

RESEARCH AND DEVELOPMENT AGENDA (2025-2030) CAGAYAN STATE UNIVERSITY COLLEGE OF ENGINEERING AND ARCHITECTURE

Introduction

The CSU-College of Engineering and Architecture (COEA) recognizes its vital role in addressing the pressing challenges facing the Cagayan Valley region and the Philippines as a whole. This Research and Development (R&D) Agenda is anchored on the Sustainable Development Goals (SDGs), the Philippine Development Plan (PDP), and the R&D thrusts and priorities of Cagayan State University (CSU), focusing on Food Security, Climate Change, Environmental Resource Management, Human Health and Nutrition, Disaster Risk Reduction and Management, Sustainable Renewable Energy Sources, and Emerging Technologies. This agenda aims to foster innovation, drive sustainable development, and contribute to the well-being of communities through impactful research and development initiatives.

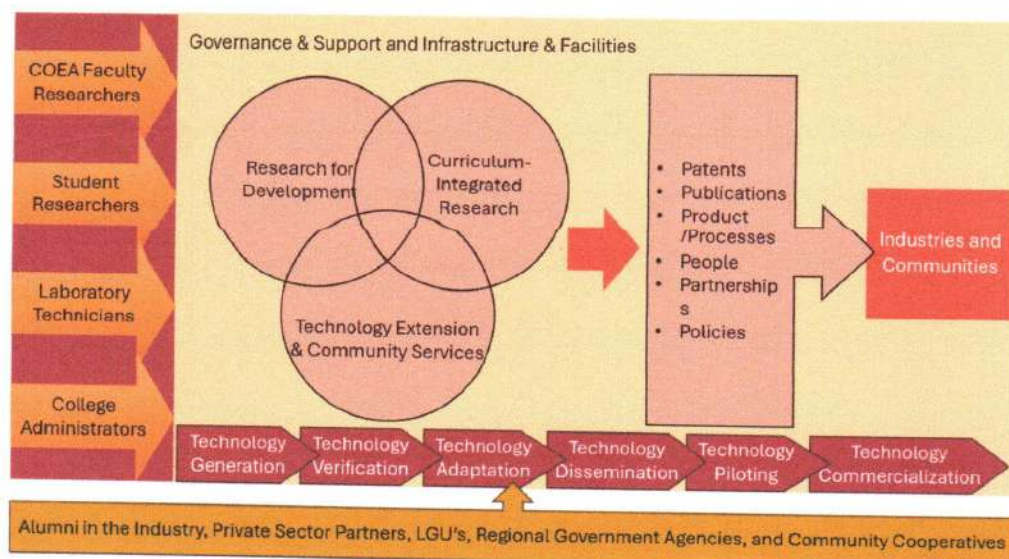
VISION

"To be a leading center for impactful engineering and architectural research, delivering practical solutions that enhance the quality of life and build resilient communities across the Philippines."

MISSION

"To drive innovation in engineering and architecture through applied research, creating and implementing practical solutions that address the evolving needs of the Cagayan Valley and the Philippines, while adhering to the SDGs, PDP, and CSU's R&D thrusts."

COEA RDE Framework



1. Inputs (The Drivers of RDE):

- **Internal Human Capital:** COEA Faculty Researchers, Student Researchers (Undergraduate Thesis/Capstone), Laboratory Technicians, and College Administrators.
- **External Stakeholders & Partners:** Alumni in Industry, Private Sector Partners (Construction, Tech, Manufacturing), LGUs (e.g., Tuguegarao City), Regional Government Agencies (e.g., DOST, DPWH, NEDA), and Community Cooperatives.

2. Enabling Environment (The Foundation):

- **Governance & Support:** College RDE Office, University RDE Policies, and a streamlined process for proposals and funding.
- **Infrastructure & Facilities:** Specialized Engineering Laboratories (e.g., Materials Testing Lab, Robotics Lab, Water Quality Lab), High-Performance Computing resources for simulations, and Prototyping/Fabrication Workshops.

