INTEGRATION OF THE AMAZON INSTITUTE OF INNOVATION AND TECHNOLOGY INTO THE AMAZONIAN RESEARCH AND INNOVATION LANDSCAPE

A INSERÇÃO DO INSTITUTO DE INOVAÇÃO E TECNOLOGIA DA AMAZÔNIA NO CENÁRIO DE PESQUISA E INOVAÇÃO AMAZÔNICA

INTEGRACIÓN DEL INSTITUTO AMAZÓNICO DE INNOVACIÓN Y TECNOLOGÍA EN EL PANORAMA DE INVESTIGACIÓN E INNOVACIÓN AMAZÓNICO

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ABSTRACT
The Brazilian Amazon, recognized for its biodiversity and socio-cultural richness, still faces deep scientific and technological inequalities in relation to other regions of the country. This article analyzes the insertion of the Institute of Innovation and Technology of the Amazon (IITA) in the context of regional research and innovation, highlighting its relevance as an institutional response to the structural gap in science, technology and innovation (ST&I) in the Amazon aligned with sustainable production. Descriptive in nature and with a qualitative approach, the research was based on documentary analysis, institutional observation and technical interviews, allowing us to understand the structure, projects and competencies of the Institute. The results show that IITA has consolidated itself as a strategic hub for Research, Development and Innovation (RD&I), with state-of-the-art laboratory infrastructure focused on automation, additive manufacturing and artificial intelligence. Its work strengthens the Amazonian innovation ecosystem by integrating science, industry and sustainability, promoting the formation of human capital and stimulating regional technological autonomy. It is concluded that IITA represents a model of sustainable territorial innovation, capable of transforming the Amazon into a producer of knowledge and technology, contributing to the scientific, social and environmental development of the region.

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RESUMO

A Amazônia brasileira, reconhecida por sua biodiversidade e riqueza sociocultural, ainda enfrenta profundas desigualdades científicas e tecnológicas em relação a outras regiões do país. Este artigo analisa a inserção do Instituto de Inovação e Tecnologia da Amazônia (IITA) no contexto da pesquisa e da inovação regional, destacando sua relevância como resposta institucional à defasagem estrutural em ciência, tecnologia e inovação (CT&I) na Amazônia alinhados à produção sustentável. De natureza descritiva e abordagem qualitativa, a pesquisa baseou-se em análise documental, observação institucional e entrevistas técnicas, permitindo compreender a estrutura, os projetos e as competências do Instituto. Os resultados evidenciam que o IITA se consolidou como polo estratégico de Pesquisa, Desenvolvimento e Inovação (PD&I), com infraestrutura laboratorial de ponta voltada à automação, manufatura aditiva e inteligência artificial. Sua atuação fortalece o ecossistema de inovação amazônico ao integrar ciência, indústria e sustentabilidade, promover a formação de capital humano e estimular a autonomia tecnológica regional. Conclui-se que o IITA representa um modelo de inovação territorial sustentável, capaz de transformar a Amazônia em produtora de conhecimento e tecnologia, contribuindo para o desenvolvimento científico, social e ambiental da região.

Palavras-chave: Amazônia. Inovação Tecnológica. Sustentabilidade. Instituto de Inovação e Tecnologia da Amazônia. Desenvolvimento Regional.

RESUMEN

La Amazonía brasileña, reconocida por su biodiversidad y riqueza sociocultural, aún enfrenta profundas desigualdades científicas y tecnológicas en relación con otras regiones del país. Este artículo analiza la inserción del Instituto de Innovación y Tecnología de la Amazonía (IITA) en el contexto de la investigación e innovación regional, destacando su relevancia como respuesta institucional a la brecha estructural en ciencia, tecnología e innovación (CTI) en la Amazonía alineada con la producción sostenible. Descriptiva y con un enfoque cualitativo, la investigación se basó en el análisis documental, la observación institucional y las entrevistas técnicas, lo que permitió comprender la estructura, los proyectos y las competencias del Instituto. Los resultados muestran que el IITA se ha consolidado como un centro estratégico de Investigación, Desarrollo e Innovación (ID&I), con una infraestructura de laboratorio de última generación centrada en la automatización, la fabricación aditiva y la inteligencia artificial. Su trabajo fortalece el ecosistema de innovación amazónico integrando ciencia, industria y sostenibilidad, promoviendo la formación de capital humano y estimulando la autonomía tecnológica regional. Se concluye que el IITA representa un modelo de innovación territorial sostenible, capaz de transformar la Amazonía en una productora de conocimiento y tecnología, contribuyendo al desarrollo científico, social y ambiental de la región.

