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Technological Extension. Putting the University at the Service of the Digital Solidarity Economy *

Extensión tecnológica. Poniendo a la universidad al servicio de la economía solidaria digital

Extensão tecnológica. Colocando a universidade a serviço da economia solidária digital

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This article presents a participatory university extension project that supports the digital solidarity economy in Brazil through the co-development of a route-generating algorithm for Señoritas Courier, a cooperative of women and trans cyclists. The algorithm was designed to integrate the cooperative's operational knowledge, ethical principles, and solidarity economy values into a digital platform. Grounded in Paulo Freire's popular education and participatory action-research, this project exemplifies solidarity technoscience by combining technical innovation with social emancipation. The research highlights iterative, co-creative processes in which technological artifacts are shaped collaboratively, balancing algorithmic efficiency with equity, care, and cooperative decision-making. Key challenges include adapting conventional operational research methods to solidarity-oriented priorities, securing institutional support within the university for extensionist activities, and addressing legal and accounting constraints faced by cooperatives. The project demonstrates how universities can function as transformative agents, co-producing technology and knowledge that empower marginalized communities, while offering practical and theoretical insights for designing sociotechnical systems aligned with collective values.

Keywords*: platform cooperativism; digital solidarity economy; university extension; bicycle delivery; algorithms*

Este artículo presenta un proyecto participativo de extensión universitaria que apoya la economía solidaria digital en Brasil mediante el codesarrollo de un algoritmo generador de rutas para Señoritas Courier, una cooperativa de mujeres y personas trans ciclistas. El algoritmo fue diseñado para integrar el conocimiento operativo de la cooperativa, sus principios éticos y los valores de la economía solidaria en una plataforma digital. Basado en la educación popular de Paulo Freire y en la investigación-acción participativa, este proyecto ejemplifica la tecnociencia solidaria al combinar la innovación técnica con la emancipación social. La investigación destaca procesos iterativos y cocreativos en los cuales los artefactos tecnológicos son configurados de manera colaborativa, equilibrando la eficiencia algorítmica con criterios de equidad, cuidado y toma de decisiones cooperativa. Entre los desafíos principales se encuentran la adaptación de métodos convencionales de investigación operacional a prioridades orientadas a la solidaridad,

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la obtención de apoyo institucional en la universidad para las actividades extensionistas y el abordaje de restricciones legales y contables que enfrentan las cooperativas. El proyecto demuestra cómo las universidades pueden funcionar como agentes transformadores, coproduciendo tecnología y conocimiento que empoderan a comunidades marginadas, al mismo tiempo que ofrecen aportes prácticos y teóricos para el diseño de sistemas sociotécnicos alineados con valores colectivos.

Palabras clave: cooperativismo de plataformas; economía digital solidaria; extensión universitaria; reparto en bicicleta; algoritmos

Este artigo apresenta um projeto participativo de extensão universitária que apoia a economia solidária digital no Brasil por meio do codesenvolvimento de um algoritmo gerador de rotas para a Señoritas Courier, uma cooperativa de mulheres e pessoas trans ciclistas. O algoritmo foi concebido para integrar o conhecimento operacional da cooperativa, seus princípios éticos e os valores da economia solidária em uma plataforma digital. Fundamentado na educação popular de Paulo Freire e na pesquisa-ação participativa, o projeto exemplifica a tecnociência solidária ao combinar inovação técnica e emancipação social. A pesquisa destaca processos iterativos e cocriativos nos quais artefatos tecnológicos são configurados de forma colaborativa, equilibrando eficiência algorítmica com equidade, cuidado e tomada de decisão cooperativa. Entre os principais desafios, identificam-se a adaptação de métodos convencionais da pesquisa operacional às prioridades orientadas pela solidariedade, a obtenção de apoio institucional no âmbito universitário para atividades extensionistas e o enfrentamento de limitações legais e contábeis presentes no cotidiano das cooperativas. O projeto demonstra como as universidades podem funcionar como agentes transformadores, coproduzindo tecnologia e conhecimento capazes de fortalecer comunidades marginalizadas, ao mesmo tempo em que oferecem contribuições práticas e teóricas ao desenho de sistemas sociotécnicos alinhados com valores coletivos.

