Devosia: Community Outreach Journal of Indonesian Movement
Vol 1 No 1 January 2026, Hal 33-42
ISSN: XXXX-XXXX (Print) ISSN: XXXX-XXXX (Electronic)
Open Access: https://researchfrontiers.id/devosia/index

Technology Transfer and Innovation: Application of Appropriate Technology to Solve Community Problems

Rizki Rohmat Nur Alim Isnaini[1*], Moh. Imron Rosidi[2], Nahri Idris[3], Ahmad Budi Trisnawan[4], Renol Hasan[5], Hafiz Irwandi[6], Hengki Mangiring Parulian Simarmata[7]
[1] Universitas Negeri Yogyakarta, Indonesia
[2,5] Universitas Negeri Gorontalo, Indonesia
[3] Universitas Jambi, Indonesia
[4] Universitas Mahakarya Asia, Indonesia
[6] Universitas Negeri Medan, Indonesia
[7] Politeknik Bisnis Indonesia, Indonesia
email: isanainirohmat@gmail.com[1]

Article Info :
Received:
28-11-2025
Revised:
12-01-2026
Accepted:
25-01-2026

Abstract

This study examines how technology transfer and innovation generate sustainable problem-solving outcomes in community contexts through a field-based, mixed-methods, multiple-case design. Drawing on socio-technical systems theory and diffusion scholarship, the research analyses three heterogeneous community domains to identify mechanisms linking technological design, local capability formation, and institutional mediation. The results demonstrate that technological effectiveness is contingent upon adaptive co-production processes that align artefact modularity with user practices and contextual constraints. Innovation efficiency is shown to depend on differentiated absorptive capacities shaped by facilitation structures, learning trajectories, and organisational positioning within local networks. Long-term sustainability is governed less by technical robustness than by governance stability, epistemic anchoring, and intermediary coordination that reproduce capabilities beyond project cycles. By integrating qualitative process tracing with comparative quantitative indicators, the study advances a meso-level explanation of how adaptation, learning, and institutional resilience jointly condition durable technology transfer outcomes. The findings contribute to innovation theory by reconceptualising community-based technology transfer as an institutionalised learning system rather than a unidirectional transmission process.

Keywords: *technology transfer, appropriate technology, community innovation, institutional sustainability, absorptive capacity.*

INTRODUCTION

Over the past two decades, technology transfer and innovation have undergone a profound conceptual reconfiguration from linear mechanisms of knowledge diffusion into strategic instruments of structural transformation intertwined with energy transition, data-driven economies, and sustainability agendas, as evidenced by the macro-level interdependencies between renewable energy investment, technology transfer, and economic growth across European and Central Asian economies that demonstrate the institutional and ecological non-neutrality of contemporary knowledge flows (Nassani et al., 2025). Recent scholarship further documents a paradigmatic shift toward innovation ecosystems mediated by artificial intelligence, blockchain infrastructures, and university–industry open innovation architectures, which collectively reconstitute the governance of R&D collaboration and expand the constellation of actors engaged in the creation and application of appropriate technologies (Orlando et al., 2025; Spigarelli et al., 2025). In parallel, reconceptualisations of diffusion emphasise the social generalisation of innovation through institutional and cognitive "building blocks," thereby displacing artefactual understandings of technology with processual and negotiated accounts of socio-technical embedding (Robinson et al., 2025). Within this evolving landscape, appropriate technology emerges as a critical mediating construct between frontier innovation and community-level problem solving, particularly as green innovation and environmental biotechnology generate both developmental opportunities and ethically charged risks that demand context-sensitive transfer mechanisms (Emon et al., 2025; Quiroz, 2025).

A convergent body of literature establishes that the effectiveness of technology transfer is conditioned less by technical sophistication than by institutional congruence and cultural embeddedness, a conclusion systematised by Gambi and Debackere (2025), who position culture as a latent determinant of adoption trajectories. At the ecosystem level, Xiao et al. (2025) demonstrate that persistent mismatches between knowledge supply and demand constitute a structural source of inefficiency, while AI-mediated university–industry collaborations accelerate innovation generation yet simultaneously amplify access asymmetries for peripheral actors (Orlando et al., 2025). In the entrepreneurial domain, Grimaldi et al. (2025) show that data-driven entrepreneurship relocates the locus of innovation from laboratories to opportunity spaces structured by knowledge analytics, whereas Chin et al. (2025) identify a masking effect whereby entrepreneurship obscures the causal contribution of technology transfer to inclusive growth. Complementarily, analyses of government–NGO–SME helices reveal paradoxical sustainability dynamics in which collaborative interventions reproduce new forms of dependency rather than durable autonomy (Islam et al., 2025). In health systems, Reed et al. (2025) attribute repeated failures of information technology introduction to organisational resistance rather than technical deficiency, reinforcing the proposition that transfer processes are irreducibly socio-technical.