Palabras clave: Amazonía. Innovación Tecnológica. Sostenibilidad. Instituto de Innovación y Tecnología de la Amazonía. Desarrollo Regional.

1 INTRODUCTION

The Brazilian Amazon represents one of the most strategic regions on the planet in terms of biodiversity, natural resources, and human potential for sustainable innovation. However, the social, economic, and environmental challenges that permeate it demand policies and institutions focused on science, technology, and innovation (ST&I) capable of articulating productive development, sustainability, and valuing local knowledge.

In this context, Law No. 8,387/1991 and the complementary instruments to encourage Research, Development and Innovation (RD&I) in the Manaus Industrial Pole (PIM) enabled the emergence of a network of Scientific, Technological and Innovation Institutions (ICTs) aimed at meeting the demands of industry and regional society.

Among these institutions, the Institute of Innovation and Technology of the Amazon (IITA) stands out, officially recognized by CAPDA Resolution No. 88, of September 11, 2025, as a private and non-profit ICT. IITA consolidates itself as a center for applied research and technological innovation dedicated to strengthening the Amazon as a territory of sustainable development, fostering projects that combine automation, artificial intelligence, advanced manufacturing and local skills training.

In this context, this article aims to analyze the insertion of the Institute of Innovation and Technology of the Amazon in the panorama of research and innovation in the region, highlighting its strategic potential for action, its technological development projects and its contribution to the construction of a sustainable model of innovation, with its own identity of the Amazon.

2 RATIONALE: SCIENCE, TECHNOLOGY AND REGIONAL INEQUALITY IN THE AMAZON

2.1 THE NATIONAL INNOVATION POLICY AND THE AMAZONIAN CHALLENGES

Law No. 10,973/2004, known as the Innovation Law, and Decree No. 9,283/2018, which regulates it, recognize Scientific, Technological and Innovation Institutions (ICTs) as pillars of the country's scientific and technological development, are instruments that provide for cooperation mechanisms between the productive sector and public and private research, in addition to tax incentives to strengthen the national science base, technology and innovation (ST&I). However, despite the existence of this legal framework, the Amazon region continues to present a significant structural gap when compared to the other regions of Brazil,

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reflecting a historical imbalance in the distribution of the country's scientific and technological capacities.

According to the Report on National ST&I Indicators (MCTI, 2023), the North Region concentrates less than 2% of research groups certified by CNPq and less than 3% of patent applications filed in the country, even though it covers almost 60% of the national territory. This disparity demonstrates that the instruments for fostering and encouraging innovation have not consistently generated local capacities for technological development. The result is a scenario of scientific and technological dependence, in which the Amazon still occupies a peripheral position in the national innovation system.

2.2 THE STRUCTURAL CAUSES OF THE TECHNOLOGICAL GAP

The technological inferiority of the Amazon stems from multiple and interrelated factors. Among them, the precariousness of the scientific and research infrastructure, the lack of qualified human resources and the low industrial density focused on RD&I stand out. Although the Manaus Industrial Pole (PIM) represents the largest production complex in the region, its production structure remains concentrated in assembly activities, with reduced internalization of research and technological development. This characteristic, as Suzigan and Albuquerque (2011) point out, reinforces a model of technological dependence, in which knowledge is imported and reproduced, and not created locally.

Another obstacle is the deficit of specialized human capital. The IBGE (2022) indicates that the North Region has the lowest percentage of professionals with postgraduate degrees in STEM (Science, Technology, Engineering, and Mathematics) areas and the lowest average investment in research grants per inhabitant. This shortage of skilled labor limits the innovation capacity of local companies and perpetuates the cycle of scientific backwardness, in which the absence of infrastructure reduces the training of specialists, and the lack of specialists, in turn, restricts technological advancement.

Technology transfer and open innovation networks also remain fragile. The integration between universities, institutes, and the productive sector is still incipient, contrasting with the "Triple Helix" model proposed by Etzkowitz (2017), which advocates cooperation between universities, government, and industry as the basis for sustainable innovative ecosystems. In the Amazon, this cooperation occurs sparsely, making it difficult to continue projects and strengthen the institutional structure of applied research.