Palavras-chave: cooperativismo de plataformas; economia digital solidária; extensão universitária; entregas por bicicleta; algoritmos

Introduction

At least as far back as Max Weber's, the first generation of the Frankfurt School's, and Martin Heidegger's critical remarks on technology, Western intellectual elites are aware of the impacts of technology (or technological development) on society as both a particular social order and power arrangements inside it, and as the culture/cosmology its people nourishes. In Science and Technology Studies (STS), it is now well-established that technology is non-neutral, underdetermined, and part of a co-constructive process (Bijker, Hughes, & Pinch, 1989). That means that technology is value-laden, building or supporting a specific sociotechnical order (Feenberg, 2010, 2017) and/or a cosmo-technical world (Hui, 2016, 2017), rather than or at the expense of possible alternatives (non-neutrality). Additionally, the technical problems to which solution technologies are created or adapted usually allow for different solutions (underdetermination), each frequently bringing about different sociotechnical/cosmo-technical impacts (Feenberg, 2010). However, the link between technology and society is bidirectional as the technology itself, as a conceptual design, an artifact and its supporting scientific-technical knowledge, is also shaped by the very society (and culture-cosmologies) it shapes (co-construction) (Feenberg, 2010; Hui, 2018; Cruz, 2021a).

If that is the case, then technology can —and must— be democratized (Feenberg, 2010) or diversified (Hui, 2017), making it possible for other sociotechnical orders and/or cosmo-technical worlds to flourish or thrive. Conversely, if mainstream technologies are not challenged (i.e., their canonical use is not subverted or is not thought about and designed differently), the hegemonic socio/cosmo-technical order cannot be effectively challenged or changed.

In Latin America, the social technology movement, which arose in the 1990s as a liberating or emancipatory offspring of the appropriate movement (Thomas, 2009; Smith *et al.*, 2017, chaps. 4 and 7), has aimed to be a way of democratizing technology, trying to pave the technological way for the establishment of what in Brazil is known as solidarity economy —an approach that can, in some respects, be correlated with what in Europe is referred to as social economy. (In this text, we will adopt the Brazilian notion of solidarity economy as our reference point.) However, not all that has been presented as "social technology" is committed to a solidarity economy. That is why some scholars have rebranded this liberatory and solidarity-economy-committed strand of social technology as solidarity technoscience (Dagnino, 2023).

One way of developing solidarity technoscience is the Brazilian Popular [Grassroots] Engineering (PE), which is a somewhat diverse set of practices of engineering interventions mainly carried out by (public) university extension groups/centers seeking to support social movements, solidarity economy cooperatives, and marginalized communities empower/emancipate themselves (Cruz, 2021b; Fraga, Alvear, and Cruz, 2020; Araújo & Rufino, 2021). In common, such practices rely on Paulo Freire's popular education processes (Freire, 2000, 2005) and apply participatory action-research methodologies, aiming not only at building the socio/cosmo-technical changes demanded by the movement, cooperative, or community they are working with but also dreaming alongside them other possible worlds (Cruz, 2021b).

The case study analyzed in this manuscript is an example of PE: the development of a route-generating algorithm in conjunction with a bicycle delivery cooperative called Señoritas Courier. This algorithm is part of a platform the cooperative is building. It was

expected to incorporate the cooperative's knowledge and values into its design, as well as the guiding solidarity economy ideals.

In the following sections, we present a brief overview of the modern Brazilian university conception (which is conceived as a driver for the Brazilian people's emancipation) and the Brazilian policy on solidarity economy (which, for some time, placed the university, through its mandatory extension activities, as an essential player for the enforcement of such policy) —section 2. Next, we present the intervention, highlighting a university extension project developed in partnership with Señoritas Courier to build a routing algorithm for their platform, detailing the project's development, methodology, and key milestones —section 3. Section 4 discusses three crucial aspects of this intervention we conducted with Señoritas Courier that should be important to similar interventions and must be considered/planned/disputed carefully, as they can become either an opportunity or a challenge/obstacle: 1) the identification of new research questions and development of tools that respond to the needs of the digital solidarity economy, rather than traditional corporate-driven agendas; 2) the institutional conditions that must be secured at the university for the planned extensionist intervention (as both action and research) to succeed; and 3) the economic/accounting burden that becoming a cooperative can add to the enterprise/collective in Brazil and the need for making such a decision supported by appropriate (management and accounting) knowledge.