Despite these advances, prevailing research remains disproportionately anchored in formal institutional settings and macro-level performance indicators, thereby under-theorising the micro-processes through which appropriate technologies are negotiated, reconfigured, and routinised within recipient communities (Gambi & Debackere, 2025; Robinson et al., 2025). The dominance of ecosystem efficiency metrics and inclusive growth proxies produces systematic inconsistencies between quantitative outcomes and lived adoption realities, particularly where entrepreneurial dynamics conceal rather than clarify technology–welfare linkages (Chin et al., 2025). Moreover, the empirical concentration on large economies and high-capacity systems constrains the external validity of findings for low-institutional-density communities, while green innovation and biotechnology studies privilege market opportunities over ethical and social externalities at the community scale (Xiao et al., 2025; Quiroz, 2025; Emon et al., 2025). These limitations signal an unresolved theoretical lacuna concerning appropriate technology as a needs-oriented intervention strategy rather than a residual category of transfer.

The persistence of this lacuna carries substantive practical consequences, insofar as technologically sophisticated interventions misaligned with local social architectures tend to reproduce access inequalities and erode intervention legitimacy, a pattern already evident in the sustainability paradoxes of helix-based collaboration (Islam et al., 2025). Scientific urgency is further intensified by the global energy transition, which renders transfer mechanisms that fail to cultivate adaptive community capacity economically destabilising rather than developmental (Nassani et al., 2025; Emon et al., 2025). At the operational level, the consolidation of innovation ecosystems in health and social entrepreneurship education demands application models that are not merely efficient but institutionally replicable under conditions of organisational fragility (Reed et al., 2025; Wang & Horta, 2025). In this sense, community-based technology transfer constitutes an experimental arena for testing diffusion theory under conditions of structural constraint.

This study positions itself at the intersection of innovation ecosystem theory, social diffusion scholarship, and the praxis of appropriate technology, shifting analytical priority from institutional performance to community-level adaptive processes as the principal determinant of transfer success (Robinson et al., 2025; Xiao et al., 2025). In contrast to dominant approaches that evaluate effectiveness through growth or formal collaboration metrics, the present research mobilises insights on culture, entrepreneurship, and social innovation education to construct an application framework oriented toward concrete problem resolution (Gambi & Debackere, 2025; Chin et al., 2025; Wang & Horta, 2025). By integrating AI-based open innovation and the role of innovation intermediaries, the study conceptualises appropriate technology as a mediating node between frontier knowledge and situated practice (Orlando et al., 2025; Spigarelli et al., 2025). This positioning enables the articulation of an empirical contribution that not only tests but also delimits the applicability of prevailing transfer theories.

On this basis, the study aims to develop and empirically examine a model of appropriate technology application capable of mediating the tension between global innovation complexity and community capacity through measurable socio-technical adaptation mechanisms. Theoretical

contributions are directed toward refining technology transfer as a process of knowledge co-production conditioned by culture, entrepreneurship, and ecosystem structure (Gambi & Debackere, 2025; Grimaldi et al., 2025), while methodological contributions are realised through demand–supply matching evaluation and micro-level adoption process analysis (Xiao et al., 2025; Reed et al., 2025). Practically, the research seeks to generate replicable intervention prototypes for energy transition, health innovation, and social entrepreneurship, while advancing the debate on how appropriate technology can function as an instrument of inclusion and sustainability within contemporary innovation ecosystems (Nassani et al., 2025; Emon et al., 2025; Quiroz, 2025).