2.3 LOGISTICAL, SOCIAL AND TERRITORIAL BARRIERS

In addition to structural issues, the Amazon faces geographic and logistical challenges that hinder the advancement of technological research. The territorial extension, the deficiencies in transport and communication and the energy limitations impose high costs of operation and maintenance of laboratories, compromising the operation of projects of greater complexity. According to Sachs (2004), the sustainable development of the Amazon requires the creation of technical and productive systems adapted to local conditions and not the simple reproduction of industrial models conceived in other economic and environmental contexts.

These barriers also influence the Amazonian population's access to scientific and technological education, reducing opportunities for professional training and specialization. The limitation of educational and research infrastructure in the cities of the interior of Amazonas and in other states in the region reinforces the concentration of knowledge in large urban centers, increasing scientific inequality within the Amazon itself.

2.4 THE NEED FOR A TERRITORIAL POLICY ON SCIENCE AND TECHNOLOGY

For Becker (2005), overcoming the technological backwardness of the Amazon requires understanding the region as a "territory of knowledge", in which scientific development is built from the interaction between local knowledge, social practices and sustainable technologies. This approach implies a science and technology policy with a territorial focus, aimed at valuing the cultural and ecological diversity of the Amazon and promoting sustainability-oriented innovation.

In this sense, Law No. 8,387/1991, which establishes tax incentives for research and development within the scope of the Manaus Free Trade Zone, represents a central instrument for regional strengthening. However, historically, these incentives have been concentrated in multinational companies, focusing on industrial processes rather than applied research. This asymmetry reinforces the need to create regional and autonomous ICTs, capable of channeling public and private resources for the development of laboratories, skills training, and innovation projects contextualized to the Amazon territory.

2.5 THE AMAZON INSTITUTE OF INNOVATION AND TECHNOLOGY AS A RESPONSE TO THE REGIONAL GAP

It is in this context that the Institute of Innovation and Technology of the Amazon (IITA) emerges, officially approved by CAPDA Resolution No. 88, of September 11, 2025, as a private and non-profit ICT, dedicated to applied research, technological development and the training of local skills. The Institute represents an institutional response to the infrastructure and innovation deficit identified in national ST&I policies, acting as a space for technological experimentation aimed at Amazonian sustainability and the integration between science and society.

IITA structures its activities in advanced laboratories that represent a qualitative leap in regional research capacity. The Laboratory of Robotics and Cyber-Physical Systems with Artificial Intelligence is dedicated to the creation of automation and control solutions applied to Industry 4.0, integrating machine learning algorithms and computer vision systems in industrial processes. The Machining and 3D Printing Laboratory, operated in partnership with the company Creaturae Tecnologia 3D, is an environment for rapid prototyping and additive manufacturing focused on practical experimentation and innovation in product engineering.

With this structure, IITA promotes the development of technologies adapted to the Amazonian reality, reducing dependence on imported solutions and strengthening regional autonomy in RD&I. Its performance reinforces the precepts of Laws No. 10,973/2004 and No. 8,387/1991, by creating bridges between universities, the productive sector and local communities, transforming the Amazon into a space for sustainable and socially inclusive innovation.

3 METHODOLOGY

3.1 NATURE AND APPROACH OF THE RESEARCH

The research has a descriptive nature and a qualitative approach, guided by the need to understand the institutional role of the Institute of Innovation and Technology of the Amazon (IITA) in strengthening the science, technology and innovation (ST&I) ecosystem in the North region. According to Gil (2010), descriptive studies aim to observe, record and interpret facts of a reality, without the interference of the researcher on the phenomenon studied. In this sense, this work seeks to characterize IITA's Research, Development and Innovation (RD&I) actions, structure and practices, describing the processes and results obtained in its laboratories and technological training programs.

The qualitative approach, according to Minayo (2012), allows us to understand the meaning of social and organizational practices within their historical and territorial context. Thus, the analysis is not restricted to the observation of quantitative data, but delves into the interpretation of the meanings attributed to the innovation actions conducted by the Institute, considering their insertion in the Amazonian reality and the specificities of its socioeconomic environment.

