

Supplementary Table S9. Node Attributes of the Analytical Cases Included in the Network Analysis (2020–2025). Note: This table presents the full list of nodes and their attributes for 11 studies (2020-2025). In the network generated for individual case analyses, each actor is represented as a unique node with attributes including a short, unique identifier (ID), the full institutional or actor name (Label), the helix category (Government, University, Industry, or Community), explicitly stated roles (semicolon-separated), and engagement level (Central or Supporting). Nodes are color-coded by helix for visual clarity: Government = Red, University = Green, Industry = Blue, and Community = Orange. Visualizations of these networks can be found in the corresponding figures presented for each individual case.

Case	ID	Label	Helix	Role	Engagement
1 (SID-b100)	ASTI	Advanced Science and Technology Institute	Government	Research ICT infrastructure support	Supporting
	ADMU	Ateneo de Manila University	University	EMR development; ICT health systems research	Central
	CICT	Commission on Information and Communications Technology	Government	ICT governance support (historical role)	Supporting
	CHITS	Community Health Information Tracking System	Industry	EMR system for health facilities	Central
	DOH	Department of Health	Government	National health governance; telemedicine implementation	Central
	DOST	Department of Science and Technology	Government	Funding ICT health innovation; device development support	Central
	ITU	International Telecommunication Union	Government	ICT-health framework co-developer	Supporting
	JR_BORJA	JR Borja General Hospital	Industry	Telepsychiatry implementation site	Central
	LGU_Navotas	Navotas City LGU	Government	CHITS implementation; mCHITS deployment	Central
	LGU_Pasay	Pasay City LGU	Government	CHITS implementation	Central
	LGU_Quezon	Quezon City LGU	Government	CHITS implementation; telemedicine services	Central
	MDH	Manila Doctors Hospital	Industry	Telemedicine and tele-education hospital	Supporting
	NTHC	National Telehealth Center	University	Telemedicine development; EMR systems; eHealth policy; training	Central
	NTSP	National Telehealth Service Program	Government	National telemedicine rollout for GIDAs	Central
	PHIE	Philippine Health Information Exchange	Government	National health data exchange system	Central
	PHILHEALTH	Philippine Health Insurance Corporation	Government	Health financing; eClaims integration	Supporting
	PREGINET	Philippine Research, Education and Government Information Network	Government	ICT network for health and research connectivity	Supporting
	RXBOX	RxBox	Industry	Biomedical telemedicine device	Central
	SHINE_OS	SHINE OS+	Industry	EMR; SMS health system; eClaims support	Central
	SMART	Smart Communications	Industry	SHINE OS+ technology provider	Supporting
	SPMC	Southern Philippines Medical Center	Industry	Telepsychiatry partner hospital	Supporting

	UNICEF	United Nations Children's Fund	Government	Maternal and neonatal health program support	Supporting
	UP-PGH	Philippine General Hospital	University	Telemedicine referral hub; specialist consultations	Central
	VMMC	Veterans Memorial Medical Center	Industry	Telemedicine and surgical training partner	Supporting
	WHO	World Health Organization	Government	Global eHealth framework provider	Supporting
2 (SID-b171)	BFAR	Bureau of Fisheries and Aquatic Resources	Government	Policy implementation; technology dissemination; training; hatchery establishment; program implementation	Central
	DOST-PCAARRD	Department of Science and Technology – Philippine Council for Agriculture and Aquatic Resources Research and Development	Government	Project initiation; coordination; funding facilitation; funding; strategic planning; R&D program support	Central
	FISH_CONS	Milkfish Consumers (Households)	Community	Consumption of table-sized milkfish	Supporting
	GROW_OUT	Milkfish Grow-out Operators	Industry	Fry consumers; table fish producers; aquaculture production	Central
	HATCH_OPS	Milkfish Hatchery Operators	Industry	Hatchery production; commercialization of fry; supply of hatchery-bred fry	Central
	IMPORT_SUP	Imported Fry Suppliers (Indonesia and Taiwan)	Industry	Supply of imported milkfish fry	Supporting
	NIFTDC	National Integrated Fisheries Technology Development Centre (BFAR)	Government	Training; technology dissemination; capacity building	Supporting
	PSA	Philippine Statistics Authority	Government	Data provision; production and price statistics	Supporting
	SEAFDEC_AQD	SEAFDEC Aquaculture Department	University	Broodstock research; hatchery technology development; demonstration operations	Central
	UNDP	United Nations Development Programme	Community	Funding support for development project	Supporting
	UPV	University of the Philippines Visayas	University	Research collaboration; project implementation support	Supporting
	WILD_GATHER	Coastal Wild Fry Gatherers	Community	Collection of wild milkfish fry	Supporting
3 (SID-b247)	PENRO_NE	Provincial Environment and Natural Resources Office (PENRO) – Nueva Ecija	Government	Implement environment and biodiversity management; provided assistance for the study; system end user; system evaluator	Central
	EMPLOYEES	PENRO Employees (10)	Government	Manage environment-related information; system end users; system evaluators	Central
	BIODIV_COM	Biologist / Biodiversity Monitoring Committee Members	Government	Manage biodiversity (species) data; system end users; system evaluators	Central
	DENR	Department of Environment and Natural Resources (DENR)	Government	Agency to which system linkage is recommended	Supporting
	LAWIN	DENR LAWIN Forest and Biodiversity Protection System	Government	Forest and biodiversity protection system; proposed linkage target	Supporting
	TSU	Tarlac State University	University	Provided substantial support in pursuing the study	Supporting

