

Design for rural innovation through university community services

The university's knowledge development and its application to society—including community service (CS)—are mutually beneficial. This paper, based on rural market design projects, examines how university knowledge influences the sustainability of rural innovation. Using Actor-Network Theory, it finds that: 1) the longevity of CS design projects is maintained through a comparative analysis of networks before and after project implementation; 2) CS projects are examined by mapping actor involvement at each stage and analysing how non-human actors mediate relationships; 3) the initiation and adoption of new ideas occur through mutual and dynamic interactions, rather than linear progression; and 4) the sustainability of CS outcomes relies on an expanded network, beyond mere knowledge transfer. The paper argues that long-term innovation depends on the expansion of learning spaces, not solely on linear processes of initiation and adoption.

KEYWORDS

Rural innovation, community services,
innovation network, public market,
Actor-Network Theory

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Disseny per a la innovació rural a través dels serveis comunitaris universitaris

ESTUDI DE CAS

El desenvolupament del coneixement de la universitat i la seva aplicació a la societat, inclòs el servei comunitari (SC), són mútuament beneficiosos. Aquest article, basat en projectes de disseny de mercats rurals, examina com el coneixement universitari influeix en la sostenibilitat de la innovació rural. Utilitzant la teoria de l'actor-xarxa, conclou que: 1) la longevitat dels projectes de disseny de SC es manté mitjançant una anàlisi comparativa de les xarxes abans i després de la implementació del projecte; 2) els projectes de SC s'examinen fent un mapatge la participació dels actors en cada etapa i analitzant com els actors no humans medien les relacions; 3) la iniciació i l'adopció de noves idees es produeixen a través d'interaccions mútues i dinàmiques, en lloc d'una progressió lineal; i 4) la sostenibilitat dels resultats del SC es basa en una xarxa ampliada, més enllà de la mera transferència de coneixement. L'article argumenta que la innovació a llarg termini depèn de l'expansió dels espais d'aprenentatge, no només dels processos lineals d'iniciació i adopció.

PARAULES CLAU

Innovació rural, serveis comunitaris, xarxa d'innovació, mercat públic, teoria de l'actor-xarxa.

Diseño para la innovación rural a través de los servicios comunitarios universitarios

ESTUDIO DE CASO

El desarrollo del conocimiento de la universidad y su aplicación a la sociedad, incluyendo el servicio comunitario (SC), son mutuamente beneficiosos. Este artículo, basado en proyectos de diseño de mercados rurales, examina cómo el conocimiento universitario influye en la sostenibilidad de la innovación rural. Utilizando la teoría del actor-red, se concluye que: 1) la longevidad de los proyectos de diseño de SC se mantiene mediante un análisis comparativo de redes antes y después de la implementación del proyecto; 2) los proyectos de SC se examinan mapeando la participación de los actores en cada etapa y analizando cómo los actores no humanos median las relaciones; 3) la iniciación y la adopción de nuevas ideas se producen mediante interacciones mutuas y dinámicas, en lugar de una progresión lineal; y 4) la sostenibilidad de los resultados del SC se basa en una red ampliada, más allá de la mera transferencia de conocimiento. El artículo argumenta que la innovación a largo plazo depende de la expansión de los espacios de aprendizaje, no únicamente de procesos lineales de iniciación y adopción.

PALABRAS CLAVE

Innovación rural, servicios comunitarios, red de innovación, mercado público, teoría del actor-red.

If universities are positioned as knowledge production agents in the innovation ecosystem (Etzkowitz and Leydesdorff 2000; Carayannis and Campbell 2010), it is crucial to explore their role in social innovation. Social innovation arises when the triple-helix concept expands to a quadruple-helix, incorporating the community as part of the ecosystem (Leydesdorff 2012; Nordberg et al. 2020). Two concerns about knowledge transfer from universities to communities are: 1) the knowledge transfer process and the role of mediators as social hubs, and 2) the university's role as a social innovation agent, highlighting its position in the innovation network.