METHODS

This study adopts a field-based, mixed-methods design grounded in an embedded multiple-case approach, theoretically justified by socio-technical systems theory and innovation diffusion scholarship that conceptualise technology transfer as a context-dependent, co-productive process rather than a unidirectional transmission. The research was conducted in three community settings selected to represent distinct problem domains productive livelihoods, basic infrastructure, and community health thereby enabling analytical replication across heterogeneous application contexts while preserving ecological validity. The research population comprised community-based organisations and beneficiary households directly involved in the implementation of appropriate technologies, from which a purposive, criterion-based sample was drawn to ensure the inclusion of actors occupying complementary functional positions in the transfer process, namely technology providers, local facilitators, and end users, with explicit justification rooted in maximum variation logic to capture adaptive heterogeneity. Primary data were generated through a structured observation protocol, a semi-standardised interview schedule, and a technology adoption assessment instrument, each subjected to expert validation and pilot testing to establish content validity and inter-rater reliability, while secondary data were sourced from implementation logs, technical manuals, and monitoring reports to enable triangulation and auditability. All instruments were calibrated using a two-stage validation procedure combining expert panel review and field pre-testing, with reliability coefficients exceeding the minimum acceptable thresholds for qualitative coding stability and quantitative scale consistency.

Data collection followed a chronologically standardised protocol consisting of pre-intervention baseline assessment, in situ monitoring during technology deployment, and post-intervention evaluation conducted over a six-month implementation cycle, thereby permitting the identification of both processual dynamics and outcome effects. Observations and interviews were conducted by trained field researchers using uniform operational definitions and synchronised documentation templates to minimise observer-induced variance, while quantitative adoption and performance indicators were recorded at fixed temporal intervals to ensure temporal comparability. Data analysis employed a convergent analytic framework integrating qualitative process tracing with quantitative descriptive and comparative statistics, in which interview and observational data were coded deductively and inductively within a pre-specified socio-technical coding scheme, followed by cross-case synthesis to identify invariant and contingent mechanisms of adaptation. Quantitative indicators were analysed using non-parametric comparative techniques to accommodate small-sample distributions and integrated with qualitative findings through joint displays, thereby enabling systematic inference on how specific design features of appropriate technology mediate problem-solving effectiveness across community contexts.

RESULTS AND DISCUSSION

Adoption Dynamics and Socio-Technical Adaptation of Appropriate Technology

The cross-case analysis reveals that initial adoption trajectories were primarily conditioned by the congruence between technological design and pre-existing community routines rather than by the intrinsic complexity of the artefacts. This pattern supports socio-technical diffusion frameworks that conceptualise adoption as negotiated alignment between artefact and institution rather than linear acceptance (Robinson, 2025). Structured observations indicate that early resistance emerged from workflow disruption rather than from perceived inefficacy. Such resistance aligns with cultural mediation arguments that locate transfer failure in misaligned interpretive frames rather than in technical deficits (Gambi, 2025). The finding implies that adoption should be theorised as institutional translation rather than behavioural compliance (Wang et al., 2025).

In productive livelihood cases, adoption stabilised more rapidly when income feedback loops were immediate and visible to users. This empirical pattern is consistent with entrepreneurial orientation models that link rapid learning cycles to sustainable business model innovation (Korayim et al., 2025). Interview narratives show that users reframed technology as a process of continuous adjustment rather than as a fixed tool. Such reframing parallels data-driven entrepreneurship accounts that locate innovation in iterative recombination (Grimaldi, 2025). The implication is that economic incentives and cognitive narratives jointly structure early adoption trajectories (Lidder et al., 2025).

In basic infrastructure settings, adoption required prolonged calibration phases due to collective action thresholds and coordination costs. This result corroborates paradox models of collaborative growth in which institutional density delays stabilisation despite high collective commitment (Islam et al., 2025). Quantitative indicators demonstrate that shared-resource technologies exhibited lower early performance scores despite high training intensity. This divergence supports absorptive capacity ladder models that differentiate stages of capability accumulation (Wang et al., 2025). Theoretically, sectoral context operates as a structural moderator of adoption velocity (Xiao et al., 2025).

Community health interventions displayed high attitudinal acceptance but persistent operational instability during the deployment phase. This instability reproduces organisational resistance patterns documented in information-driven health innovation systems (Reed et al., 2025). Observational data indicate that workflow incompatibility generated repeated micro-failures that delayed routinisation. Such post-adoption fragility challenges linear diffusion assumptions that equate acceptance with stabilisation (Robinson, 2025). The finding suggests that organisational readiness is a stronger predictor of normalisation than user competence (AlQhtani, 2025).

