative elements, such as compensating creators for the use of their works in AI training—a unique feature in the region—and a hybrid approach combining ethical principles with risk-based regulation. Nonetheless, the exclusion of social media algorithms from the high-risk category has drawn criticism due to concerns over private sector influence and potential ethical gaps.

The Brazilian model provides a valuable reference, especially regarding the promotion of free software and large-scale training programs, which are key given the region's technological and economic constraints. In 2023, a comprehensive bill was introduced and subsequently approved by the Senate in 2024, establishing a mandatory legal framework for the development and use of AI systems. This framework emphasizes responsible governance, transparency, fundamental rights protection, and innovation, while also implementing a risk-based classification system and creating a regulatory body under the coordination of the National Data Protection Authority (ANPD).

At the global level, the UNESCO Recommendation on the Ethics of Artificial Intelligence [15] establishes a regulatory framework grounded in fundamental principles for the responsible development and use of AI. It is centered on human dignity, justice, inclusion, and respect for human rights. This normative instrument, the product of an intergovernmental and multidisciplinary process, seeks to guide governments, the private sector, and civil society in formulating policies and laws that ensure AI benefits humanity while safeguarding rights such as privacy, non-discrimination, and gender equality.

In the Cuban context, digital sovereignty constitutes a guiding principle of the national Digital Transformation Policy. This policy prioritizes the development of Cuban technological solutions and cooperation with Global South countries to reduce technological dependence and reinforce autonomy in strategic sectors. A notable example is the SocIA platform, developed by the MSME Avangenio. This initiative represents not only a significant step toward digital emancipation and technological sovereignty, but also a form of cultural defense against global algorithmic hegemony. According to its

creators, the platform provides task automation and data processing tailored to national needs. Although it continues to face technical and infrastructural challenges, its ongoing development demonstrates Cuba's commitment to applying AI in ways that address concrete national problems while strengthening digital sovereignty.

Algorithmic Ethics and Social Responsibility

Algorithmic ethics encompasses the set of principles and standards that guide the design, development, and application of algorithms, with the aim of ensuring that their decisions are fair, transparent, and socially responsible. In the media context—where AI and algorithms influence information, communication, and decision-making—algorithmic ethics acquires crucial importance. The fundamental principles include:

Transparency: Systems must be understandable and auditable, allowing users and regulators to examine the criteria underlying decision-making.

Equity: Algorithms must avoid reproducing biases and discrimination, thereby ensuring equal opportunities and fair treatment.

Responsibility: Developers and operators of AI systems must assume responsibility for the consequences of automated decisions.

Privacy: Personal information must be safeguarded, ensuring its ethical use and protection.

In Cuba, the debate on algorithmic ethics has centered on the need to adapt these principles to national values and priorities, while promoting cultural diversity and the protection of citizens' rights. During the UNESCO–MINCOM Regional Workshop on the Ethics of Artificial Intelligence (March 2025), Mayra Arevich, Cuba's Minister of Communications, stressed the importance of harmonizing technological progress with adequate regulation. She highlighted that, in Cuba, it is a priority to evaluate the risks and challenges of AI in order to maximize its benefits for national digital transformation. Her emphasis was placed on a humanist approach that recognizes AI as a social phenomenon and not merely a technological tool.

Critical Theory of Media Applied to AI

Critical theory, originating in the Frankfurt School, proposes a reflexive and emancipatory perspective on power relations in society, including the media. Applied to AI, this approach questions the supposed technical neutrality of algorithms and underscores their role in shaping narratives, distributing information, and automating decision-making processes that impact both social and political life.

Reference [16] develops a theory of philosophy as conceptual design. It argues that information is central to understanding reality: information is both a property of the universe and a medium for constructing models. This framework establishes theoretical foundations on the relationship between information, philosophy, and technology, offering a new way of thinking about philosophy and science by focusing on conceptual design and the epistemological role of information.

Similarly, [17], a contemporary philosopher, advances a critical theory of algorithmic reason, contending that AI operates under an instrumental and predictive logic incapable of grasping context and human common sense. This "algorithmic reason" tends to become naturalized, masking ideological assumptions and restricting the plurality of rationalities. The author warns that the automation of political decisions through AI entails institutional redesigns that may threaten democracy if not accompanied by mechanisms of transparency, participation, and social control.