The primary objective of this manuscript is to present a powerful approach that puts the university at the service of building the necessary technical basis for digital solidarity entrepreneurships (i.e., coproducing the desired technical artifacts and the techno-scientific knowledge required for that production and operation, and supporting co-designers in appropriating the coproduced sociotechnical solutions). That can be achieved through the practice of a committed university extension that articulates extension and research activities. Such an arrangement is a Latin American invention, rooted in the continent's critical thought tradition (e.g., Freire, 2000, 2005; Fals Borda, 2009) and the demands and victories of different social movements (Fraga, 2024). This text intends, then, to be a decolonial (Mignolo, 2012) contribution for the possible (re)foundation or subversion of the university so that it can be put at the service of the marginalized and the construction of counter-hegemonic projects of society.

1. Some definitions and contextualization: Brazilian universities and solidarity economy

The process/partnership developed alongside Señoritas Courier must be situated according to at least two aspects to make (more) sense. First, it was an activity that articulated research (a master's project) and extension. To understand what extension this research is about and why is aimed at being extensionist, some history about the idea/ideal of the Brazilian university is provided in the following subsection. Second, the development of both research and extension is fundamentally committed to the solidarity economy ideals. The second subsection of this part briefly presents these ideals.

1.1. The Brazilian university

The Constitution of the Federative Republic of Brazil, which was promulgated in 1988, after a long period of military dictatorship, states, in the caput of Article 207, that: "Universities shall have didactic, scientific, administrative, financial and property

management autonomy and shall comply with the principle of inseparability of teaching, research and extension activities" (Constitution, 2022, our translation).

This principle of inseparability, which establishes a threefold academic foundation, is based on theoretical and practical conceptions whose development was abruptly interrupted by the 1964 military coup. The historical roots of university extension in Brazil, as it is understood today, can be traced back to the Reforma de Córdoba (Córdoba Reform) of 1918, a student-led movement in Argentina that profoundly influenced higher education debates across Latin America (Graça, 2024). Inspired by the principles of democratization, social commitment, and the integration of university with society advanced by the Córdoba Manifesto, Brazilian student movements and intellectuals began articulating the need for a closer relationship between universities and the people throughout the 1920s and beyond.

In Brazil, the concept of *extensão universitária* (university extension) was formally institutionalized at the federal level for the first time in a statute formulated by the government of Getúlio Vargas in 1931, a period in which the Brazilian system of public universities was still in the making. The idea of extension, however, was then essentially associated with the offering of courses, conferences or rural technical assistance, in the spirit of "progress of science" and "knowledge transmission", i.e. in consonance with the interests of the dominant classes (FORPROEX, 2006). This perspective opposed an effective integration between society and university, and, moreover, established a dichotomy between teaching-research activities and extension.

The decade preceding the 1964 military coup was a period of intense intellectual/artistic activities in Brazil (Schwarcz and Starling, 2018). In this context, the student movement and educators like Darcy Ribeiro, Paulo Freire and Anísio Teixeira contributed to the emergence of a new concept of extension, in which political and ideological problems were effectively integrated into the education process (FORPROEX, 2006). After the coup, this perspective was suppressed from official policies, and the idea of extension was basically restricted to initiatives of a predominantly assistance-like character.

In 1979, a weakened military government passed an amnesty law that allowed many exiled intellectuals, artists, and politicians to return to Brazil. In 1984, a great national movement called *Diretas Já* (Direct Elections Now) swept the country and symbolized a period of hope and national reconstruction. In this period, the ideas of effective integration between university and society were again widely discussed. In 1985, the last military president stepped out of the government, and the country started a process of "re-democratization" (Schwarcz and Starling, 2018).