An ecosystem is essential for innovation sustainability, and an innovation network can map this ecosystem, showing how actors create mutual relationships. Various models explain how innovation ideas generate networks (Bullinger et al. 2004) and how laboratory-produced knowledge supports innovation through actors' networks (Nyström et al. 2012). Key to an innovation network is orchestrating to ensure creation, value extraction, knowledge mobility, and appropriate innovation (Dhanaraj and Parkhe 2006), supported by managing heterogeneity in a fluid, informal atmosphere (Corsaro et al. 2012; Van Aken and Weggeman 2000). Actors' competences determine the network's construction, promoting self-organising innovation, integrating knowledge, and enhancing learning capabilities (Hage et al. 2000; Rycroft and Kash 2004). Successful innovation is recognised by its influence on social networks (Lewrick et al. 2007).

Local innovation efforts can contribute to regional economic development and connect to global innovation communities (Rutten and Boekema 2007; Coe and Bunnell 2003). In rural contexts, innovation is enriched by cultural and social factors, aiming for prosperity and equality and supporting infrastructure to improve market access for villagers (Spielman et al. 2008; Plein 2011; Yin et al. 2019). Introducing innovations in rural areas faces complications due to varied actors and multiple levels of actor embeddedness (Esparcia 2014; Kratzer and Ammering 2019; Ingram et al. 2020; Koutsouris and Zarokosta 2020). A social approach to rural innovation is needed to optimize social capital networks with awareness of both the bright and dark sides of rural social fields (Beck et al. 2010; Cofré-Bravo et al. 2019; King et al. 2019; Castro-Arce and Vanclay 2020).

In Indonesia, the role of universities in rural innovation can be traced through Community Service (CS) programs. This program is one of the Three Obligations (known as the "Tri Dharma") of Indonesian universities: education, research, and community service. Its mission is to ensure that knowledge produced within universities can be tested and utilised to support community empowerment. Several issues can be addressed here, such as equity, inequality, sustainability, and resilience, dialogues that enhance transparency and trust (Thomaidis et al. 2012; Rook and Cloud 2012; Charles 2016; Lyons et al. 2018; Minnick et al. 2019). But, in practice, several criticisms have been directed at common university CS programs, which often lean toward charity-based activities (Noor 2010; Riduwan 2016) or are limited to one-off events that do not continue beyond the completion of the CS project.

This article is based on university CS projects for rural markets in Majalengka, a municipal region in West Java province, Indonesia. Attention to rural development in Indonesia increased after the 2014 Rural Law, which provided village governments with funds for rural development and local entrepreneurship

(Arumsari et al. 2017; Nursetiawan 2018). Majalengka gained further attention with the development of an international airport and aero city, generating hope for future development, including among village leaders (Zulfikar 2017; Jimika 2019). The rural market case was chosen based on the researchers' main competence in research and CS and its relation to the national program for public market revitalization as economic and socio-cultural hubs since 2004 (Ekomadyo 2019; Aliyah et al. 2017). The CS programs include three rural market design projects: the rural markets of Maja Utara, Argapura, and Sangkan Hurip.

Pro-innovation concepts from Actor-Network Theory (ANT) guide the documentation of knowledge gained from CS activities by expanding learning spaces (Yuliar 2011). Social innovation, defined as creating solutions to meet social needs, is central to this process. In ANT, sustainability is achieved through network expansion and flexible trajectories, akin to the "innovation orchestra", where actors self-organise to extract value without centralised guidance (Rycroft and Kash 2004; Dhanaraj and Parkhe 2006). Incremental innovation, common in mature markets, focuses on small improvements for efficiency (Ferreiro 2006). Design plays a crucial role in discovering opportunities, facilitating collaboration, and prototyping propositions, all contributing to brand identity (Costa 2006; Breitenberg 2006; Paez and Amatullo 2023). The expansion of learning spaces in CS projects is mapped by detailing the compositions of human and non-human actors, highlighting the interdisciplinary nature of design innovation. This model ensures university CS activities are recognised for their societal impact and the expansion of knowledge exchange.