These perspectives underscore that algorithmic systems can reproduce inequalities and exercise power in opaque ways. Consequently, regulation must transcend mere technical efficiency and prioritize social justice, transparency, and democratic participation. Effective public policies in this

domain require clear regulatory frameworks, oversight mechanisms, and inclusive spaces for collaboration among stakeholders, ensuring that AI development and use remain aligned with fundamental values and rights.

Critical theory also highlights that digital society is not simply characterized by an increase in data, but rather by a qualitative transformation that requires examining the tools that produce and process data as instruments of both knowledge and power. The dominant ideology of the digital age—the belief in the calculability of social reality—risks reducing complex political and social issues to technical problems, thereby stripping citizens of critical capacity and democratic agency. This approach warns that AI is not neutral: it reproduces and amplifies existing power relations, potentially generating discrimination, bias, and large-scale social inequalities if not properly regulated.

2.2 Cuba: Regulatory Frameworks

Cuba currently has a fragmented legal framework that includes general laws on Information and Communications Technologies (ICT) and data protection, but lacks specific regulations for generative AI and mechanisms for algorithmic auditing. The most relevant instruments include:

- Law No. 88 of 1999, on the protection of national sovereignty in cyberspace [18];
- Decree Law No. 370 of 2018, on the use of ICT and computer security;
- Law No. 149 of 2022, on personal data protection [19];
- Law No. 162/2023, on Social Communication and its regulations [20];
- Digital Transformation Policy;
- Digital Agenda 2030 [21];
- National Strategy for the Development of Artificial Intelligence (2024) [22].

The regulation of AI in audiovisual media is articulated around the principles of sovereignty, ethics, and the protection of cultural diversity. Among the most significant regulatory tools are:

- Law No. 162/2023 on Social Communication and its Regulations, which reinforces information sovereignty and ethics in the use of technologies [20].
- The National Strategy for the Development of Artificial Intelligence (2024), which establishes guidelines for technological development and prioritizes strategic sectors such as education and health[21].

Overall, the design of Cuban regulations seeks to create an ecosystem conducive to innovation, human resource training, and the protection of audiences, balancing openness to innovation with the prevention of risks associated with automation and AI-generated content.

In the analysis of this legal framework, in force since October 4, 2024, Chapter XII: "On Research, Development and Innovation in Social Communication" highlights the importance of science, technology, and innovation as fundamental pillars for the development of the national Social Communication System in a context of constant change[20].

Article 7 emphasizes key principles such as information sovereignty (subsection m), ethics and responsibility in the use of technologies (subsection n), and the protection of cultural identity and socialist values (subsections j and k). Article 92 identifies various priority areas of research, including digital transformation, the use of new technologies, interaction on social networks, risk management, and crisis communication. Notably, clause n specifically addresses artificial intelligence (AI), recognizing its influence on communication processes and its broader impact on Cuban society. The explicit inclusion of AI demonstrates the legislator's concern with anticipating global technological changes and adapting them to the Cuban context, thereby framing AI as a strategic priority.

From this perspective, AI is not regarded merely as a technical tool, but as a phenomenon with

ethical, social, and cultural implications that must be critically examined. Its implementation in Cuban radio and television, therefore, should be guided by the principles of sovereignty, ethics, and social justice. Equally important is the need to analyze how AI transforms the production, distribution, and consumption of media content. Such analysis must address not only the opportunities for improving efficiency, creativity, and accessibility but also the risks associated with algorithmic bias, misinformation, technological dependence on external actors, and potential threats to cultural identity.

In this regard, Article 92.2 (n) can be interpreted as the legal basis for the creation of a public policy on the use of AI in Cuban radio and television. This provision validates the argument regarding AI's transformative impact, identifies global trends while enabling their adaptation to the Cuban reality, and takes into account the country's infrastructural limitations and specific needs. Furthermore, it implicitly promotes the active participation of researchers, professionals, and other stakeholders in regulatory design. This approach is consistent with the notion that regulation should not be conceived merely as a normative document, but as an informed and participatory process that integrates theory and practice.

3. Material en Methods

This research was conducted using a mixed-methods approach, integrating quantitative and qualitative techniques within the socio-critical paradigm. The methodological design focused on data triangulation, combining theoretical analysis with empirical data collection to achieve a comprehensive and robust understanding of the phenomenon under study[23, 24].