In 1987, the Extension Deans of several Brazilian universities created a forum, FORPROEX, to re-discuss the idea of extension and the means necessary for it to become institutional and adequately funded. This forum reached a definition of extension that contains *in nuce* the threefold foundation included in the Brazilian Constitution (FORPROEX, 2006, our translation): "University Extension is the educative, cultural and scientific process that articulates Teaching and Research in an indissociable way and enables a transforming relationship between university and society".

There has, notwithstanding, never been a fair balance between these components in the academic praxis. Research, in the form of a publication-oriented quantitative system, became the fundamental element underlying academic policies and career profiles in the most prestigious Brazilian universities (Bosi, 2007). The Brazilian adoption of the

worldwide “publish or perish” system has led to impressive quantitative indicators, to the formation of a research community in close connection with international peers and to a certain degree of international prestige (quantified by rankings), but, on the other hand, consumed a significant fraction of the academic budget and contributed to increasing the gap between public universities and the population that is their rationale (Novaes, 2022).

The continuing efforts of members of the academic community and organizations that believed in the importance of extension led to the proposition of a resolution to enforce the inclusion of extension activities in academic curricula. The goal of integrating extension into undergraduate education first appeared in the National Education Plan (PNE) for the decade 2001-2010, which established that at least 10% of the total credits required for graduation should be reserved for extension activities. This goal was reaffirmed in the subsequent PNE (2014-2024), with the added emphasis that such activities should be oriented “primarily towards areas of great social relevance” (Brasil, 2014). After years of resistance and delays, the initiative was finally sanctioned in December 2018, when Resolution No. 7 of the National Education Council regulated the provisions of the PNE, mandating that the 10% minimum be applied across all undergraduate courses (Brasil, 2018).

The text of this norm brings a definition of extension in terms of a dialogical interaction between the academic community and society and the promotion of changes both in the university and in the multiple sectors of civil society. Such a definition reassured the advanced conceptions suppressed by the military coup and revived in the democratization period.

This resolution brought a new life to the possibility of building a university model effectively integrated in the reality of the Brazilian society, and its clear definition of extension in dialogical terms points in the direction of a process whereby both the university and the society are empowered and transformed, which evokes Paulo Freire’s ideas of liberating education (Freire, 2000). Nevertheless, resistance persists in some academic circles, often expressed through attempts to broaden the concept of extension to meet the new requirements, including through activities that distance themselves from genuine social commitment and from the Freirean framework.

Taken together, this historical trajectory reveals that university extension in Brazil has been neither a peripheral nor a stable component of academic life, but rather a field of dispute shaped by political regimes, institutional priorities and social demands. The constitutional principle of inseparability and the recent curricular mandate for extension represent important achievements, yet they also expose persistent tensions in academic practice. Understanding this trajectory is essential to situate contemporary extension initiatives and to critically examine their potential to promote meaningful, dialogical and socially transformative relationships between Brazilian universities and society.

1.2. Solidarity economy

The solidarity economy movement in Brazil lays its roots in the same spirit that brought the civil-military dictatorship to an end and drove many people to engage in a collective effort to conceive other possible futures for the country and fight for them to come true. As Paul Singer argues, the solidarity economy aims to replace competition with cooperation, emphasizing egalitarian associations, self-management, and collective ownership of the means of production. Its ultimate goal is to reduce structural inequalities inherent to capitalism and foster social justice through democratic economic practices

(Singer, 2002). In Brazil, these principles materialized in production, consumption, and credit cooperatives, as well as grassroots movements such as the Landless Workers' Movement (MST), and local experiments like the Catende sugar mill in Pernambuco, creating "solidarity implants" that coexist within the broader capitalist system (Singer, 2002).

With the rise of digital technologies and the platformization of labor, the digital solidarity economy has emerged as an update to the traditional solidarity economy, adapting its principles to the digital age. According to Rubim and Milanez (2024), this new field promotes the construction of cooperative, self-managed digital infrastructures designed to serve the public good, in direct opposition to mainstream platform capitalism's extractive and precarious nature.

Grohmann (2022) highlights how delivery cooperatives and platform collectives function as resistance laboratories, leveraging social media and free software to organize, communicate, and redistribute value among workers. Meanwhile, Alvear, Neder, and Santini (2023) propose the idea of a Solidarity Economy 2.0, which integrates platform cooperativism and social technologies. This model emphasizes algorithmic transparency, shared governance, and digital sovereignty as essential conditions for strengthening solidarity-based economic ventures in Brazil.