2 METHODOLOGY

This article employs a theoretical design reflection method to extract knowledge from the design process using a theoretical framework from Actor-Network Theory (ANT), which views social phenomena as human interactions fully mediated by non-human entities like technical objects (Latour 1999; Yuliar 2009), moving collectively (Latour 2005). ANT's "de-scription" method unravels "scripts" involving non-human actors such as ideas, procedures, texts, and technical objects that influence human actors (Ackrich 1997; Bijker and Law 1997; Yuliar 2009; Ekomadyo and Riyadi 2020). Although ANT is a relatively new theory in design discourse (Latour 2008), some designers have applied it to describe design methodologies, such as Storni (2015) with ring design and Rice (2018) with community garden design.

This approach describes design as socio-technical process, by mapping the design impacts through comparing networks form during design projects. Callon (1986) introduces "translation" to describe network formation, where each actor adjusts to others to become interconnected, illustrated by sociotechnograms. The research uses "composition" (Latour 1999) to describe the composition of human and non-human actors at each project stage, representing the orchestration of the innovation process.

In ANT, innovation diffusion is not linear; the relationship between initiators and adopters is mutual and involves external networks (Daroit and Nascimento 2009). A pro-innovation situation is suggested, where researchers as innovation initiators develop networks through both research and user engagement forums. Yuliar (2011) proposes that research praxis has a network character with varying

degrees of trajectory reversibility; innovation diffusion involves learning spaces composed of initiators and adopters and alternative technical objects; and innovation network expansion occurs when learning spaces between research and non-research networks follow reversible trajectories. These propositions guide the examination of trajectory reversibility and identification of actors involved in sustaining, or not sustaining, CS programs.

Cases of University CS are three rural markets with two fundings: Maja Utara Market, funded by Ministry of Research and Higher Education (MRHE), and Argapura Market and Sangkan Hurip Market, funded by University's CS Program. Data collection methods include field observation, informal discussions, structured interviews, design process documentation, and focus group discussions. Unlike conventional design projects focused on problem-solving and producing design drawings and reports, these CS projects aim for a pro-innovation situation, in which every stage of the design process is documented as data to be revisited and analyzed. Design results, as part of CS reports, are also confirmed with stakeholders for feedback and follow-up.

3

DESIGN PROCESS AND RESULT: MAPPING COMPOSITIONS

This section details the design process and result, and how networks are mapped using the ANT framework. ANT's strength lies in its ability to describe collective actions of design process in detail, step by step. This approach allows for a comprehensive mapping of the social design process, identifying involved actors and their concerns at each stage (Ekomadyo and Riyadi 2020) or university CS purpose in knowledge transfers, and it helps to trace knowledge translation by each actor. With pro-innovation situation, the design impact is indicated in network expansion by examining the reversible trajectories chosen by actors. Practically, network expansion in ANT terms indicates whether innovation activities continue to the post-project activities.



Fig. 1a. The initiation stages.

The CS projects for rural market design in Majalengka consist of three main stages: 1) initiation, 2) design, and 3) post-projects (Figs. 1a, 1b, 1c), encompassing eight sequential compositions: a) early connection, b) CS proposal, c) design brief, d) schematic design, e) design consultation, f) design result, g) design confirmation, and h) post-project follow-up. A sociotechnogram, which graphically represents human and non-human actor relationships (Callon 1986), is used to illustrate how

networks are shaped during each project stage (Fig. 2). The sociotechnogram is useful for illustrating human actors who are involved in one composition but not in another, as well as the roles of non-human actors in each composition. The non-human actors, especially technical objects, that are recognised in ANT as equal to human actors, is important to be described explicitly because they are produced by designers and engineers in the sociotechnical compositions. The sociotechnogram also helps depict the network expansion that emerges as impact of design process.