3. Core Process (The COEA RDE Nexus): This is the heart of the framework, adapting the university's Venn diagram to the college's specific functions:

- **Research for Development:** This circle represents the formal R&D projects conducted by faculty under the **seven RDE themes** (e.g., developing new concrete mixes, designing AI diagnostic tools).
- **Curriculum-Integrated Research (Instruction):** This circle represents the integration of the RDE agenda into teaching. This includes undergraduate thesis projects, capstone design projects, and course-based research activities that are directly aligned with the faculty's RDE projects.
- **Technology Extension & Community Services:** This circle represents the application and deployment of research outputs. This includes training local communities on new technologies (e.g., solar dryers), providing technical assistance to LGUs, and conducting community-based participatory planning for infrastructure projects.

4. Technology Maturation Pathway (The Process Flow):

- **Technology Generation:** Conceptualization and basic research based on the RDE agenda topics.
- **Technology Verification:** Prototyping, simulation, and laboratory testing of the concept (e.g., building and testing an e-trike battery management system).
- **Technology Adaptation:** Refining the prototype based on local conditions and feedback from research cooperators (e.g., adjusting a solar dryer design for a specific local crop).

- **Technology Dissemination:** Sharing knowledge through publications, conferences, and training manuals.
- **Technology Piloting:** Implementing the technology on a small scale with a partner community or industry (e.g., installing the smart traffic system at one intersection).
- **Technology Commercialization / Knowledge for Dissemination:** Scaling up the technology through licensing, spin-off companies, or integration into public policy and industry standards.

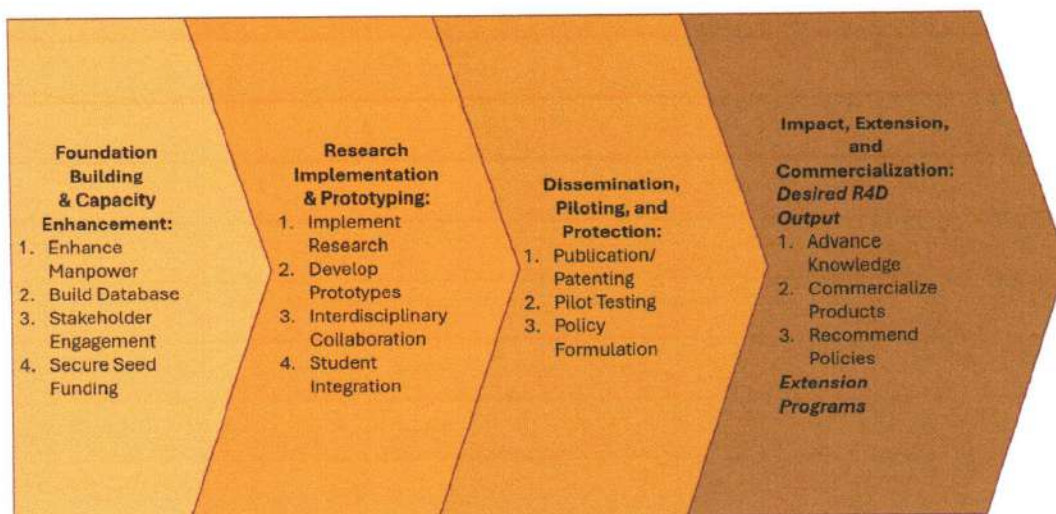
5. Outputs & Outcomes (The Results - The 6Ps):

- **Patents:** Utility models for new building materials, software copyrights, or designs for renewable energy systems.
- **Publications:** Articles in high-impact engineering, architecture, and technology journals.
- **Products/Processes:** Working prototypes (e.g., AI diagnostic tools, eco-friendly building panels), optimized processes (e.g., flood control models), and architectural designs.
- **People:** Competent graduates with strong research skills, trained faculty, and empowered community members.
- **Partnerships:** MOAs with industry for technology adoption, partnerships with LGUs for policy implementation.
- **Policies:** Policy briefs and recommendations submitted to LGUs on topics like resilient building codes, urban traffic management, or waste management strategies.

6. Beneficiaries (The Impact):

- **Industries:** Construction, Agriculture, Energy, and Technology sectors.
- **Communities:** More resilient, sustainable, and technologically equipped local, regional, and national communities.