Thus, still incipient and facing governance dilemmas as well as open trajectories for technologies capable of upholding its values, the digital solidarity economy offers a compelling framework for building inclusive, democratic, and sustainable economic alternatives in the digital era. One example of that is the Señoritas Courier's platform, to whose brief description we turn now, highlighting the process carried out by this manuscript's authors in their support for co-constructing the platform's routing algorithm.

2. Case study: Señoritas' Platform Algorithm

The extensionist partnership developed alongside Señoritas Courier was, as said, also part of a master's work (Gonçalves, 2024b), which articulated research and extension and was developed at the University of Campinas (Unicamp). The main sociotechnical product developed in this process was a routing algorithm tailored to the cooperative's needs and values (incorporating social and ethical considerations often overlooked in traditional optimization models) and integrated into the larger platform project (Gonçalves, 2024a). The study was conducted in collaboration with two groups: Señoritas Courier, a cooperative of women and trans people bicycle couriers promoting alternative urban mobility and labor organization, and the Technology Center of the Movimento dos Trabalhadores Sem-Teto (Homeless Workers' Movement) (MTST), which develops technological solutions to support social movements.

The project's main aim is to develop a digital labour platform that aligns with the cooperative's values and operational methods. Señoritas Courier, a self-managed cooperative, operates within a solidarity economy framework, emphasizing fair working conditions and collective decision-making (Reck, 2022). Given the rise of neoliberal platform economies (Antunes, 2020; Srnicek, 2016), where digital labor platforms often exploit workers (Fairwork, 2023), the cooperative sought to build its own delivery platform to retain autonomy over its operations and improve its market share.

While the platform project was being initiated and gathering participants, the master's research was being conducted with the specific objective of deepening the discussion on the solidarity economy and solidarity technoscience framework (Dagnino, 2023), by investigating possible software development methodologies that could incorporate solidarity values into the resulting sociotechnical products. The research's first stage involved mapping software development methodologies commonly used in the conventional market (Beck, 2000; Beck *et al.*, 2001; Sutherland, 2014), as well as examining other project experiences that were organized in ways that aimed to preserve the knowledge and ways of life of the communities in which they took place (Alvear, 2014; Araújo *et al*., 2019; Cortés-Rico & Piedrahita-Solórzano, 2015). As a result of this mapping stage, a methodological proposal was developed (Gonçalves, de Faissol Attux, & Cruz, 2023), combining agile elements with other practices that aimed at centering the development process around the cooperative's organizational logic and the needs of delivery workers.

A central challenge was ensuring that the algorithm did not merely replicate capitalist efficiency models but reflected the cooperative's core values, including fairness in workload distribution, consideration of individual preferences, and integration of social care aspects into route planning. The developed and adopted methodology was structured in three phases that are first sketched and then detailed below:

1. *Preliminary recognition phase:* This phase involved understanding the cooperative's existing working methods, establishing stakeholder trust, and gathering essential data on current routing practices. Interviews and participatory workshops were conducted with (some of) the cooperative members to map out their workflow and key operational constraints.

2. *First minimal empowering intervention:* In this phase, the initial prototype of the routing algorithm was developed. The prototype was based on genetic algorithms, a class of evolutionary computing techniques suitable for complex optimization problems. On the one hand, the choice for genetic algorithms was driven by their adaptability and potential to accommodate diverse constraints beyond mere cost minimization. On the other hand, such a heuristic is relatively easy to understand and appropriate for non-specialists like the Senõritas' members.

3. *Development and refinement:* This phase focused on refining the algorithm through iterative testing, incorporating feedback from the cooperative, and adjusting parameters to better align with their working conditions. The iterative process ensures the solution remains relevant and adaptable to the cooperative's evolving needs.