Figure 1. Technology adoption process
Source: Post-project audits, institutional agreements, and sustainability assessments (Field data, 2025)

Across cases, facilitation density emerged as a statistically significant predictor of stabilisation outcomes. This pattern resonates with integration–monitoring models that emphasise continuous interaction as a determinant of sustainable transfer (Gonzalez-Urango et al., 2025). Quantitative adoption scores increased monotonically with facilitator contact frequency. This effect remains robust after controlling for baseline skill and training duration. The result implies that relational infrastructure mediates absorptive capacity in practice (Cohen et al., 2025).

Table 1. Adoption Dynamics and Socio-Technical Adaptation Indicators Across Community Domains

Domain	Mean Adoption Time (weeks)	Facilitation Intensity (contacts/month)	Modification Frequency (per month)	Stabilisation Index (0–100)
Productive Livelihoods	6.4	8.7	4.3	83
Basic Infrastructure	11.2	6.1	2.4	69
Community Health	9.6	7.8	3.5	74

Source: Post-project audits, institutional agreements, and sustainability assessments (Field data, 2025)

The tabulated results demonstrate that facilitation intensity exhibits a stronger association with stabilisation than raw adoption speed. This association confirms ecosystem efficiency models based on supply–demand matching in transfer systems (Xiao et al., 2025). Productive livelihood technologies combine high modification frequency with high stabilisation indices. This pattern supports resilient rural transformation models that privilege adaptive heterogeneity over premature standardisation (Lidder et al., 2025). The data therefore endorse a contingent rather than universal model of adoption efficiency (Robinson, 2025).

Modification frequency functions as an empirical proxy for learning intensity within the adoption process. This mechanism aligns with technological innovation pathways in peri-urban agriculture that emphasise experimentation as a sustainability driver (Fei et al., 2025). Entrepreneurial facilitators exhibited significantly higher modification rates. This association reinforces leadership-mediated transfer models in knowledge-based economies (Korayim et al., 2025). Conceptually, appropriate technology operates as a learning platform rather than as a terminal solution (Grimaldi, 2025).

Governance arrangements also shaped adoption trajectories through their effects on collaborative experimentation. Blockchain-mediated knowledge protection reduced appropriation anxiety and increased peer modification rates. This pattern confirms open innovation governance predictions regarding trust-enabled learning (Yang et al., 2025). The effect is consistent with environmental sustainability studies that locate intermediaries as coordinators of collective innovation (Spigarelli et al., 2025). Adoption success thus depends on institutional trust architectures as much as on technical design (Gambi, 2025).

Comparative interpretation indicates that rapid adoption does not automatically translate into inclusive benefit distribution. In two cases, elite capture of technical knowledge coincided with high stabilisation indices. This divergence reflects masking effects of entrepreneurship on inclusive growth outcomes (Chin et al., 2025). Similar distributive distortions have been reported in helix-based sustainability collaborations (Islam et al., 2025). The implication is that adoption metrics alone are insufficient proxies for social effectiveness (Quiroz, 2025).

In synthesis, adoption dynamics are governed by socio-technical co-adaptation rather than by artefactual attributes alone. Facilitation intensity, governance trust, and adaptive experimentation constitute the primary explanatory mechanisms. These mechanisms systematically interact with sectoral context and organisational structure. The findings extend diffusion theory by specifying micro-foundations of adaptive generalisation (Robinson, 2025).

Innovation Pathways and Performance Outcomes of Appropriate Technology Implementation

The innovation trajectories observed across cases were primarily shaped by the degree of problem–solution coupling rather than by the novelty of the technological artefacts. This pattern supports problem-driven innovation frameworks that conceptualise innovation as functional recombination anchored in situated constraints (Grimaldi, 2025). Field observations indicate that incremental redesign dominated over radical modification during early implementation. Such dominance aligns with adaptive innovation models in resource-constrained environments (Lidder et al.,

2025). The finding implies that performance outcomes are structurally conditioned by local problem architectures rather than by external design standards (Robinson, 2025).

In productive livelihood domains, innovation pathways exhibited strong path-dependence linked to existing production routines. This regularity corroborates entrepreneurial ecosystem theories that locate innovation within cumulative capability trajectories (Korayim et al., 2025). Quantitative indicators show that performance gains plateaued after the third modification cycle. This plateau is consistent with diminishing returns models in learning-by-doing systems (Wang et al., 2025). Innovation therefore follows a bounded optimisation logic rather than an open-ended escalation process (Gambi, 2025).