COEA R4D Roadmap



Phase 1: Foundation Building & Capacity Enhancement (2025-2026)

- **Goal:** Strengthen the college's internal capacity to execute the RDE agenda.
- **Key Activities:**
 - **Enhance Manpower:** Conduct specialized training for faculty in the agenda's aspirational areas, such as Materials Science (Theme 4) and AI/Machine Learning (Theme 5).
 - **Build Database:** Create a comprehensive inventory of faculty expertise and existing laboratory equipment, mapping them against the seven RDE themes to identify strengths and gaps.
 - **Stakeholder Engagement:** Conduct workshops with industry partners and LGUs to refine the specific research topics under each theme and establish initial partnerships.
 - **Secure Seed Funding:** Prioritize securing internal and small external grants to initiate foundational research in each of the seven themes.

Phase 2: Research Implementation & Prototyping (2026-2028)

- **Goal:** Actively pursue research projects and develop tangible, verifiable outputs.
- **Key Activities:**
 - **Implement Research:** Full-scale implementation of grant-funded research projects (e.g., developing concrete mixes with plastic waste, building the drone-based crop monitoring system).

- **Develop Prototypes:** Focus on creating working prototypes and models for all technology-based research.
- **Interdisciplinary Collaboration:** Foster joint projects between collaborating programs (e.g., a joint project between CE, CpE, and Archi on a smart building design).
- **Student Integration:** Actively assign undergraduate thesis and capstone projects that are sub-components of the larger faculty-led RDE projects.

Phase 3: Dissemination, Piloting, and Protection (2028-2029)

- **Goal:** Share research findings, test solutions in real-world settings, and protect intellectual property.
- **Key Activities:**
 - **Publication/Patenting:** Target publications in Scopus-indexed journals and file for patents or utility models for all viable prototypes and innovations.
 - **Pilot Testing:** Deploy and test technologies with partner communities or industries (e.g., pilot the mobile-based early warning system in a target barangay).
 - **Policy Formulation:** Begin drafting policy briefs based on research findings (e.g., recommendations for landslide susceptibility zoning based on LiDAR mapping).

Phase 4: Impact, Extension, and Commercialization (2029-2030)

- **Goal:** Translate research outputs into lasting societal impact and sustainable solutions.
- **Key Activities:**
 - **Desired R4D Output:**
 - **Advance Knowledge:** Publish synthesis reports and contribute to the national body of knowledge in key engineering fields.
 - **Commercialize Products:** Develop business plans for commercializing the most promising technologies through the university's IP and commercialization office.
 - **Recommend Policies:** Formally submit policy briefs to relevant LGUs and government agencies to influence local ordinances and regional development plans.
 - **Extension Programs:** Develop and roll out formal training and extension programs to transfer knowledge and technologies to the wider community.

OVERARCHING THEMES AND SPECIFIC RESEARCH AREAS

1. Sustainable and Smart Infrastructure

Rationale: The Cagayan Valley region is frequently exposed to seismic and hydro-meteorological hazards, making the development of resilient infrastructure a critical priority. This theme addresses the urgent need to design, construct, and maintain structures and systems that can withstand environmental stresses while integrating smart technologies to enhance efficiency, safety, and quality of life in our urban and rural centers. The focus is on creating a built environment that is not only durable but also adaptive and responsive to the future needs of our communities.

Theme Alignments:

- **Campus RDE Agenda:** Industry, Engineering, Emerging Technology; Environment, Climate Change and Disaster Risk Reduction Management
- **University RDE Thrusts:** Disaster Risk Reduction and Management; Climate Change; Environmental Resource Management; Emerging Technologies
- **National/Global Goals:** SDGs 9 (Industry, Innovation and Infrastructure), 11 (Sustainable Cities and Communities), 13 (Climate Action); PDP: Resilient Infrastructure

Collaborating Programs: Civil Engineering (CE), Architecture (Archi), Computer Engineering (CpE), Geodetic Engineering (GE), Agriculture and Biosystems Engineering (ABE), Electronics Engineering (ECE), Electrical Engineering (EE), and Chemical Engineering (ChE).