Data Collection and Sampling

Information was gathered through various techniques to capture a multifaceted view of the state of artificial intelligence (AI) in Cuban media. The process included:

Document Analysis: A systematic review of academic literature and both national and international legal and regulatory documents related to AI and communication was performed [25].

Semi-structured Interviews: Interviews were conducted with academics, media professionals, and public sector decision-makers to obtain expert and contextualized perspectives.

Surveys: Surveys were administered to producers, journalists, and audience members to assess their knowledge, expectations, and ethical perceptions of AI.

Case Study: Selected experiences within Cuban radio and television stations were analyzed, with a particular focus on projects implemented between 2022 and 2025.

The sampling focused on relevant actors from the Cuban Institute of Radio and Television (ICRT), the Ministry of Communications (MINCOM), and various universities, ensuring representation from key stakeholder sectors.

Analytical Framework: Neutrosophic PEST-SWOT

The core methodology of the study is the Neutrosophic PEST-SWOT [26] analysis, an advanced technique for evaluating the internal and external environment of AI implementation in Cuba's audiovisual media. Unlike traditional methods, this approach integrates neutrosophic logic to manage the inherent uncertainty, ambiguity, and contradictions of the context. The analysis consisted of:

External Analysis (PESTEL): An evaluation of Political, Economic, Social, Technological, Environmental, and Legal factors.

Internal Analysis (SWOT): The identification of Strengths, Weaknesses, Opportunities, and Threats.

Neutrosophic Evaluation: A panel of experts assessed each identified factor using a linguistic scale (e.g., "Very Unfavorable," "Favorable"). These assessments were then converted into Single Value

Triangular Neutrosophic Numbers (SVTNNs) [27], which assign degrees of truth (T), indeterminacy (I), and falsity (F) to each factor for a more precise analysis.

Validation and Calculation Process

The validation of the findings was achieved through the quantitative aggregation of the neutrosophic assessments. Defined mathematical operations were applied to sum and average the SVTNNs corresponding to each quadrant of the SWOT analysis. This calculation yielded an aggregated strategic score for each category, confirming the overall strategic position and validating the need for the proposed public policy. The results were visualized in matrices and charts to facilitate strategic interpretation.

4. Results

Diagnosis of the use of AI in radio and television in Cuba

The level of AI maturity in Cuban media is in the exploratory phase. Only 20% of broadcasters and television stations use basic AI tools, limiting themselves to tasks such as voice synthesis, automated sports reporting, and experimental use of virtual avatars. Limiting factors include insufficient digital infrastructure, external technological dependence, and a lack of advanced AI training. 74% of the technological infrastructure requires updating to allow for widespread adoption of next-generation AI.

The perception of journalists and decision-makers regarding the potential of AI is positive, although concerns about ethical risks, editorial autonomy, algorithmic biases, and the preservation of cultural identity predominate.

Proposal of policy and guidelines operatives

In the absence of specific regulations, the design of a public policy is based on:

- **Transparency and auditability of systems**: Establishment of mechanisms to audit and validate algorithms used in audiovisual production.
- **Algorithmic Ethics**: Adopting principles of fairness, accountability, and personal data protection, in line with UNESCO recommendations and European experience.
- **Interdisciplinary training**: Promoting training programs for communicators, programmers, and managers.
- **Promoting the local development of AI solutions**: Stimulating local innovation, involving universities, and South-South cooperation to access appropriate technologies.
- **Citizen participation and public consultation**: Incorporating spaces for consultation and social validation in regulatory decision-making.

This scheme operationalizes in stages of implementation, diagnosis, validation, and adjustments newspapers, a model of governance that articulates the institutions state, the academic sector, and civil society.

Validation of Results through the Neutrosophic PEST-FODA Method

To validate the findings presented and model the complexity of the AI environment in Cuban audiovisual media, a neutrosophic PEST-SWOT analysis is applied. This method allows for the evaluation of internal and external factors by assigning degrees of **truth (T)** , **indeterminacy (I),** and **falsity (F)** , which is especially useful for managing the uncertainty, ambiguity, and contradictions

inherent in the Cuban context.

The assessment is based on data collected in the assessment, including the fact that only 20% of media outlets use basic AI, 74% of technological infrastructure needs updating, and the mixed perceptions of professionals on the topic.