3.2 METHODOLOGICAL PROCEDURES

The methodological path adopted was based on documentary analysis, institutional observation and guided technical interviews, complemented by a literature review on sustainable innovation and regional ST&I policies.

The desk analysis involved the systematization of primary and secondary sources, including technical reports, RD&I plans, project portfolios, intellectual property registrations, and the Institute's accreditation dossier with the CAPDA Coordination, which formalized its approval as a private ICT in 2025. These documents made it possible to understand the administrative structure, the composition of the research teams, the investments made and the strategic axes of IITA's action.

The guided institutional observation took place during technical visits to the Institute's facilities, located on Avenida Professor Cláudio Portilho, Japiim neighborhood, in Manaus (AM). In these visits, the operation of the Robotics and Cyberphysical Systems Laboratories with Artificial Intelligence and the Machining and 3D Printing Laboratory, both described in the Institute's RD&I plan, were observed. The direct monitoring of laboratory activities made it possible to identify the main technical and scientific competencies developed, the equipment used, the types of experimentation in progress and the interface between applied research and professional training.

In addition, guided interviews were conducted with researchers, engineers and managers of the Institute, in order to understand the processes of project development, the mechanisms of interaction with companies and universities and the strategies for training local labor. This qualitative step was essential to capture the human and institutional dimension of the innovation process, revealing how IITA's practices articulate technology, sustainability and valuing regional knowledge.

3.3 AXES OF ANALYSIS

To ensure interpretative consistency, the data were organized into four main analytical axes, defined based on the source triangulation method (Triviños, 1987):

a) Institutional role and socio-environmental mission, highlighting the legal nature and strategic objectives of the Institute;

b) Infrastructure and RD&I laboratories, describing the physical spaces, equipment, lines of research and technical capacities available;

c) Scientific and technological skills, analyzing professional profiles, team formation and the articulation between theory and practice; e

d) Contribution to regional sustainable development, considering the application of research results and potential impacts on the Amazonian economy and society.

The analysis of these axes sought to correlate the institutional elements with the socioeconomic context of the Amazon, identifying how IITA acts as a structuring agent of territorial innovation. Thus, the study not only describes the Institute's infrastructure and competencies, but also interprets its importance as a model of integration between science, technology and sustainability.

4 RESULTS

4.1 INSTITUTIONAL CONSOLIDATION AND STRATEGIC ROLE OF IITA

The institutional and documentary analysis shows that the Institute of Innovation and Technology of the Amazon (IITA) has consolidated itself as one of the main centers of Research, Development and Innovation (RD&I) in the North region. The official recognition by CAPDA Resolution No. 88, of September 11, 2025, confirms its classification as a private, non-profit Scientific, Technological and Innovation Institution (ICT), strengthening its legitimacy to capture, manage and execute RD&I projects based on Law No. 8,387/1991 and Law No. 10,973/2004.

The Institute acts as a strategic link between the productive sector, academia and the public power, fostering the integration between science and industry through the execution of technological projects with a direct impact on the Manaus Industrial Pole (PIM). Its central mission is to boost scientific and technological autonomy in the Amazon, through innovative solutions that reconcile sustainability, industrial competitiveness, and the formation of local skills.

4.2 LABORATORY STRUCTURE AND AREAS OF COMPETENCE

IITA has its own laboratory infrastructure installed in Manaus (AM), on Avenida Professor Cláudio Portilho, Japiim neighborhood, in a total area of 175 m². The laboratories are equipped to meet the demands of applied research, prototyping, industrial automation, and advanced manufacturing.

The Institute's laboratory structure is composed of two reference centers:

a)   Laboratory of Robotics and Cyberphysical Systems with Artificial Intelligence

This laboratory is focused on the research and development of automated systems, collaborative robotics and artificial intelligence applied to Industry 4.0. His activities include the creation of mechatronic prototypes, the development of embedded software and computer vision algorithms, as well as tests in industrial automation for PIM companies.

Figure 1

Laboratory of Robotics and Cyber-Physical Systems with Artificial Intelligence – IITA

Source: Authors, 2025.

The laboratory has an infrastructure composed of high-tech equipment, including the 6-axis collaborative robot Aubo, used in research and tests aimed at various applications in the Manaus Industrial Pole (PIM) and in the development of software and cyber-physical systems. Also part of the environment are HitBot robots (Scara) and Delta-type robots, with capacities of 1 kg and 3 kg, used in studies on automation, manipulation and precision production processes.