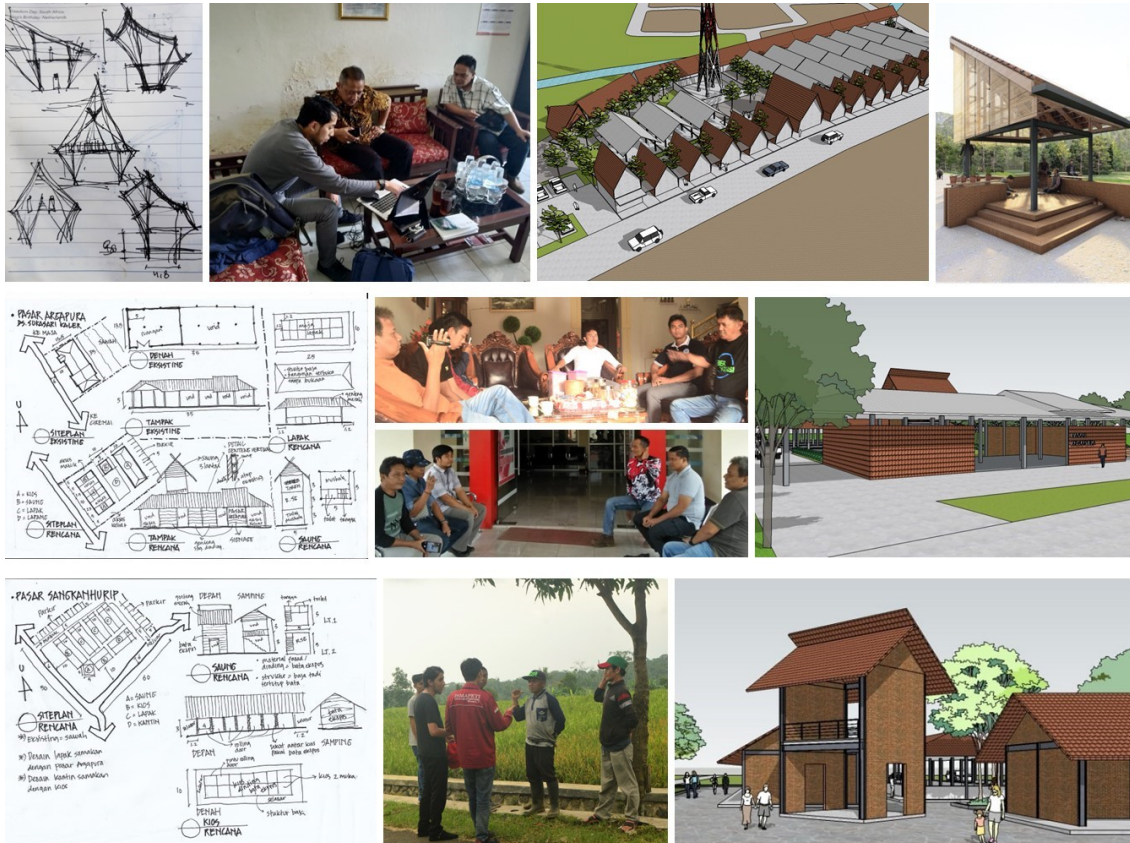


Fig. 1b. The design stages: Pasar Maja Utara (above), Pasar Argapura (middle), and Pasar Sangkan Hurip (below), each contains the schematic design, design consultation, and design results.



Fig. 1c. The design confirmations: Pasar Maja Utara (left), Pasar Argapura (middle), and Pasar Sangkan Hurip (right).