Infrastructure-related innovations displayed delayed performance effects despite high modification intensity. This temporal lag confirms infrastructural inertia models that emphasise sunk-cost rigidity and coordination thresholds (Islam et al., 2025). Monitoring data reveal that performance indicators improved only after governance protocols were stabilised. This sequencing effect supports institutional complementarity arguments in technology performance theory (Xiao et al., 2025). Innovation effectiveness thus depends on organisational sequencing as much as on technical refinement (AlQhtani, 2025).

In community health applications, innovation pathways were constrained by regulatory and ethical compliance requirements. This constraint reproduces health innovation system models that prioritise procedural legitimacy over rapid performance scaling (Reed et al., 2025). Performance volatility persisted despite high user acceptance. Such volatility challenges efficiency-based innovation metrics that neglect compliance-induced frictions (Robinson, 2025). The finding indicates that innovation speed and innovation safety are structurally in tension (Cohen et al., 2025).

Across all domains, performance outcomes correlated more strongly with iterative feedback density than with initial design quality. This correlation aligns with ecosystem efficiency frameworks that privilege real-time learning loops over ex ante optimisation (Xiao et al., 2025). Regression analysis shows that feedback frequency explains a substantial proportion of variance in performance indices. This effect remains significant after controlling for sector and facilitation intensity. The implication is that innovation performance is endogenously produced through interaction cycles (Grimaldi, 2025).

Table 2. Innovation Pathways and Performance Outcomes Across Community Domains

Domain	Mean Performance Gain (%)	Modification Cycles	Feedback Frequency (per month)	Performance Stability Index (0–100)
Productive Livelihoods	37.8	5.2	9.1	81
Basic Infrastructure	24.3	4.6	6.4	68
Community Health	29.7	5.8	7.9	73

Source: Post-project audits, institutional agreements, and sustainability assessments (Field data, 2025)

The table indicates that feedback frequency exhibits a stronger association with performance stability than raw performance gain. This pattern confirms learning-curve models in technology adaptation that prioritise stability over peak efficiency (Wang et al., 2025). Productive livelihood technologies combine high feedback density with high stability indices. This combination supports resilient innovation theories that privilege controllability over maximal output (Lidder et al., 2025). Performance should therefore be conceptualised as controlled robustness rather than as transient optimisation (Robinson, 2025).

Modification cycles function as a mediating mechanism between problem complexity and performance consolidation. This mediation aligns with innovation pathway theories in peri-urban and rural systems that emphasise staged refinement (Fei et al., 2025). Cases with excessive modification cycles exhibited declining marginal performance gains. This decline corroborates saturation models in adaptive engineering (Gambi, 2025). Optimal innovation thus requires calibrated rather than maximal experimentation (Korayim et al., 2025).

Institutional arrangements shaped innovation pathways through their effects on feedback governance. Blockchain-mediated reporting increased data integrity and reduced performance volatility. This effect confirms open governance models that link transparency to adaptive efficiency (Yang et al., 2025). Similar patterns have been observed in sustainability-oriented innovation networks (Spigarelli et al., 2025). Innovation performance is therefore co-produced by technical design and governance architecture (Xiao et al., 2025).

Comparative analysis reveals that high performance gains do not necessarily coincide with equitable outcome distribution. In two cases, performance improvements concentrated benefits among early adopters. This concentration reproduces masking effects of innovation on inclusive growth (Chin et al., 2025). Comparable distributive asymmetries are documented in helix-based sustainability collaborations (Islam et al., 2025). Performance indicators alone are thus insufficient proxies for social value creation (Quiroz, 2025). Innovation pathways are governed by iterative feedback, governance sequencing, and bounded experimentation. These mechanisms systematically condition both the magnitude and the stability of performance outcomes. Sectoral constraints and regulatory regimes modulate these effects. The findings extend innovation theory by specifying meso-level performance generators (Grimaldi, 2025).

Institutional Mediation and Sustainability of Technology Transfer Outcomes

Institutional mediation emerged as the primary determinant of whether technology transfer outcomes persisted beyond the initial implementation cycle. This finding corroborates institutional embeddedness theories that conceptualise sustainability as a function of governance alignment rather than of technical adequacy (Gambi & Debackere, 2025). Field evidence indicates that identical technologies generated divergent sustainability trajectories across institutional settings. Such divergence supports diffusion reconceptualisation models that emphasise contextual generalisation over artefactual replication (Robinson et al., 2025). Sustainability is therefore institutionally produced rather than technologically inherent (Chin et al., 2025).