IITA has high-performance computers, such as the Dell G3 and XPS desktops, used in the development of software with AI, computer vision and industrial automation. A 3-meter

conveyor belt complements the environment, allowing for automated process testing and simulations.

The laboratory also functions as a space for technical training and integration between engineers and students, stimulating project-based learning (PBL) and the development of experimental solutions in sustainable automation.

b) 3D Machining and Printing Laboratory — IITA and Creaturae 3D Technology Partnership

Operated in a technical agreement with the company Creaturae Tecnologia 3D (CNPJ 38.077.906/0001-87), the Machining and 3D Printing Laboratory is a hybrid environment focused on rapid prototyping, precision machining, additive manufacturing and the manufacture of customized mechanical components.

Figure 2

*Machining and 3D Printing Laboratory – IITA & Creaturae*

Source: Authors, 2025.

The IITA laboratory has a complete machining, prototyping and digital fabrication infrastructure, including CNC lathe, mini milling cutters, hydraulic press, drills, grinder, saws and measuring equipment. For prototyping and 3D printing, it has FDM and SLA/DLP printers, curing oven and ESD Dry Cabinet. Computing support is guaranteed by notebooks, high-performance desktops, 3D scanners and professional monitors, as well as countertops, cabinets and air conditioning systems. This framework enables advanced manufacturing and automation research, development, and testing.

The IITA–Creaturae partnership allows for the shared use of infrastructure and know-how, combining Creaturae's expertise in digital manufacturing and quality control with IITA's scientific base, RD&I management and institutional articulation. This collaborative model integrates automation, robotics, 3D printing, and advanced manufacturing, enabling technically complex and low-cost projects, strengthening regional industrial competitiveness.

Figure 3

Technical-Scientific Partnership – IITA & Creaturae
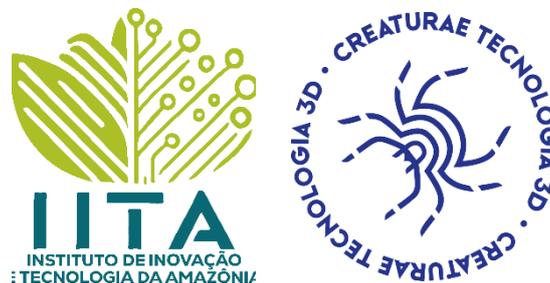
Source: IITA and Creaturae websites, 2025.

4.3 RESEARCH, DEVELOPMENT AND INNOVATION (RD&I) PROJECTS

The projects developed by IITA reflect the institution's strategic focus on automation, artificial intelligence, bioeconomy and industrial sustainability. The 2025–2026 RD&I Plan presented to CAPDA lists initiatives that add up to investments of more than R$ 14 million, evidencing the consolidation of the Institute as an agent of applied innovation in the region.

Among the outstanding projects are:

- Auto Battery – battery assembly line automation, integrating robotics, AI and occupational safety;
- Trafo Winding ULC_Flex – transformer winding automation, with intelligent torque control and dielectric insulation;

- Burn-in Intelligent Drivers – national development of a reliability testing system for LED drivers, replacing imported technology;
- Predictive Analysis of ESD Effects – application of neural networks to monitor and prevent electrostatic failures in electronic processes;
- Preparing Local Industry for the Future – creation of a neural network for prediction of social impacts of automation on PIM and professional training.

Figure 4

RD&I projects focused on Industry

Source: IITA Archives, 2025.

These projects reflect IITA's commitment to transforming scientific knowledge into practical and measurable applications, capable of generating economic, social and environmental impacts. By adopting methodologies based on machine learning, computer vision and smart manufacturing, the Institute raises the technological maturity level (TRL) of the solutions developed, bringing them closer to industrial application.

4.4 SUSTAINABLE INNOVATION PROJECTS APPLIED TO REGIONAL CULTURE AND PRODUCTION

In addition to initiatives aimed at manufacturing development, the Institute also fosters projects that dialogue directly with the social and cultural reality of the Amazon, using additive manufacturing as a tool for sustainable innovation. The partnership with Creaturae Tecnologia

3D has made it possible to carry out pioneering studies in the region, promoting the integration between technology, sustainability and cultural identity.