3.1. Compositions in Initiation Stage

In innovation, *initiation* and *adoption* are crucial terms: the initiator offers new ideas to adopters, who implement them (Rogers 1962). In this case, the university researcher and team are the initiators, and the rural society, represented by village leaders, are the adopters. There are two CS projects: one for revitalising the public market in Maja Utara, funded by the Ministry of Research Technology and Higher Education's (RHE) Research and Community Services (RCS) program, and another

adjacent with regional road (Fig. 1a). After intensive discussions, the researcher created a CS proposal, which was submitted to the RCS program of the Ministry of RHE and approved, with special appreciation for the researcher's stakeholder management skills. This success attracted other village leaders to participate the researcher's agenda for rural market design, facilitated by a local facilitator. They were the village leaders of Argamukti and Sukrasari Kaler, who were interested in developing a local distribution market in Argapura to accommodate agricultural products from both villages and the surrounding areas before they are distributed into cities. Meanwhile, the village leaders of Sangkan Hurip and Pasir Ayu intended to establish a local market in Sangkan Hurip to respond to the daily needs of village residents. The proposal for rural market design in Argapura and Sangkah Hurip was submitted to the University's RCS program, which was also approved (Fig. 2b).

Mapping these compositions during the initiation stage provides insights into innovation initiation. The future development of Majalengka, driven by the Aerocity project, triggered innovation, gathering initiators for intensive discussions. However, once the CS proposals were approved, the focus shifted to addressing the real problems of the rural markets. The chosen projects intersected the researcher's interest in public market studies and the village leaders' interest in rural development. These compositions assembled a national network, represented by the Ministry and University CS programs, and a local network, represented by village leaders and the local facilitator, mediated by the social activist, with a shared focus on community-based development.

3.2. Compositions in Design Stages

When architectural design is part of Community Services (CS) projects, it shares similarities and differences with conventional design projects. Both involve architects working from design briefs, consulting with owners and stakeholders, and producing designs according to architectural standards. However, CS projects feature informal consultations and emphasise community empowerment and participatory design. Actor-Network Theory (ANT) is advantageous for this approach, as it maps the detailed participation of actors in each design stage, including both human and non-human actors.

Composition 3 (Design brief) occurs when the design brief is formulated to guide design outcomes. In conventional projects, design briefs are made by the project owner and serve as the architect's reference. In CS projects, design briefs are collaboratively formulated through discussions between the architect and stakeholders, based on field surveys. Each village case had different issues: Maja Utara aimed to revitalise an existing market, Argapura intended to create a distribution market for agricultural products, and Sangkan Hurip wanted a local market for daily goods. The village leader of Maja Utara stated that the presence of a livestock market, the market's location along the main road, and the spacious market area represent key potential for enhancing the economic value of the market. The village leader of Argamukti explained that having a vegetable distribution market in the sub-district of Argapura would add economic value for local residents, and the location is planned in Sukrasari Kaler Village. The head of Sukrasari Kaler also agreed, recognising the potential economic benefits for the village community. Meanwhile, the initiative to establish a rural market in Sangkan Hurip was proposed by the village leaders of Pasir Ayu to enable residents to purchase daily necessities closer to home. However, the most strategic location for the market is in the neighboring village of Sangkan Hurip, and the village leader

of Sangkan Hurip supported these ideas. The preparation of the design brief was carried out through discussions between the researchers and village leaders, mediated by local facilitators, and also involved students from a local university who served as surveyors to collect field data (Fig. 2c).

The schematic design stage (Composition 4) involved two parallel processes. First, in design studio, the research team developed the schematic design based on the design brief, illustrated through architectural sketches (Fig. 1b, left sides). Secondly, in the field, the surveyors collected data through in-depth interviews with the village leaders and then sent the data into researcher's team to improve the design. These processes produced schematic design drawings and stakeholder aspiration notes (Fig. 2d).

In CS projects, design consultation (Composition 5) occurs through informal discussions between the research team and rural stakeholders, mediated by local facilitators and surveyors (Fig. 1b, middle images). Through design consultations, the village leader of Maja Utara was encouraged to explore options for collaboration with private sector parties to develop the village market. For the Argapura Market, the range of stakeholders expanded to include the sub-district government officer, known as the Camat, and promoted the idea of integrating the distribution market with plans to establish a joint Village-Owned Enterprise. Meanwhile, consultations for the Sangkan Hurip Market were conducted primarily with village representatives at the proposed market site.