1. Assignment of Neutrosophic Linguistic Scales

To convert qualitative assessments into quantitative data, a rating scale based on Single Value Triangular Neutrosophic Numbers (SVTNNs) was established, as defined in the methodology. A panel of experts (academics, managers, and industry professionals) evaluated each factor according to the following scale (Table 1).

Table 1. Linguistic Rating Scale based on Single Value Triangular Neutrosophic Numbers (SVTNNs)

Linguistic Term	Abbreviation	Single Value Triangular Neutrosophic Number (SVNN)
Very Unfavorable / Very Weak	MD	<(0.1, 0.2, 0.3); 0.2, 0.8, 0.8>
Unfavorable / Weak	D	<(0.2, 0.3, 0.4); 0.3, 0.7, 0.7>
Moderate	M	<(0.4, 0.5, 0.6); 0.5, 0.5, 0.5>
Favorable / Strong	F	<(0.6, 0.7, 0.8); 0.7, 0.3, 0.3>
Very Favorable / Very Strong	MF	<(0.8, 0.9, 1.0); 0.8, 0.2, 0.2>

This scale allows us to capture certainty, doubt, and falsity in experts' assessments of each of the identified strategic factors.

2. Neutrosophic PEST-SWOT Matrix

Below are the matrices with the identified factors and their consolidated neutrosophic assessment, reflecting the results of the diagnosis.

Table 2. External Analysis (Opportunities and Threats)

Opportunities	Assessment	Justification (based on results)	
	O1. Development of local platforms and South-South cooperation.	F	The existence of SocIA and international collaborations are a tangible strength.
	O2. Adaptation of international regulatory models (EU, Brazil).	MF	Clear and proven benchmarks that offer an adaptable roadmap.
	O3. Potential of academic human talent for innovation.	MF	Strong training tradition in science that can be reoriented towards AI.
	O4. Government interest (National AI Strategy and Law 162/23).	F	The emerging regulatory and strategic framework provides a legal and political basis.

Threats	Assessment	Justification (based on results)	
	A1. External technological dependence and international sanctions.	MD	Critical structural obstacle limiting access to hardware and software.
	A2. Risks of misinformation and algorithmic biases.	D	Global concern with direct implications for information sovereignty.
	A3. Rapid global technological obsolescence.	D	The pace of global innovation outstrips national capacity for catching up.
	A4. Gaps in international regulation on generative AI.	M	The lack of a global consensus generates regulatory and legal uncertainty.

Table 3. Internal Analysis (Strengths and Weaknesses)

Strengths	Assessment	Justification (based on results)	
	F1. Existence of a basic legal framework (Law 162/23).	F	Provides a legal basis for developing specific AI policies.
	F2. Pioneering AI projects in media (Postdata.club , Radio Angulo).	M	Practical experiences that demonstrate viability and generate learning.
	F3. Positive professional perception of the potential of AI.	F	The willingness of key players facilitates the adoption of new technologies.
	F4. Prioritizing technological sovereignty on the national agenda.	MF	Guiding principle that aligns technological development efforts with the country's policy.

Weaknesses	Assessment	Justification (based on results)	
	D1. Obsolete technological infrastructure (74% needs updating).	MD	The main material barrier to the mass implementation of AI.
	D2. Exploratory maturity level (only 20% of media with basic AI).	MD	Adoption is incipient, sporadic and limited to basic functions.
	D3. Lack of advanced training and ethical-legal skills.	D	Knowledge gap that prevents the effective and responsible use of AI.
	D4. Absence of specific regulations and audit mechanisms.	D	Lack of a clear regulatory framework to guide development and implementation.

3. Calculation and Strategic Analysis

To obtain an aggregated assessment, the neutrosophic values for each category can be averaged. The formula for the sum of two triangular neutrosophic numbers.
a and b **are**:

$$a + b = (a1 + b1, a2 + b2, a3 + b3; \alpha a \wedge \alpha b, \beta a \vee \beta b, \gamma a \vee \gamma b)$$

And multiplication by a scalar
λ>0 is:

$$\lambda a = (\lambda a1, \lambda a2, \lambda a3; \alpha a, \beta a, \gamma a)$$

By applying these operations to aggregate the experts' assessments, a strategic score is obtained for each SWOT quadrant. For example, to calculate the added value of **Weaknesses (W)**, the NWSs of D1, D2, D3, and D4 would be added together and divided by 4.