The Institute of Innovation and Technology of the Amazon (IITA) has stood out for its support to artists, local stylists, carnival associations and folklore associations in Parintins, encouraging the creative use of 3D printing in the making of fabrics and props. In addition, the institute develops innovative and pioneering research focused on mitigating environmental challenges, applying advanced manufacturing in various sectors. Among these, the production of river vehicles (printed boats), furniture for corporate and residential environments, and investigations aimed at creating sustainable solutions to generate employment and income through the use of biodegradable filaments in additive manufacturing stand out.

These initiatives promote the use of post-consumer plastics, such as PETs improperly disposed of in the environment, and replace polluting materials, such as plastics and Styrofoam, with sustainable alternatives produced by additive manufacturing. In this way, IITA actively contributes to reducing the environmental impact and combating the incorrect disposal of these materials. With this, the institute solidifies its pioneering role in promoting sustainable regional production, aligning with the UN Sustainable Development Goals (SDGs), driving the technological transformation of the region and encouraging a new culture of responsible and environmentally conscious innovation.

Figure 5

IITA's pioneering spirit in Amazonian 3D printing

Source: IITA Archives, 2025.

In summary, IITA seeks to develop research with real regional impact focusing on several research fronts, due to the high need for sustainable production to preserve local natural resources, such as soil, water resources, fauna and flora. Identifying through his

research the possibility of applying additive manufacturing in pieces of costumes, allegories and props of cultural artistic manifestations, application of vehicles used by riverside dwellers aiming at reducing excessive use of wood and making production for fishing more agile, and finally in the same sense the production of home and office pieces with 3D printing, in addition to other ongoing research aimed at sustainable impact.

Figure 6

IITA's lines of research in additive manufacturing

Source: IITA Archives, 2025.

4.5 TECHNICAL AND SCIENTIFIC SKILLS DEVELOPED

IITA's technical and scientific staff is composed of professionals with multidisciplinary training in mechanical engineering, industrial automation, software, data science and innovation management. Among the researchers, doctors, masters and engineers stand out who work in an integrated way in the Institute's lines of research.

Table 1

Research Team of the Institute

RESEARCHER	EDUCATION	DEGREE	LINE OF RESEARCH	INSTITUTIONAL LINK
Ana Carolina Paiva Cruz	Accounting Sciences	Bachelor of Accounting	Acting in the cost controls of the research and framing in the project according to current legislation, purchases and imports.	Financial and Accounting Analyst
Humbernilson de Souza Calandrini	Technical Course in Industrial Automation / Mechanical Engineering.	Industrial Automation Technician / Engineering Graduate.	Research and Sensors, actuators and systematic Assembly of Cyberphysical Systems in laboratory trials and tests.	Industrial Automation Technician Researcher
Léo Fernando Castelhano Bruno	Mechanical Engineering	Master of Science in Mechanical Engineering, MSc. in Management, Ph.D. in Applied Behavioral Sciences.	Quality Management, Leadership Development, Change and Organizational Behavior focused on efficiency, organizational development and innovation management.	Doctor Researcher
Paulo Rafael Rodrigues Feitosa	Control and Automation Engineering	Bachelor of Science in Automation Engineering	AI Research and Development applied to the various PIM processes.	Research Analyst
Rodrigo Moura de Carvalho	Software Engineering	Bachelor of Software Engineering	Automation and Control Software, in web development, responsive design, prototyping, database modeling and	Researcher

			development, object-oriented programming, development in Java, Python, JavaScript, TypeScript, Kotlin, HTML5, CSS, Spring Boot, Vue, Angular, MySQL.	

Source: Authors, 2025.

The skills developed include:

- Integration of cyber-physical systems and intelligent industrial automation;
- Development of mechanical and electronic prototypes with additive manufacturing;
- Analysis and development of new sustainable applications for additive manufacturing;
- Application of AI and computer vision in production processes;
- Development of human-machine interfaces and control software;
- Training and qualification of local professionals for the operation of emerging technologies;

In addition to the technical domain, the Institute stands out for the training of regional human capital, promoting courses, internships and workshops in partnership with universities and companies. This model strengthens the Amazonian knowledge base, generating professionals prepared for the challenges of digital transformation and industrial sustainability.