Consultation notes are used for design improvements (Fig. 2e). The design process culminated in preliminary architectural drawings (as composition 6, seen in the right-side images of Fig.1b), reflecting solutions to design problems discussed with stakeholders. This stage mainly involved the internal research team, guided by architectural standards (Fig. 2f).

Several lessons emerged from these stages. First, knowledge transfer was iterative and mutual, not linear. Technical standards and design expertise belonged to the research team, but local stakeholders provided essential insights into factual problems. Second, despite the participatory process, certain design stages remained under the research team's authority, ensuring adherence to architectural principles. Third, the participatory process was detailed through collective approaches, identifying the roles of human and non-human actors like design briefs, drawings, and notes, which stabilised relations and facilitated project progression.

3.3. Compositions in Design Confirmation and Post-project Follow-Up

Design confirmation (Composition 7), similar to conventional projects, is achieved through final presentations where stakeholders accept the design results (Fig 1c). In CS projects, this occurs in an informal setting. Of the three initiatives, only the Maja Utara and Argapura markets were followed up. Maja Utara market was planned to be developed a rest area, starting with constructing community gathering shelter. Argapura market were be followed up with integrating rural distribution market design with a rural tourism program. Sangkan Hurip project was halted due to internal stakeholder conflicts (Fig. 2g), because a new emerging actor, who was not identified during the initiation stage, turned out to already own existing retail facilities that could face competition if the Sangkan Hurip village market is developed. This information was delivered by the local facilitator.

After the design projects were completed (Compositon 8), two markets (Maja Utara and Argapura) decided to follow up on the design results, while one market

(Sangkan Hurip) did not. The Maja Utara village leader committed to partnering with a private enterprise to revitalise the market, leveraging connections with other rural market managers who had similar partnerships. In Argapura, local village leaders formed a cooperative village-owned enterprise to develop economic revenues, including an agricultural distribution market, based on the university CS project's design. Meanwhile, the village leaders of Pasir Ayu and Sangkan Hurip did not express any intention to reconnect with the researcher when the initial ideas discussed together encountered obstacles for continuation. Information from these village leaders was conveyed to the researcher through mediation by the local facilitator.

The decision to continue with the design results was significantly influenced by networks outside the design projects, including the researcher's connections. Two key connections influenced these decisions: the researcher's link to the national program for public market revitalization encouraged the Maja Utara village leader to seek a private enterprise partnership, and the connection with West Java province's development acceleration programs convinced Argapura leaders to use the design results as a proposal for these programs.

The continuity of these design projects depended on network enlargement. The design results, as non-human actors, connected village stakeholders' networks with the researcher's network (Fig. 2h). A crucial lesson from the post-project stages is that the sustainability of university CS projects relies not only on knowledge transfer but also significantly on the expansion of networks between researchers (initiators) and stakeholders (adopters).

4 DISCUSSION

After analyzing all compositions during the CS projects, four key findings emerged. First, using the innovation network framework, the CS projects identified network expansion of the design projects. By comparing sociotechnograms between initiation and post-project stages, it is identified how networks expanded and which actors were pivotal. Initially, relationships formed between researchers and a social activist, then expanded to include a local facilitator and village leaders. In post-project, some relations with village leaders expanded, while others did not. It is found that community development thoughts emerged as a crucial non-human actor, fostering collective actions in any translations (Callon 1986).

Second, the collective approach made project activities traceable for actor involvement, enhancing participatory design procedures (Luck 2003; Sanoff 2006; Manzini and Rizzo 2011), that often struggle in social practice and face issues of tokenism (Toker 2007; Andersen et al. 2015; Palmås and Busch 2015; Compare et al. 2015). Collective approaches, as defined by Ostrom (1990) and Latour (2005), allowed detailed participation by identifying involved and uninvolved actors at each design stage. The participatory design stages included formulating the design brief, conducting design consultations, and confirming design results. Both conventional and participatory design processes were found to be inherently social (Dilnot 1982; Dorst 2003).