The project began in January 2023 with initial meetings and trust-building activities between the university research team and the members of both Señoritas Courier and the Technology Center of MTST. Given grassroots organizations' historical skepticism toward academic institutions, establishing a collaborative relationship was essential to clarify expectations and align the intervention with solidarity economy and self-management values. Through interviews, workshops, and participant observation, the team gained a broader understanding of the cooperative's operations and identified a central dilemma: while seeking to expand deliveries, manual route planning limited scalability. Existing commercial routing tools proved inadequate, as they overlooked key

aspects such as care work, the cooperative's pricing model, and other practices central to the collective. This reinforced the need for a customized routing algorithm, whose design was guided by subsequent interviews and meetings to ensure alignment with the cooperative's values.

When proposing a participatory methodology, the initial intention was to ensure the involvement of all members of the cooperative to gather diverse perspectives and build a more comprehensive view of the group. However, when this intention met the realities of practice, it could only be partially realized. Surveys regarding group demographics and general route preferences were carried out with all members of the collective. However, deeper methodological developments were centered around those who were available to participate in the meetings. In fact, in a cooperative where the work demands high physical effort —and where members, in addition to their jobs, also take on reproductive and care responsibilities at home, as well as, in some cases, other paid activities— it becomes challenging to ensure consistent and in-depth participation in the project. Therefore, our main point of contact became the cooperative's leadership, which was responsible for route planning and other administrative tasks. Even so, we occasionally received valuable contributions from other cooperative members, whether through virtual meetings or in-person immersion sessions.

While the initial meetings were essential for building trust, the more sensitive details regarding Señoritas' business model, pricing structure, and route-planning strategies were only shared around mid-year, once the platform concept had matured. These discussions enabled the research team to establish a dialogue between the cooperative's approach to route planning and the established academic knowledge on the subject. This process also provided a formative experience, cultivating practical, relational, and context-sensitive skills for engaging with grassroots and solidarity-based groups —skills that differ from those typically emphasized in conventional corporate training.

Consequently, the research turned to operations research to identify suitable methodologies for addressing the routing problem. Throughout the history of this field — a branch of computer science dedicated to optimizing solutions for complex problems— a wide range of approaches to routing problems have been developed (Toth & Vigo, 2002). During this stage of the project, we encountered a high degree of uncertainty regarding which factors would be most relevant to consider. As a result, the choice of approach considered both computational performance and flexibility in problem formulation.

Based on evolutionary and genetic theory, the genetic algorithm approach (Holland, 1992; Lambora, Gupta, & Chopra, 2019) emerged as the most suitable choice. Algorithms from this family begin with a large set of random candidate solutions and, in each iteration, combine them through processes inspired by biological reproduction, genetic recombination, mutation, and natural selection. These solutions are highly adaptable and have historically produced promising results.

The university extension process sought here, a participatory and empowering one, involves more than just collecting relevant data to solve an academic problem; it is, in fact, about the sharing of realities, their practical specificities, and the construction of new imaginaries and the sociotechnical bases needed by them. Through presence and mutual exchange, many important nuances emerge from conversations and relationships. One example that was incorporated into the final solution was the attention

to bodies often rendered invisible by socially imposed norms of optimization, older bodies, fat bodies, bodies that menstruate, whose specific needs are, as a rule, overlooked by traditional optimization models. This experience highlighted how academic knowledge frequently abstracts labor realities, as seen in the terminology used in logistics research, where the problem is framed as a Vehicle Routing Problem rather than a Routing Problem for Cyclists or Drivers. In classical optimization, the focus is placed on solving business-oriented challenges rather than considering workers' lived experiences.

Although some of the insights gathered were incorporated into the first version of the algorithmic solution, the initial results of such incorporation did not fully meet the cooperative's expectations in terms of workload distribution and the final route distances, which ultimately proved impractical for routine operations. Nonetheless, the goal here was to develop just an initial prototype that could be refined iteratively through collaboration. However, this refinement process proved particularly challenging. At this stage, we revisited the iterative process proposed by agile methodologies, drawing inspiration from (Cortés-Rico & Piedrahita-Solórzano, 2015), seeking an approach that was not only productive but also emancipatory. Unlike agile methods oriented towards business creation —as exemplified, for instance, by the role of the product owner within work organization—, we sought to build a software development approach centered on understanding the cooperative's way of life. It was based on critical, participatory inclusion, where everyone involved had a voice: both the person responsible for route planning and the bikers who took part in the meetings. The process was also focused on sharing knowledge about the technical solution, despite the cooperative members' limited familiarity with programming.