	CLSU	Central Luzon State University	University	Provided substantial support in pursuing the study	Supporting
	IT_EXPERTS	Information Technology (IT) Experts (3)	Industry	Evaluated database design; functionality; maintainability; security; user interface	Supporting
	COMMUNITY	General Users / People of the Community (20)	Community	Accessed/viewed environment and biodiversity information; system evaluators	Central
4 (SID-b694)	BI_CSU	CSU BI Personnel	University	Incubation staff; mentors; program implementers	Central
	BI_ISU	ISU BI Personnel	University	Incubation staff; mentors; program implementers	Central
	BI_NVSU	NVSU BI Personnel	University	Incubation staff; mentors; program implementers	Central
	Biz_Grads	Business Graduates	Community	Alumni beneficiaries of UBI exposure and employability outcomes	Central
	Biz_Students	Business Students	Community	Learners engaged in incubation training and exposure	Central
	Biz_Assisted	Businesses Assisted	Community	Enterprises supported through incubation programs	Central
	Cacao_Growers	Cacao Growers	Community	Agricultural producers engaged in cacao value chain	Central
	CHED	Commission on Higher Education	Government	Curriculum policy; standards for BSBA/entrepreneurship programs	Supporting
	Cooperative_Banks	Cooperative Banks	Industry	Financial support and facilitation of funding access	Supporting
	CSU	Cagayan State University	University	HEI administration; host institution of UBIs	Central
	CSU_BIZNEST	Business Incubation Zone for Novel and Sustainable Enterprises	University	Business incubation; start-up support; technopreneur assistance	Central
	DOST	Department of Science and Technology	Government	Funding support; technical validation; mentorship	Central
	DTI	Department of Trade and Industry	Government	Mentorship; technical support; funding; partnerships	Central
	External_Biz	External Businesses	Industry	Partner enterprises; potential employers and collaborators	Supporting
	Incubatees	Incubatees	Community	Individuals/teams receiving incubation support	Central
	IPO_Taguig	Intellectual Property Office Taguig City	Government	IP registration; utility model and patent certification	Supporting
	ISU	Isabela State University	University	HEI administration; host institution of UBIs	Central
	ISU_CVCDC	Cagayan Valley Cacao Development Center	University	Business incubation; cacao processing support; product development	Central
	Kasama_Company	Kasama Company (Canada)	Industry	International chocolate enterprise; product promotion partner	Supporting
	LBP	Land Bank of the Philippines	Government	Financial intermediation; funding support for ventures	Supporting
	LGUs	Local Government Units	Government	Event support; facilitation of partnerships	Supporting
	NGAs	Non-Government Agencies	Industry	Support services; partnerships and facilitation roles	Supporting
	NVSU	Nueva Vizcaya State University	University	HEI administration; host institution of university business incubators (UBIs)	Central
	NVSU_Sabatan	Sabatan Technopreneurs Hub	University	Business incubation; training; mentoring; facilitation of start-ups	Central