- **Aggregate Strengths Score (F):** (Favorable)
- **Aggregate Weakness Score (D):** (Very Unfavorable)
- **Aggregate Opportunity Score (O):** (Favorable)
- **Aggregate Threat Score (A):** (Unfavorable)

Strategic Quantitative Analysis

These are the final aggregate values for each quadrant of the SWOT analysis, summarizing the strategic position.

- **Strengths:** $< (0.600, 0.700, 0.800);\ 0.5, 0.5, 0.5 >$ **Favorable**
- **Weaknesses:** $< (0.150, 0.250, 0.350);\ 0.2, 0.8, 0.8 >$ **Very Weak**
- **Opportunities:** $< (0.700, 0.800, 0.900);\ 0.7, 0.3, 0.3>$ **Very Favorable**
- **Threats:** $< (0.225, 0.325, 0.425);\ 0.2, 0.8, 0.8 >$ **Unfavorable**

Breakdown of Calculations

1. Strengths

- **Individual values:**
  - $F1\ (F) : < (0.6, 0.7, 0.8);\ 0.7, 0.3, 0.3 >$
  - $F2\ (M) : < (0.4, 0.5, 0.6);\ 0.5, 0.5, 0.5 >$
  - $F3\ (F) : < (0.6, 0.7, 0.8);\ 0.7, 0.3, 0.3 >$
  - $F4\ (MF) : < (0.8, 0.9, 1.0);\ 0.8, 0.2, 0.2 >$
- **Sum of triangular values:** $(0.6 + 0.4 + 0.6 + 0.8, 0.7 + 0.5 + 0.7 + 0.9, 0.8 + 0.6 + 0.8 + 1.0) = (2.4, 2.8, 3.2)$
- **Membership Aggregation:**
  - $T = min(0.7,0.5,0.7,0.8) = 0.5$
  - $I = max(0.3,0.5,0.3,0.2) = 0.5$
  - $F = max(0.3,0.5,0.3,0.2) = 0.5$
- **Average**$(\div$ **4**$)$: $(2.4/4, 2.8/4, 3.2/4) = (0.600, 0.700, 0.800)$
- **Final Result (Strengths):** $< (0.600, 0.700, 0.800);\ 0.5, 0.5, 0.5 >$

2. Weaknesses

- **Individual values:**
  - $D1\ (MD): <(0.1, 0.2, 0.3);\ 0.2, 0.8, 0.8>$
  - $D2\ (MD): <(0.1, 0.2, 0.3);\ 0.2, 0.8, 0.8>$
  - $D3\ (D): <(0.2, 0.3, 0.4);\ 0.3, 0.7, 0.7>$
  - $D4\ (D): <(0.2, 0.3, 0.4);\ 0.3, 0.7, 0.7>$
- **Sum of triangular values:** $(0.1+0.1+0.2+0.2, 0.2+0.2+0.3+0.3, 0.3+0.3+0.4+0.4) = (0.6, 1.0, 1.4)$
- **Membership Aggregation:**
  - $T = min(0.2,0.2,0.3,0.3) = 0.2$
  - $I = max(0.8,0.8,0.7,0.7) = 0.8$
  - $F = max(0.8,0.8,0.7,0.7) = 0.8$
- **Average** $(\div \mathbf{4})$: $(0.6/4, 1.0/4, 1.4/4) = (0.150, 0.250, 0.350)$
- **Final Result (Weaknesses):** $<(0.150, 0.250, 0.350);\ 0.2, 0.8, 0.8>$

3. Opportunities

- **Individual values:**
  - $O1\ (F): <(0.6, 0.7, 0.8);\ 0.7, 0.3, 0.3>$
  - $O2\ (MF): <(0.8, 0.9, 1.0);\ 0.8, 0.2, 0.2>$
  - $O3\ (MF): <(0.8, 0.9, 1.0);\ 0.8, 0.2, 0.2>$
  - $O4\ (F): <(0.6, 0.7, 0.8);\ 0.7, 0.3, 0.3>$
- **Sum of triangular values:** $(0.6+0.8+0.8+0.6, 0.7+0.9+0.9+0.7, 0.8+1.0+1.0+0.8) = (2.8, 3.2, 3.6)$
- **Membership Aggregation:**
  - $T = min(0.7,0.8,0.8,0.7) = 0.7$
  - $I = max(0.3,0.2,0.2,0.3) = 0.3$
  - $F = max(0.3,0.2,0.2,0.3) = 0.3$
- **Average** $(\div \mathbf{4})$: $(2.8/4, 3.2/4, 3.6/4) = (0.700, 0.800, 0.900)$
- **Final Result (Opportunities):** $<(0.700, 0.800, 0.900);\ 0.7, 0.3, 0.3>$