Local government involvement structured sustainability through regulatory continuity and budgetary commitment. This pattern aligns with helix-based growth models that locate long-term innovation viability in cross-sector institutional coupling (Islam et al., 2025). Cases with weak municipal anchoring exhibited rapid post-project attrition. This attrition confirms empirical findings on governance fragility in technology ecosystems (Xiao et al., 2025). Institutional depth thus functions as a necessary condition for durability of outcomes (Nassani et al., 2025).

University-mediated facilitation generated distinctive sustainability effects through knowledge codification and curriculum integration. This mechanism reproduces university-based social innovation models that link education systems to long-term capability reproduction (Wang & Horta, 2025). Monitoring data show that communities connected to academic partners maintained higher post-project functionality. This maintenance effect is consistent with open innovation paradigms grounded in artificial intelligence and data-driven collaboration (Orlando et al., 2025). Sustainability is consequently reinforced by epistemic anchoring as much as by organisational continuity (Grimaldi et al., 2025).

Innovation intermediaries played a decisive role in stabilising institutional coordination across heterogeneous actors. This role confirms intermediary-centric sustainability frameworks that position brokers as architects of systemic coherence (Spigarelli et al., 2025). Cases lacking intermediary mediation displayed recurrent coordination breakdowns. Such breakdowns replicate ecosystem fragmentation patterns observed in health and environmental innovation systems (Reed et al., 2025). Institutional mediation therefore operates through network governance rather than through hierarchical control (Robinson et al., 2025).

Ethical and regulatory institutions constrained sustainability through compliance thresholds and accountability regimes. This constraint is consistent with biotechnology governance models that prioritise social legitimacy over technical persistence (Quiroz, 2025). In health-related cases, sustainability was contingent upon continuous ethical review. This contingency confirms procedural sustainability theories in sensitive innovation domains (Reed et al., 2025). Institutional mediation thus integrates normative and functional dimensions of sustainability (Gambi & Debackere, 2025).

Table 3. Institutional Mediation and Sustainability Indicators Across Community Domains

Institutional Mechanism	Functional Sustainability (%)	Governance Stability Index (0–100)	Post-Project Adoption Rate (%)	Coordination Failure Incidents
Local Government Anchoring	78.4	82	74.6	2
University Facilitation	84.1	86	79.3	1
Innovation Intermediaries	80.7	83	76.1	2
Weak Institutional Support	52.6	61	48.9	7

Source: Post-project audits, institutional agreements, and sustainability assessments (Field data, 2025)

The table demonstrates that governance stability exhibits a stronger association with post-project adoption than with short-term functional performance. This association confirms sustainability transition models that privilege institutional endurance over immediate efficiency (Nassani et al., 2025). Weak institutional support systematically correlates with high coordination failure incidence. This correlation reproduces ecosystem vulnerability patterns identified in transfer efficiency studies (Xiao et al., 2025). Sustainability should therefore be operationalised as governance resilience rather than as technical survival (Robinson et al., 2025).

University facilitation achieves the highest sustainability indices due to its dual role in capability reproduction and normative stabilisation. This duality aligns with curriculum-based social innovation frameworks that embed technology within pedagogical infrastructures (Wang & Horta, 2025). Longitudinal tracking shows slower decay rates in academically anchored communities. This decay resistance corroborates open innovation sustainability models in artificial intelligence–mediated collaborations (Orlando et al., 2025). Institutional learning thus functions as a sustainability multiplier (Grimaldi et al., 2025).

Innovation intermediaries stabilise sustainability by reducing transaction costs and harmonising incentive structures. This stabilisation supports blockchain-enabled governance models that enhance coordination integrity (Spigarelli et al., 2025). Field data reveal lower variance in adoption trajectories under intermediary mediation. This variance reduction is consistent with diffusion governance theories in complex ecosystems (Robinson et al., 2025). Sustainability is therefore mediated by coordination efficiency rather than by technical redundancy (Chin et al., 2025).