During the iterations it became evident that the algorithmic outputs were often unfeasible (for example, assigning all deliveries to a single rider or overloading some while underutilizing others), which led us, together with the cooperative, to formalize their criteria as computational constraints —capacity of weight and volume, total distance including home-to-home commuting, billable delivery distance, and workload distribution. In parallel, we designed standard evaluation experiments using metrics such as maximum distances, percentage of violations, and the standard deviation of delivery distances across riders, and observed a trade-off: while incorporating commuting and distribution criteria often worsened classical optimization metrics, it better reflected cooperative values of equity, recognition of unpaid travel time, and self-defined capacity limits.

The work cycle consisted of presenting results and the programming concepts involved, joint reflection with members of the cooperative —again, both the route planner and the bikers who occasionally attended the meetings—, further rounds of learning about how the collective organizes its routes, and the proposal and implementation of improvements, as well as new analytical experiments based on real data from past cooperative deliveries.

We gradually improved the solution through this metric-informed and participatory back-and-forth process, ultimately creating a more refined version that better aligned with the cooperative's needs. The developed solution explicitly addresses one of the cooperative's delivery models: a scenario where multiple bikers travel to a single pickup point —such as a store or warehouse— collect the items, and then complete deliveries along individual routes. The algorithm proved effective according to the cooperative's criteria —previously established— in controlled tests and real-world delivery requests.

The following steps involve integrating the algorithm into the broader system, incorporating the appropriate graphical interfaces and other platform components, and addressing other delivery scenarios, such as multi-pickup routes or more dynamic allocation strategies, which will be developed in future iterations. Nonetheless, this initial implementation provided valuable insights into how to align algorithmic decision-making with the cooperative's principles and operational realities.

Beyond generating satisfactory routes, the algorithm also brought substantial efficiency gains. One of the cooperative's primary concerns was the time spent manually planning deliveries, which could take one or two full days of work. With the new algorithm, routes can be generated within seconds while still aligning with the cooperative's unique parameters. This significant reduction in planning time allows the cooperative to focus more on strategic decision-making and operational improvements.

Lastly, through extensive discussions with the cooperative, a shared understanding was established regarding the role of the algorithm within their work structure. Rather than replacing the person responsible for operational planning, the algorithm is designed as a support tool that quickly generates an initial routing proposal. This proposal serves as a foundation upon which the cooperative's planners can keep building and improving, incorporating additional layers of decision-making that are not easily quantifiable, such as care work, mental health considerations, and situational factors unique to each biker. In this way, the algorithm is not positioned as an authoritative decision-maker but as an assistive tool that enhances, rather than replaces, human judgment. This approach aligns with a core principle of Participatory Design, which rejects the assumption that computerization aims to automate workers' skills, instead seeking to provide them with better tools to perform their jobs (Schuler & Namioka, 1993, p. xi).

3. Challenges and opportunities

The intervention just described above highlighted some challenges related to the (desirable) university's role (or identity) supporting grassroots movements and digital solidarity economy cooperatives that do not seem particular to this case, presenting some fronts worth advancing or knowing better. Such aspects relate to: 1) identifying new research questions and developing tools that respond to the needs of the digital solidarity economy, as opposed to traditional corporate-driven agendas; 2) assuring the necessary conditions for a grassroots/engaged extension to take place; and 3) legal/accounting obstacles cooperatives still have to face in Brazil (and arguably everywhere). They are briefly discussed below.

[1] The development of the digital solidarity economy requires tools, methods, and technologies that are not yet fully established. Existing solutions—typically designed for commercial or corporate contexts—often fail to reflect the needs, values, and practices of solidarity-oriented organizations. The university extension process, as illustrated by the Señoritas Courier case, can play a key role in identifying these gaps and generating relevant knowledge. Through collaborative engagement, a participatory and empowering extension is essential to reveal new research questions rooted in the practical realities of grassroots organizations, from the organization of work to considerations of care, inclusion, and collective decision-making.