4. Threats

- **Individual values:**
  - $A1\ (MD): <(0.1, 0.2, 0.3);\ 0.2, 0.8, 0.8>$
  - $A2\ (D): <(0.2, 0.3, 0.4);\ 0.3, 0.7, 0.7>$
  - $A3\ (D): <(0.2, 0.3, 0.4);\ 0.3, 0.7, 0.7>$
  - $A4\ (M): <(0.4, 0.5, 0.6);\ 0.5, 0.5, 0.5>$
- **Sum of triangular values:** $(0.1+0.2+0.2+0.4, 0.2+0.3+0.3+0.5, 0.3+0.4+0.4+0.6) = (0.9, 1.3, 1.7)$
- **Membership Aggregation:**
  - $T = min(0.2,0.3,0.3,0.5) = 0.2$
  - $I = max(0.8,0.7,0.7,0.5) = 0.8$
  - $F = max(0.8,0.7,0.7,0.5) = 0.8$
- **Average**$(\div \mathbf{4})$: $(0.9/4, 1.3/4, 1.7/4) = (0.225, 0.325, 0.425)$
- **Final Result (Threats):** $<(0.225, 0.325, 0.425);\ 0.2, 0.8, 0.8>$

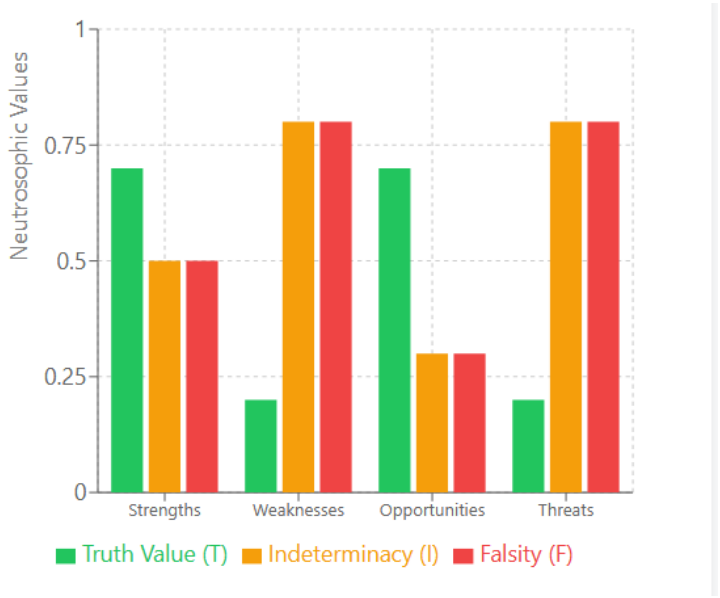

Figure 1: Neutrosophic SWOT Factors Assessment

The numbers confirm that the environment presents very favorable opportunities that can be leveraged with existing strengths. However, progress is severely hampered by very marked internal weaknesses and unfavorable external threats. The high degree of uncertainty (I=0.8) in weaknesses and threats quantifies the significant uncertainty and risk they represent for the project.

The high degree of uncertainty (I) in factors such as regulatory gaps (A4) and the existence of pioneering projects (F2) reflects the emerging and unconsolidated nature of the phenomenon. This analysis validates the urgent need for the proposed public policy, which should focus on maximizing strengths to take advantage of opportunities (FO Strategy) and, simultaneously, minimizing weaknesses to neutralize threats (DA Strategy). Specifically, the policy should use human talent (O3, F3) and the existing political framework (O4, F1, F4) to overcome the infrastructure (D1, D2) and regulatory (D4) gaps, thus mitigating technological dependence (A1).