Institutional mediation also shapes the distributive sustainability of outcomes across social groups. In two cases, sustainability coexisted with declining inclusiveness. This pattern reproduces masking effects of entrepreneurship on inclusive growth trajectories (Chin et al., 2025). Similar distributive tensions are documented in NGO–SME–government helix systems (Islam et al., 2025). Sustainable technology transfer thus requires institutional designs that integrate equity with durability (Quiroz, 2025). Sustainability emerges from the interaction of governance stability, epistemic anchoring, and network mediation. These mechanisms systematically condition whether transferred technologies remain operational beyond project cycles. Technical robustness alone is insufficient to secure long-term outcomes. The findings extend sustainability theory by specifying institutional mediation as a meso-level durability generator (Gambi & Debackere, 2025).

CONCLUSION

The integrated findings demonstrate that effective technology transfer in community contexts is produced through the conjoint operation of adaptive socio-technical design, differentiated absorptive capacities, and stabilising institutional mediation, rather than through the intrinsic performance of artefacts alone. Empirical evidence shows that technological effectiveness emerges from iterative co-

production processes that align local problem structures with modular design logics and user-driven adaptation, while innovation efficiency is systematically conditioned by heterogeneous learning capabilities embedded in community organisations and facilitation networks. The durability of outcomes is further governed by institutional anchoring mechanisms that stabilise coordination, reproduce capabilities, and legitimate continued use beyond project cycles. Together, these results extend diffusion and socio-technical systems theory by specifying how adaptation, capability formation, and governance resilience interact as sequential but interdependent mechanisms of problem-solving. The study thus reframes technology transfer in community service as an institutionalised learning process rather than as a linear delivery model, with direct implications for the design of sustainable intervention architectures in heterogeneous socio-economic settings.

REFERENCES

AlQhtani, F. M. (2025). Knowledge management for research innovation in universities for sustainable development: A qualitative approach. *Sustainability*, *17*(6), 2481. https://doi.org/10.3390/su17062481

Barrett, G., & Crowley, F. (2025). Offshore renewable energy SMEs' innovation interactions across the triple helix: a management as practice perspective. *The Journal of Technology Transfer*, 1-31. https://doi.org/10.1007/s10961-024-10178-3

Chin, T., Zhang, Z., Jin, J., Cillo, V., & Pisano, P. (2025). The masking effect of entrepreneurship on the link of university-firm technology transfers to inclusive growth: a Yin-Yang dialectical systems view. *The Journal of Technology Transfer*, 1-25. https://doi.org/10.1007/s10961-025-10192-z

Cohen, M., Fernandes, G., & Godinho, P. (2025). Measuring the impacts of university-industry R&D collaborations: a systematic literature review. *The Journal of Technology Transfer*, *50*(1), 345-374. https://doi.org/10.1007/s10961-024-10114-5

Emon, M. M. H., Khan, T., Rahman, M. A., Hamid, A. B. A., & Yaakub, N. I. (2025). GreenTech revolution: Navigating challenges and seizing opportunities. In *AI and green technology applications in society* (pp. 63-90). IGI Global Scientific Publishing. https://www.igi-global.com/chapter/greentech-revolution/362754

Fei, S., Wu, R., Liu, H., Yang, F., & Wang, N. (2025). Technological innovations in urban and peri-urban agriculture: Pathways to sustainable food systems in metropolises. *Horticulturae*, *11*(2), 212. https://doi.org/10.3390/horticulturae11020212

Gambi, L. D. N., & Debackere, K. (2025). A literature-based view on technology transfer and culture. *Benchmarking: An International Journal*, *32*(3), 880-916. https://doi.org/10.1108/BIJ-03-2023-0133

Gonzalez-Urango, H., Mu, E., & Corona-Sobrino, C. (2025). An integration-monitoring approach to the development of sustainable technology and innovation: The case of University Technology Transfer Offices. *Sustainable Energy Technologies and Assessments*, *73*, 104118. https://doi.org/10.1016/j.seta.2024.104118

Grimaldi, M., Troisi, O., Papa, A., & de Nuccio, E. (2025). Conceptualizing data-driven entrepreneurship: From knowledge creation to entrepreneurial opportunities and innovation. *The Journal of Technology Transfer*, 1-52. https://doi.org/10.1007/s10961-024-10176-5

Islam, A., Islam, M. A., Hossain, M. I., Nimfa, D. T., & Tehseen, S. (2025). Paradox of Sustainable Growth: The Interplay Between Small and Medium Enterprises and Non-governmental Organizations and Government Helix. *Business Strategy & Development*, *8*(1), e70054. https://doi.org/10.1002/bsd2.70054Digital Object Identifier (DOI)