Research Topics:

- Modeling and Simulation of Urban Flood Control Systems in Response to Climate Change Scenarios
 - **Rationale:** With increasing rainfall intensity due to climate change, urban centers like Tuguegarao City face significant flood risks. This research will develop predictive models to design and evaluate more effective flood management and mitigation strategies, directly contributing to community resilience.
- Implementation of IoT-Based Smart Traffic Management Systems for Tuguegarao City
 - **Rationale:** Traffic congestion is a growing problem that impacts economic productivity and environmental quality. This research aims to develop and deploy an intelligent traffic management system using IoT sensors and data analytics to optimize traffic flow, reduce commute times, and minimize vehicle emissions.
- High-Resolution LiDAR Mapping and Analysis of Landslide Susceptibility in Mountainous Regions of Cagayan

- **Rationale:** Landslides pose a significant threat to communities in the region's mountainous areas. By using advanced LiDAR technology, this research will create detailed susceptibility maps to inform land-use planning, guide infrastructure development, and establish early warning systems.

2. Smart and Sustainable Agriculture & Food Security

Rationale: As a major food producer, the Cagayan Valley is central to the nation's food security. This theme leverages engineering and technology to address key challenges in the agricultural sector, from production to consumption. The goal is to develop innovative solutions that increase yield, optimize resource use (water, energy), reduce post-harvest losses, and add value to local agricultural products, thereby ensuring a stable, safe, and sustainable food supply for the region and the country.

Theme Alignments:

- **Campus RDE Agenda:** Food Innovation; Industry, Engineering, Emerging Technology
- **University RDE Thrusts:** Food Security, Self-sufficiency and Safety; Climate Change; Emerging Technologies
- **National/Global Goals:** SDGs 2 (Zero Hunger), 12 (Responsible Consumption and Production); PDP: Food Security

Collaborating Programs: Agriculture and Biosystems Engineering (ABE), Computer Engineering (CpE), Electronics Engineering (ECE), Chemical Engineering (ChE).

Research Topics:

- Development of Drone-Based Multispectral Imaging for Real-Time Crop Health Monitoring
 - **Rationale:** Early detection of crop stress, nutrient deficiencies, and diseases is crucial for maximizing yields and minimizing the use of fertilizers and pesticides. This research will develop a drone-based system to provide farmers with rapid, actionable data for precision agriculture.
- Evaluation and Improvement of Solar Drying Technologies for Agricultural Produce in Cagayan Valley
 - **Rationale:** Significant post-harvest losses for high-value crops are often due to inadequate drying and storage facilities. This research aims to design, evaluate, and improve affordable and efficient solar drying technologies to reduce spoilage, enhance food safety, and increase income for farmers.
- Development of Sustainable Food Packaging Materials from Local Agricultural Waste
 - **Rationale:** This research addresses the dual problems of agricultural waste management and plastic pollution. It aims to convert local biomass (e.g., rice husks, corn cobs) into

biodegradable packaging materials, creating a value-added product that supports a circular economy.

3. Renewable Energy and Electro-Mobility

Rationale: Ensuring energy security and reducing carbon emissions are national priorities. This theme focuses on developing and optimizing sustainable energy solutions and promoting cleaner transportation alternatives. Research will concentrate on harnessing the region's abundant renewable energy resources (solar, wind) and advancing the adoption of electro-mobility, particularly for public transportation, to create a more secure, affordable, and environmentally friendly energy landscape.

Theme Alignments:

- **Campus RDE Agenda:** Industry, Engineering, Emerging Technology; Environment, Climate Change and Disaster Risk Reduction Management
- **University RDE Thrusts:** Sustainable Renewable Energy Sources; Climate Change; Emerging Technologies
- **National/Global Goals:** SDGs 7 (Affordable and Clean Energy), 13 (Climate Action); PDP: Clean Energy

Collaborating Programs: Electrical Engineering (EE), Computer Engineering (CpE), Electronics Engineering (ECE), Agriculture and Biosystems Engineering (ABE).