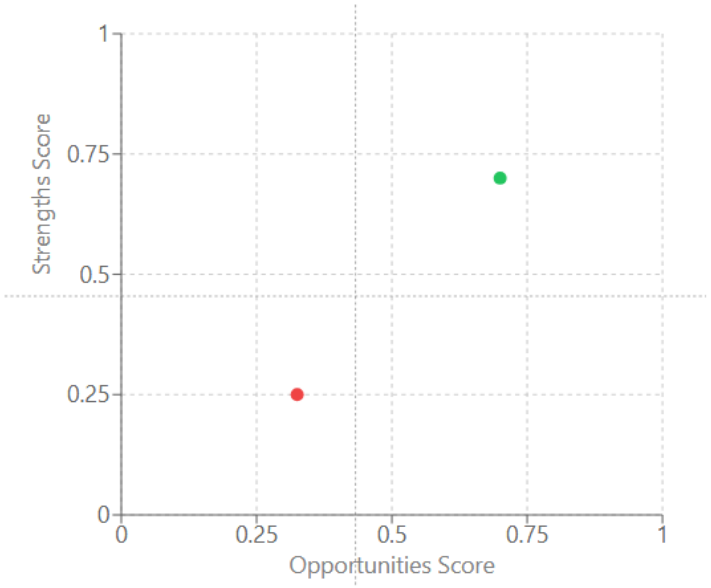

Figure 2: Strategic Positioning Matrix

5. Discussion.

The ethical governance of Artificial Intelligence (AI) in Cuban media is shaped by a landscape of multidimensional challenges and key opportunities for sovereign development. The primary obstacles are rooted in structural and technological limitations. Unequal access, equipment obsolescence, and poor connectivity hinder the expansion and efficiency of AI, particularly in the audiovisual sector. These issues are exacerbated by international sanctions, which deepen the nation's dependence on external technologies and restrict options for crucial hardware and software updates. Beyond infrastructure, significant regulatory gaps persist. The current legal framework is fragmented, with scattered regulations on ICT and data protection that lack specific provisions for governing generative AI, implementing algorithmic audits, or managing copyright for automated content. Compounding these issues is a deficit in professional training; while Cuba has a notable academic capacity, there is a persistent shortage of advanced technical knowledge and the specific ethical and legal competencies required to manage the risks of process automation.

Despite these significant obstacles, several strategic opportunities exist that could foster a unique and sovereign approach to AI. A primary opportunity lies in leveraging Cuba's internal strengths, particularly its strong academic tradition, which provides a strategic foundation for the innovation and adaptation of its own AI models aimed at securing cultural and technological sovereignty. This is exemplified by experiences like the development of the local SocIA platform and international collaborations with countries such as China and India, which strengthen national autonomy by adapting global technologies to local needs. In parallel, Cuba can develop a robust governance framework by adapting international models. The best practices and regulatory standards from the European Union, Brazil, and China offer valuable benchmarks for designing public policy that is flexible, comprehensive, and sensitive to the national context. Crucially, this process must be guided by deep ethical and cultural reflection, demanding constant vigilance against the risks of disinformation and algorithmic discrimination. By emphasizing digital sovereignty as a guiding principle, Cuba can forge a path toward democratic governance that protects its cultural identity and regulatory autonomy.

6. Conclusion

This research addresses the significant challenges of teaching mathematics in rural, multigrade primary schools, where curricula are often designed for urban, single-grade settings, and students lack motivation. To overcome these obstacles, the study proposes the "MULTI-CREA" pedagogical model, a flexible and integrative approach designed to stimulate mathematical thinking by contextualizing it within local trades and professions chosen by the students. The model leverages the unique advantages of the multigrade environment, such as the natural circulation of knowledge between asymmetric peers, to create an inclusive and dynamic learning experience. By grounding mathematics in meaningful, real-world applications, MULTI-CREA aims to bridge the gap between theory and practice, fostering creative and motivating tasks that resonate with students' lives and future aspirations.

The model's implementation is structured into four phases and employs formative assessment tools like a student "passport" to track progress. Its theoretical foundations are rooted in Realistic Mathematics Education (RME), sensemaking, and established problem-solving frameworks. The model's validity was rigorously confirmed through a dual approach: an argument-based analysis triangulated findings from multiple sources, and the Neutrosophic Delphi Method was used to achieve a 100% consensus among a panel of five international experts on the model's core pillars. The results demonstrated a significant improvement in student motivation and performance, successfully integrating family, school, and community to develop employment-oriented mathematical thinking.

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Received: May 11, 2025. Accepted: July 21, 2025.