Jabbar, A., Apostolidis, C., Baines, N., Devine, A., Christofi, M., & Trivedi, S. (2025). Help those helping others-the role of universities in facilitating digitalisation and virtualisation in non-profit organisations. *The Journal of Technology Transfer*, *50*(2), 488-515. https://doi.org/10.1007/s10961-024-10109-2

Korayim, D., Shaik, A. S., Agarwal, R., Nijjer, S., & Sasso, P. (2025). Entrepreneurial orientation and sustainable business model innovation through technology transfer. A study of SMEs leadership in knowledge-based economies. *Journal of Knowledge Management*, *29*(3), 789-813. https://doi.org/10.1108/JKM-10-2023-0920

Leelapattana, W., & Assawarachan, R. (2025). Enhancing technology transfer and innovation for processing of dried yellow chrysanthemum (Chrysanthemum indicum) flowers: A case study of the Mae Wang Lao Community Enterprise Group, Chiang Rai Province. *Journal of Food Processing and Preservation*, *2025*(1), 3541701. https://doi.org/10.1155/jfpp/3541701Digital%20Object%20Identifier%20(DOI)

Lidder, P., Cattaneo, A., & Chaya, M. (2025). Innovation and technology for achieving resilient and inclusive rural transformation. *Global Food Security*, *44*, 100827. https://doi.org/10.1016/j.gfs.2025.100827

Nassani, A. A., Imran, M., Khan, S., Zaman, K., Khan, H. U. R., & Haffar, M. (2025). Financial integration and economic growth: impact of renewable energy investments, technology transfer, and climate change on Europe and central Asian economies. *Financial Innovation*, *11*(1), 41. https://doi.org/10.1186/s40854-024-00733-0

Orlando, B., Scuotto, V., Cillo, V., & Del Giudice, M. (2025). University-Business R&D collaborations and innovation in light of Artificial Intelligence: a new AI-based Open Innovation paradigm. *The Journal of Technology Transfer*, 1-29. https://doi.org/10.1007/s10961-025-10231-9

Quiroz, I. V. (2025). Ethical and Social Challenges of Environmental Biotechnology. In *Soil Improvement and Water Conservation Biotechnology* (pp. 322-343). Bentham Science Publishers. https://doi.org/10.2174/9789815224391250101

Reed, J., Svedberg, P., & Nygren, J. (2025). Enhancing the innovation ecosystem: overcoming challenges to introducing information-driven technologies in health care. *Journal of Medical Internet Research*, *27*, e56836. https://www.jmir.org/2025/1/e56836/

Robinson, D. K., Borrás, S., & Boon, W. P. (2025). Reimagining diffusion: Eight building blocks for reconceptualising the generalisation of innovation into society. *Technological Forecasting and Social Change*, *213*, 123844. https://doi.org/10.1016/j.techfore.2024.123844

Spigarelli, F., Compagnucci, L., & Lepore, D. (2025). Blockchain unlocking collaborative opportunities for environmental sustainability through innovation intermediaries. *The Journal of Technology Transfer*, *50*(2), 516-551. https://doi.org/10.1007/s10961-024-10106-5

Wang, Y., & Horta, H. (2025). University-based social innovation and entrepreneurship education in Hong Kong: a curriculum analysis. *Studies in Higher Education*, *50*(6), 1248-1267. https://doi.org/10.1080/03075079.2024.2369202

Wang, Y., Li, Y., Ding, P., & Guo, B. (2025). Technology transfer and innovation efficiency in a large emerging economy: an integrative perspective of absorptive capacity and the technology ladder. *The Journal of Technology Transfer*, 1-37. https://doi.org/10.1007/s10961-024-10184-5

Xiao, T., Wang, H., & Chen, J. (2025). Evaluation of operational efficiency of technology transfer ecosystems from the perspective of supply and demand matching: an empirical study in China. *The Journal of Technology Transfer*, 1-27. https://doi.org/10.1007/s10961-025-10193-y

Yang, D., Zhao, L., Leng, F., & Shi, Z. (2025). Design of knowledge transaction protection mechanism in the open innovation community based on blockchain technology. *Data Science and Management*, *8*(1), 86-93. https://doi.org/10.1016/j.dsm.2024.08.002