Research Topics:

- Design and Development of a Hybrid Solar-Wind Power System for Rural Electrification in Cagayan Valley
 - **Rationale:** Many remote and off-grid communities in the region lack access to reliable electricity. This research aims to develop a robust and cost-effective hybrid renewable energy system tailored to local conditions, improving livelihoods and enabling economic development.
- Development of a Battery Management System for Electric Tricycles Using Locally Available Materials
 - **Rationale:** The high cost and limited lifespan of batteries are major barriers to the widespread adoption of electric vehicles. This research will focus on developing a more affordable and efficient battery management system, potentially using local materials, to make e-trikes a more viable option for public transport.
- Conversion of Conventional Diesel Buses to Electric Buses for Public Transportation in Tuguegarao City
 - **Rationale:** Public transportation is a major source of urban air pollution. This research will explore the technical and economic feasibility of retrofitting existing diesel buses into electric vehicles, providing a practical pathway to decarbonize the city's transport sector.

4. Materials Innovation and Industrial Development

Rationale: The development of novel materials is fundamental to advancing construction, manufacturing, and other key industries. This theme is designed to establish a strong research program in materials science, focusing on the creation of sustainable, high-performance, and cost-effective materials from locally available and recycled resources. This will support regional industrial growth, promote sustainable construction practices, and enhance the competitiveness of local industries.

Theme Alignments:

- **Campus RDE Agenda:** Industry, Engineering, Emerging Technology
- **University RDE Thrusts:** Emerging Technologies; Environmental Resource Management
- **National/Global Goals:** SDGs 9 (Industry, Innovation and Infrastructure), 12 (Responsible Consumption and Production); PDP: Industrial Development

Collaborating Programs: Chemical Engineering (ChE), Civil Engineering (CE).

Research Topics:

- Development of Concrete Mixes Incorporating Recycled Plastic Waste for Sustainable Construction
 - **Rationale:** This research addresses the environmental problem of plastic waste by investigating its potential as a component in concrete. The goal is to develop a durable and lightweight construction material that reduces landfill burden and promotes a circular economy in the construction industry.
- Utilization of Agricultural Waste for the Production of Eco-Friendly Building Materials
 - **Rationale:** The region produces a vast amount of agricultural waste. This research will explore methods to convert this biomass into eco-friendly building materials like insulation boards or composite panels, providing a sustainable alternative to conventional materials and creating new income streams for the agricultural sector.
- Synthesis and Characterization of Nanomaterials for Enhanced Corrosion Resistance in Marine Environments
 - **Rationale:** Corrosion is a major challenge for infrastructure in coastal areas. This research aims to develop advanced nanomaterial coatings that provide superior protection against corrosion, extending the service life of critical marine and coastal structures.

5. Information and Communication Technology for Development

Rationale: Information and Communication Technology is a powerful enabler of development across all sectors. This theme focuses on applying emerging digital technologies—such as Artificial Intelligence (AI), machine learning, and mobile systems—to create innovative and scalable solutions for pressing challenges in healthcare, disaster management, and education. The objective is to harness the power of ICT to improve access to services, enhance public safety, and foster inclusive growth.

Collaborating Programs: Computer Engineering (CpE), Electronics Engineering (ECE), Agriculture and Biosystems Engineering (ABE).

Theme Alignments:

- **Campus RDE Agenda:** Industry, Engineering, Emerging Technology; Human Health & Wellness; Environment, Climate Change and Disaster Risk Reduction Management
- **University RDE Thrusts:** Emerging Technologies; Disaster Risk Reduction and Management; Human Health and Nutrition
- **National/Global Goals:** SDGs 9 (Industry, Innovation and Infrastructure), 17 (Partnerships for the Goals); PDP: ICT for Development

Research Topics:

- Development of an AI-Powered Disease Diagnostic System for Rural Health Clinics
 - **Rationale:** This research aims to improve access to quality healthcare in underserved areas by developing an AI tool that can assist rural health workers in diagnosing common diseases from medical images or patient data, enabling earlier treatment and better health outcomes.
- Development of a Mobile-Based Early Warning System for Natural Disasters in Cagayan Valley
 - **Rationale:** Timely and effective communication is critical for disaster preparedness. This project will develop a user-friendly mobile application that disseminates real-time hazard information, evacuation alerts, and safety instructions to residents in disaster-prone areas.
- Development of a Machine Learning System for Flood Prediction
 - **Rationale:** This research will leverage historical weather data, river levels, and topographical information to build a machine learning model capable of providing more accurate and timely flood predictions, enhancing the region's flood forecasting and response capabilities.