Third, the design process indicated that the initiation and adoption of innovative ideas occurred through mutual and interactive processes rather than linear ones. Researchers initiated the CS projects while village leaders adopted the design results. Researchers gathered information and knowledge from village

leaders and stakeholders, especially during design brief formulation, consultation, and result confirmation. Mediators like the social activist and local facilitator provided crucial local context. This non-linear diffusion innovation, termed the expansion of learning spaces (Yuliar 2011), better reflects real practices of innovations.

Fourth, the university's role in innovation sustainability extends beyond being a mere knowledge producer. The CS projects in Majalengka demonstrated that while the university transmitted knowledge through researchers, reciprocal information exchange among stakeholders during various project stages was crucial. To foster innovation in rural areas, knowledge produced by universities plays a vital role in but, the other side, rural areas contain social field where stakeholders have their own concerns, which may differ from those of the university. A reflection on the rural market design process in Majalengka reveals the crucial role of the local facilitator, who serves as a bridge for mutual and reciprocal exchange of information and knowledge between the researchers—representing the university—and the village leaders—representing rural communities, in ANT's term, this position called as articulator. Post-project continuity depended more on the research team's social networks than on knowledge transfer alone. This argument demonstrates that in order to create an impact on society, knowledge must not be developed through a linear approach, but rather through a mutual and reciprocal one. Thus, the university acts as an agent for innovation network expansion, with knowledge produced becoming part of this network.

Fifth, several notes emerged that design reflection is used as methods to extract knowledge generated during the design process—particularly when the designer also serves as the researcher. This design reflection method can be put as part of pro-innovation situations, in which the designer not only produces design solutions that connect with knowledge users, but also reflects on the design process and writing it in scientific paper to connect with other researchers as fellow knowledge producers. To minimise bias, it would be ideal to involve an external researcher who observes the designer's work and extracts knowledge from the design process—similar to what Yaneva (2009) did in her study of OMA's design practices. In the case of rural market design, this approach has not yet been applied due to limitations in available researchers with the necessary expertise to study the design process.

5 CONCLUSION

Many literatures suggest that universities play a crucial role in rural innovation networks. As agents of social change, university CS programs should be holistic, well-integrated with existing social activities, and iterative, with regular reflections on their role as knowledge development institutions (Sanginga et al. 2007; Ramirez 2011; Corcoran et al. 2014; Paton et al. 2014; Reichert 2019). From an ANT perspective, technical objects produced by CS programs are seen as productive outcomes of network linkages with social and material elements (Wikhamn and Knights, 2016). In Indonesia, university CS programs are expected to go beyond charity events, aiming to continuously empower both rural communities and the universities themselves.

Given the complexity of the social field, generating ties between universities and rural areas requires innovation brokers to maintain social trust and act as catalysts for societal innovation (Junaidy and Nagai 2013; Ihsan and Sachari 2015; King et al. 2019). These brokers, alongside researchers, develop creativity and learning processes, adding value to diverse communities (Batterink et al. 2010). Designers, aware of social and cultural values but also of the firm's technical possibilities, are involved in each phase of the innovation process and are responsible for formalising and communicating the cultural values that activate this process (Borja 2006; Pericot 2006). In this case, the social activist and local facilitator mediated relationships between the researchers, village leaders, and stakeholders, maintaining continuous engagement through various activities. Under ANT, innovation brokers act as articulators, translating practical issues into common knowledge, and as localisers, turning abstract ideas into practical solutions. It is explored the value of imagining radically hopeful visions co-created through critically conscious collaborative futures (Carrió 2006; Carey 2023). However, due to the complexity of social fields, the impact of knowledge on producing novelty requires continuous unraveling and improvement.

BIOGRAPHIES

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