	PLTCI	PLT College Inc.	University	Potential source of incubatees and mentors	Supporting
	SMU	Saint Mary's University	University	Potential source of incubatees and mentors	Supporting
	Startups	Start-ups	Community	Early-stage ventures supported by UBIs	Central
	Technopreneurs	Technopreneurs	Community	Entrepreneurial actors supported by UBIs	Central
5 SID- b695	BSU	Batangas State University	University	Technical skills provision; equipment support	Supporting
	CBA	Community-Based Associations	Community	Formation and management of SEs; member coordination	Central
	CDA	Cooperative Development Authority	Government	Cooperative and association development support	Supporting
	DOLE	Department of Labor and Employment	Government	Provision of utensils and raw materials	Supporting
	DOST	Department of Science and Technology	Government	Grants-In-Aid funding; technology transfer; project conceptualization; proposal preparation; training; equipment provision; packaging and marketing assistance	Central
	DOST_PCAARRD	DOST – Philippine Council for Agriculture and Aquatic Resources Research and Development	Government	Technology transfer support; funding support	Supporting
	DSWD_SLP	DSWD Sustainable Livelihood Program	Government	Funding support for production facility establishment	Central
	EZFI	Enrique Zobel Foundation Inc.	Community	Funding support; production facility establishment; enterprise monitoring; marketing assistance	Central
	FDA	Food and Drug Administration	Government	Licensing and regulatory approval (LTO)	Supporting
	FNRI	Food and Nutrition Research Institute	Government	Technology transfer assistance	Supporting
	KabisigKALAHl	Kabisig ng KALAHl	Community	Marketing support	Supporting
	LGU_Cuenca	Local Government Unit of Cuenca	Government	Enterprise assistance coordination; supervision	Central
	LGU_Ibaan	Local Government Unit of Ibaan	Government	Funding support; skills training; facility support; marketing assistance	Central
	LGU_Rosario	Local Government Unit of Rosario	Government	Facility provision; technical assistance; marketing support; supervision	Central
	LGU_Taal	Local Government Unit of Taal	Government	Enterprise formation; funding support; training; marketing assistance; supervision	Central
	MSMEs	MSMEs Batangas Province	Industry	Enterprise sector context	Supporting
	PHP_NGO	Philippine Partnership for the Development of Human Resources in Rural Areas (PHP)	Community	Formation of women associations; funding support; enterprise management guidance; marketing assistance	Central
	ProvVetOffice	Provincial Veterinary Office	Government	Agricultural technical instruction	Supporting
	PSTC_Batangas	DOST CALABARZON PSTC Batangas	Government	Program implementation; technology service delivery; enterprise development support	Central
	PTRI	Philippine Textile Research Institute	Government	Technology transfer support	Supporting

	SEARCA	SEARCA	University	Technology transfer support	Supporting
	SEC	Securities and Exchange Commission	Government	Enterprise registration authority	Supporting
	SEs	Selected Social Enterprises (Batangas)	Industry	Production; marketing; employment; social enterprise operations	Central
	SIMabini	Soroptimist International of Mabini	Community	Skills training funding; production facility funding; enterprise support	Central
	UB	University of Batangas	University	Equipment provision support	Supporting
6 (SID-b110)	ADM	School Administrators / Principals	Government	Attendance record oversight; report compilation; school management	Central
	CHED	Commission on Higher Education	Government	Higher education oversight (mentioned as system stakeholder only)	Supporting
	DepEd	Department of Education	Government	Attendance policy enforcement; school monitoring framework	Supporting
	PAR	Parents of Students	Community	Monitoring student attendance; ensuring school attendance compliance	Supporting
	RES	Researchers (Santos, Balba, Rebong)	University	System design; algorithm development; evaluation of system	Central
	SCH	Schools in the Philippines (Public/Private)	Government	Institutional site; attendance administration; manual-to-digital transition context	Central
	STD	Students / Learners	Community	Attendance subjects; academic participation	Central
	AMS	Attendance Monitoring System	Community	Automated attendance recording; seating-based identification; report generation; optimization query processing	Central
	TCH	Teachers / Educators	University	Attendance taking; classroom monitoring; grading input	Central
7 (SID-b209)	AT	Agricultural Technologists	Government	Field data collection; submission of surveillance forms and pest damage reports; weekly validation	Central
	CIT_U	Cebu Institute of Technology–University	University	Academic institution of researcher; research and software development environment	Supporting
	DA_SAM	Department of Agriculture – Province of Samar	Government	Agricultural development; monitoring and management of farming systems; pest and disease control oversight	Central
	FARMERS	Farmers (Province of Samar)	Community	Crop production; reporting pest and disease occurrences via surveillance forms	Central
	PA	Provincial Agriculturist	Government	Manual data processing; analysis of surveillance forms; report generation; decision support	Central
	RCPC	Regional Crop Protection Center	Government	Receives consolidated reports; supports regional crop protection decision-making	Central
	SCI	Agricultural Scientists	Community	Assists interpretation of pest and disease data; supports analysis of agricultural conditions	Supporting
8	AMReL	Additive Manufacturing Research Laboratory (AMReL)	University	Research laboratory integrating MakerLab	Central