4.6 SCIENTIFIC PRODUCTION

IITA also seeks to strengthen academia through the production and dissemination of scientific knowledge resulting from the projects it fosters in the region. Such initiatives are aimed at the demands of local production chains and potential microproduction niches, contributing to the advancement of applied research and the sustainable development of the Amazon.

Figure 7

IITA's scientific production focused on Amazonian demands

Source: Aracê Magazine, 2025.

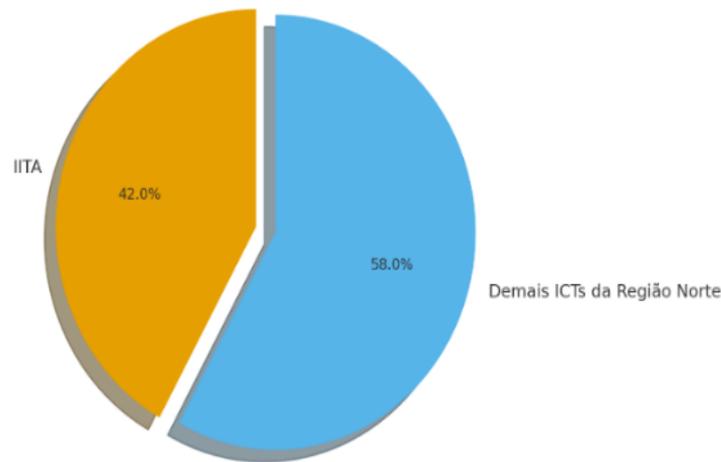## 4.7 COMPARATIVE POTENTIAL OF THE IITA AMONG THE ICTS OF THE AMAZON

The results obtained and the structural evidence indicate that IITA is among the most robust ICTs in the North region, standing out for its laboratory infrastructure and the breadth of its research lines.

The comparison between the Institute and other Amazonian ICTs demonstrates a differentiated potential, especially in the RD&I capacity focused on Industry 4.0 and in the integration between applied science and productive innovation.

The following is a visual estimate of the representativeness of IITA in relation to the set of ICTs in the Northern Region, considering infrastructure, number of researchers and volume of active projects (approximate data from CAPDA information and the 2025 regional RD&I reports):

Figure 8

IITA's RD&I potential compared to other Amazonian ICTs

The Figure shows the estimated representativeness of the Institute of Innovation and Technology of the Amazon (IITA) compared to the other ICTs in the North Region. The percentage of 42% was calculated based on four evaluation axes, laboratory infrastructure, volume of projects and investments, number of researchers and institutional partnerships, showing that the Institute concentrates almost half of the regional RD&I capacity. This result reflects the combination of its robotics and advanced manufacturing laboratories, the partnership with Creaturae Tecnologia 3D and the execution of strategic projects in automation and artificial intelligence. which positions IITA as the technical center with the greatest maturity and innovative impact in the Amazon.

5 DISCUSSION: IMPORTANCE OF THE AMAZON INSTITUTE OF INNOVATION AND TECHNOLOGY FOR REGIONAL SCIENTIFIC DEVELOPMENT

The creation and consolidation of the Institute of Innovation and Technology of the Amazon (IITA) represent a significant milestone in the structuring of an autonomous scientific and technological base in the northern region of Brazil. Its importance transcends the institutional sphere, as it materializes a new paradigm of science and technology policy that recognizes the Amazon not only as a space for environmental conservation, but also as a territory that produces knowledge, innovation and cutting-edge technology (Becker, 2005).

The analysis of IITA's actions and results shows a decisive contribution to strengthening the regional Research, Development and Innovation (RD&I) ecosystem. From its robotics, advanced manufacturing and 3D printing laboratories, the Institute introduces methodologies and processes that were previously restricted to technological centers in the Southeast and South of the country. This technological decentralization directly contributes to the reduction of regional asymmetries in ST&I, stimulating the retention of talents and the generation of local skills (Suzigan and Albuquerque, 2011).

5.1 IITA AS A LINK OF INTEGRATION BETWEEN SCIENCE, INDUSTRY AND TERRITORY

The Institute's performance reinforces the Triple Helix model (Etzkowitz, 2017), by articulating universities, the productive sector and public authorities around common objectives of sustainable innovation. IITA operates as a technical and institutional mediator between academia and industry, transforming research results into solutions applicable to the production processes of the Manaus Industrial Pole (PIM). This approximation between research and production is one of the factors that allow the increase in the degree of technological maturity (TRL) of locally developed solutions, reducing dependence on imported technologies.