6. Engineering Education and Professional Practice

Rationale: The core mission of the College is to produce competent, ethical, and industry-ready engineers and architects. This theme formalizes the critical, scholarly work of self-assessment and continuous improvement of our academic programs. Research under this theme is not an administrative task

but a strategic necessity to ensure our curricula remain relevant, our pedagogical methods are effective, and our graduates possess the skills required by a rapidly evolving professional landscape. This theme directly supports accreditation efforts, enhances institutional reputation, and ensures we are fulfilling our primary mandate to our students and society.

Theme Alignments:

- **Campus RDE Agenda:** Governance
- **University RDE Thrusts:** Social Sciences (specifically covering Higher Education and Governance)
- **National/Global Goals:** SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth)

Collaborating Programs: This theme is led by the **College Administration** and involves **all academic programs**.

Research Topics:

- A Gap Analysis of Engineering Curricula versus Industry 4.0 Competencies
 - **Rationale:** Industries are increasingly demanding skills in AI, IoT, data analytics, and automation. This research will systematically evaluate the current curricula of all engineering programs against these emerging industry needs to identify gaps and provide evidence-based recommendations for curriculum modernization.
- The Efficacy of Project-Based Learning (PBL) in Developing Critical Thinking and Problem-Solving Skills in Engineering Students
 - **Rationale:** While traditional lecture-based methods are common, modern pedagogy emphasizes active learning. This research will assess the impact of PBL methodologies on the development of higher-order thinking skills, providing data to guide the adoption of more effective teaching and learning strategies across the college.
- Developing a Framework for Integrating Professional Ethics and Non-Technical "Soft Skills" into the Engineering Curriculum
 - **Rationale:** Industry leaders consistently cite communication, teamwork, and ethical judgment as critical skills for graduate success. This research aims to move beyond standalone courses by developing and testing a comprehensive framework for embedding these essential professional competencies throughout the technical curriculum of all programs.

7. Socio-Technical Systems and Environmental Stewardship

Rationale: The most technically brilliant engineering solutions can fail if they are not aligned with human behavior, cultural contexts, and societal needs. This interdisciplinary theme addresses the critical human dimension of engineering and architecture. It recognizes that technology and society are deeply intertwined. Research under this theme explores the social, economic, and ethical impacts of engineering interventions, ensuring that our solutions are not only technically sound but also socially robust, culturally sensitive, and truly sustainable. It positions the college to tackle complex challenges like

climate change and sustainable development in a more holistic and impactful way.

Theme Alignments:

- **Campus RDE Agenda:** Environment, Climate Change and Disaster Risk Reduction Management; Socioeconomics
- **University RDE Thrusts:** Environmental Resource Management; Climate Change; Social Sciences
- **National/Global Goals:** SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), SDG 16 (Peace, Justice and Strong Institutions)

Collaborating Programs: **Architecture (Archi)** is identified as a lead collaborator.

Research Topics:

- Socio-Cultural Factors Influencing the Adoption of Renewable Energy Technologies in Rural Communities of Cagayan
 - **Rationale:** The successful deployment of technologies like solar panels in rural areas depends on more than technical feasibility; it requires community acceptance. This research will investigate the social, cultural, and economic factors that facilitate or hinder the adoption of renewable energy, providing crucial insights for effective implementation and extension programs.
- An Analysis of Community Engagement and Participatory Planning in Local Infrastructure Projects
 - **Rationale:** Top-down infrastructure projects often face community resistance. This research will study the effectiveness of different community engagement models in the planning and implementation of local infrastructure (e.g., water systems, roads), aiming to develop a best-practice framework that enhances project success and social equity.
- A Behavioral Study on Promoting Sustainable Waste Management Practices in the CSU Community
 - **Rationale:** Effective waste management relies heavily on individual behavior. This research will use principles of behavioral science to identify the key drivers of and barriers to proper waste segregation and reduction, and will design and test interventions (e.g., nudges, incentives) to foster a stronger culture of environmental stewardship on campus.

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