(SID-b318)	Balanga_City	City Government of Balanga	Government	Supports local makerspace initiative and technology ecosystem vision	Supporting
	BPSU	Bataan Peninsula State University	University	Establishes academic makerspace; conducts research; provides facilities for students and faculty	Central
	BPSU_Faculty	BPSU Faculty	Community	Users and beneficiaries of makerspace	Central
	BPSU_Students	BPSU Students	Community	Users of makerspace for academic and extracurricular projects	Central
	CHED	Commission on Higher Education	Government	Higher education support agency in technopreneurship context	Supporting
	DOST	Department of Science and Technology	Government	Innovation ecosystem support agency	Supporting
	DOST-PCIEERD	DOST-PCIEERD	Government	Jointly supports establishment of MakerLab	Central
	DTI	Department of Trade and Industry	Government	Partner agency in technopreneurship ecosystem	Supporting
	MakerLab	BPSU MakerLab	University	Academic makerspace for ideation, prototyping, manufacturing, innovation	Central
	MSMEs	MSMEs	Industry	External collaborators in prototyping and fabrication	Supporting
	Miriam_College	Miriam College	University	Hosts innovation center facilities	Central
	Miriam_Innovation	Miriam College Innovation Center	University	Design, robotics, engineering, entrepreneurship learning facility	Central
	SLU	Saint Louis University	University	Hosts technopreneurship hub	Central
	SLU_FabLab	SLU Fabrication Laboratory	University	Prototyping and manufacturing facility	Central
	SLU_SIRIB	SIRIB Center	University	Ideation, design thinking, R&D support facility	Central
	SLU_TBI	SLU TBI	University	Incubation and mentoring support facility	Central
	SLU_TechHub	SLU Technopreneurship Hub	University	Innovation ecosystem facility	Central
	SM_Group	SM Group	Industry	Donor of innovation center to Miriam College	Central
9 (SID-b469)	CMU	Central Mindanao University	University	Project implementer; training provider; technical assistance provider; monitoring and evaluation; extension services	Central
	DOST-PCAARRD	Department of Science and Technology – Philippine Council for Agriculture and Aquatic Resources Research and Development	Government	Project funding agency; grant provider	Central
	FARMERS	Project-Cooperators (39 cacao farmers)	Industry	Cacao plantation establishment; farm management; project participation	Central
	LGUs	Local Government Units (Lantapan, Maramag, Malaybalay City, Valencia City)	Government	Selection of project-cooperators; project coordination	Central
10	COMPETITORS	Competitor-Supplier Firms	Industry	Supply relationships; competition; network linkage in halal value chain	Supporting

(SID-b582)	CUSTOMERS	Halal Customers/Consumers	Industry	Demand creation; certification influence; market feedback	Supporting
	EXPORT_MARKETS	International Export Markets (GCC, ASEAN, EU, US)	Industry	Destination markets; demand for halal-certified goods	Supporting
	GOV_PH	Philippine Government	Government	Policy formulation; implementation of RA 10817; export promotion; accreditation mandate	Central
	HALAL_EXP	Philippine Halal Exporters	Industry	Halal food production; export; certification compliance; innovation adaptation	Central
	HCB	Halal Certifying Bodies (Philippines)	Government	Halal certification; auditing; compliance verification	Central
	IDCP	Islamic Da'wah Council of the Philippines	Government	Halal certification issuance; auditing companies; certification governance	Central
	MIDDLE_EAST_CERT	Middle East Halal Certification Authorities	Government	External certification authority; recognition of standards; export compliance gatekeeping	Supporting
	MNL_HALAL_SYSTEM	Philippine Halal Industry System	Industry	Halal ecosystem structure; certification-driven production system	Central
	PAB	Philippine Accreditation Bureau	Government	Accreditation of halal certifying bodies; policy implementation under RA 10817	Central
	SUPPLIERS	Raw Material Suppliers	Industry	Supply of inputs for halal production; compliance with halal sourcing requirements	Supporting
	TOURISM_SECTOR	Tourism Sector Partners	Industry	Domestic linkage; consumption channels; network expansion	Supporting
11 (SID-b590)	Biz	Businesses	Industry	Users of G2B e-government services; beneficiaries of digital transactions	Supporting
	CIT	Citizens of Valencia City	Community	Users of e-government services; participants in feedback and engagement	Central
	EMP	Government Employees	Community	Users of internal e-government systems (G2E)	Supporting
	GOVAG	Government Agencies	Government	Inter-agency coordination partners in G2G services	Supporting
	ICT	ICT Systems / Digital Platforms	Industry	Enabling infrastructure for e-government service delivery	Supporting
	LGULEAD	LGU Leadership	Government	Governance direction, decision-making, administrative oversight	Central
	LGU_Valencia	LGU-Valencia City	Government	E-government service provider; policy implementer; ICT governance adopter; service delivery manager	Central
	NATLEG	National Legislature (Philippines)	Government	Creator of e-governance legislation (E-Governance Act, HB 7327)	Supporting