In addition, the Institute plays a strategic role in aligning technological innovation with environmental and socio-cultural sustainability (Sachs, 2004). Projects aimed at sustainable 3D printing, carried out in partnership with Creaturae Tecnologia 3D, exemplify IITA's ability to adapt global technologies to Amazonian realities, promoting low-impact production practices and integrating technical and cultural knowledge.

5.2 HUMAN CAPITAL BUILDING AND STRENGTHENING LOCAL SKILLS

One of IITA's most relevant legacies is the training of qualified human resources in the region itself. The continuous interaction between engineers, technicians, students and researchers creates a project-based learning environment (PBL) and practical experimentation, which favors the consolidation of technical and scientific skills aimed at Industry 4.0.

The presence of professionals specialized in automation, artificial intelligence, additive manufacturing and software engineering expands the regional knowledge base and stimulates the creation of new opportunities for applied research. In a context in which the

human capital deficit is recognized as one of the main limitations to Amazonian development (MCTI, 2023), IITA's formative role takes on a strategic dimension.

5.3 SUSTAINABILITY, INNOVATION AND TECHNOLOGICAL AUTONOMY

The Institute also stands out for aligning its performance with the UN Sustainable Development Goals (SDGs), especially those focused on industry, innovation and infrastructure (SDG 9), quality education (SDG 4) and decent work and economic growth (SDG 8). The integration between sustainability and innovation, observed in IITA's practices, demonstrates that it is possible to promote technological development without compromising Amazonian ecosystems, adopting a growth model based on energy efficiency, reuse of materials and productive circularity (Sachs, 2004).

The stimulus to regional technological autonomy is another central aspect. By internalizing the development of prototypes, industrial software and cyber-physical systems, IITA reduces dependence on external suppliers and strengthens local capacity for innovation. This movement is aligned with the national ST&I guidelines and the Regional Development Policy, but it does so from a territorial and identity approach, in which the Amazon is seen as a producer of knowledge, and not only as a recipient of technologies (Becker, 2005).

5.4 IMPACTS ON THE AMAZON INNOVATION ECOSYSTEM

IITA's impacts on the regional innovation ecosystem are multiple and interconnected. In institutional terms, the Institute consolidates an RD&I structure capable of raising public and private funds, establishing national and international partnerships, and participating in collaborative research networks (CAPDA, 2025). In the economic field, it contributes to diversifying the productive base of the Manaus Free Trade Zone, stimulating the transition from the traditional industrial model to a digital and sustainable model.

From a social point of view, the Institute expands the access of the Amazonian population to technological education and innovation, by offering internships, workshops and training programs. This social dimension of innovation is a differential that makes IITA a transforming agent, contributing to the formation of a new regional scientific culture, especially relevant in a context of great social and educational inequalities in the country (IBGE, 2022).

6 CONCLUSION

The Institute of Innovation and Technology of the Amazon (IITA) has consolidated itself as one of the main vectors for strengthening the scientific and technological base of the North region, representing a milestone in the construction of an Amazon capable of producing knowledge, innovation and its own technological solutions. Its official recognition by CAPDA Resolution No. 88/2025 reinforces the institutional importance of applied research and the integration between science, industry, and society, in line with the principles of Laws No. 8,387/1991 and No. 10,973/2004.

The Institute's laboratory structure, with emphasis on the Robotics and Cyber-Physical Systems with Artificial Intelligence and 3D Machining and Printing laboratories, in partnership with Creaturae Tecnologia 3D, demonstrates IITA's ability to act at advanced technological levels, promoting intelligent automation, additive manufacturing and the development of sustainable industrial prototypes. These initiatives contribute to the modernization of the Manaus Industrial Pole and to the formation of qualified human capital, reducing regional inequalities and strengthening the technological autonomy of the Amazon.

By combining innovation, sustainability and valuing local knowledge, IITA proposes a model of scientific development that respects the environmental and cultural specificities of the region. Its performance reinforces the Sustainable Development Goals (SDGs) and points to a new stage of Amazonian science, more inclusive, technological, and socially committed. Thus, the Institute asserts itself as a reference in the construction of a territorial innovation ecosystem, essential for the Amazon to play a leading role in the national scenario of research and sustainable development.

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