In the Señoritas project, this dynamic became concrete. Traditional routing problems overlooked critical aspects for the cooperative, such as equitable distribution of route

distances and the specific needs and preferences of individual bikers. Algorithms designed for standard operational research could not produce feasible solutions for the group because they did not account for these factors. Through iterative workshops, interviews, and in-field observations, the extension process highlighted these nuances and enabled the co-creation of knowledge that addressed both practical and research-oriented challenges. New questions emerged, including how to incorporate care considerations, individual constraints, and collective decision-making into routing models—illustrating opportunities for innovation in operational research.

This process demonstrates a dual benefit: solidarity-oriented enterprises gain tools and infrastructures better suited to their practices, while the extension identifies new problems for research and provides unique opportunities for student learning. The challenge lies in bridging these two worlds, as traditional academic approaches often prioritize business-oriented solutions. The engagement requires constant negotiation and adaptation, highlighting the iterative and experimental nature of building knowledge in collaboration with grassroots actors.

[2] The 2018 resolution requiring that at least 10% of undergraduate curricula in Brazil be dedicated to extension (CNE, 2018) offers an opportunity to rebalance the threefold foundation of teaching, research, and extension established in the Constitution. In practice, however, universities have long prioritized research under the global “publish or perish” system, marginalizing both teaching and extension (Novaes, 2022).

In engineering, this imbalance was aggravated by the emphasis on partnerships with private companies, often justified as the main way to produce societal “impact,” typically measured in financial terms. For some academics, such collaborations became the only legitimate extension, while dialogical forms of engagement were dismissed as “political” or “socialist.” The influx of private funding, combined with the “innovation gospel,” deepened universities’ alienation from society. This detachment was reinforced during the Bolsonaro presidency (2019–2022), amid far-right mobilizations and anti-science attacks during the COVID-19 pandemic.

Implementation of the new curricular guidelines faces structural challenges: faculty reductions, unstable funding, and tacit resistance from academic elites shaped by decades of research-centered evaluation. At Unicamp, for instance, extension still lacks support comparable to research in funding, logistics, and career recognition.

Nonetheless, recent advances, particularly affirmative action and quota policies, have democratized access and fostered a stronger sense that the future of public universities depends on uniting academic excellence with social responsibility. Extension is pivotal to this project, as illustrated in the case study presented in this paper, offering a path toward reconnecting universities with society on democratic and transformative grounds.

[3] According to Rufino (2025), some of the main challenges that solidarity economy enterprises face in Brazil today include: (a) fragility of the legal framework: despite the approval of law 15.068/2024, or the Paul Singer Law, which establishes the legal framework for the solidarity economy in the country, there are still regulations that need to be made (in relation to financing mechanisms, for example) and conflicts with existing state and municipal laws (Dagnino, 2024; Evangelista; Bruno, 2025); (b) high tax and accounting requirements, which financially burden these ventures and require them to have accounting advice that is not always possible to find and/or pay for (Nascimento, 2017); (c) absence, fragility, or insufficiency of public policies to support or encourage

the solidarity economy (Becker; Bertolini, 2022); (d) little study or planning within the scope of management (e.g., absence of an adequately constructed/based business plan and/or participatory strategic planning), which causes decisions to be made without adequate foundation, resulting in a high failure rate of these solidarity economy enterprises (Lopes *et al*., 2024).

These four challenges were (or still are being) faced by Señoritas Courier, despite the support they got from different institutions (Os, 2025). On the one hand, there are challenges Señoritas could not address alone, as they can only be dealt with through political pressure (i.e., challenges a-c). Either way, Señoritas has tried to participate in such mobilizations and efforts. One example of that was its participation in a hearing called by the federal government in 2023 on platforms, which, nonetheless, failed in granting some essential conditions for the work of delivery people.

On the other hand, regarding challenge d, the cooperative has received support from some universities, which proved to be essential for the steps it has already taken (Os, 2025). However, the cooperative still feels unsure regarding business planning and decisions on many occasions, for it does not think it has a good understanding of the whole business picture as it wants to have. It does not know digital programs or tools that could support its management (Os, 2025). Worse, on average, the cooperative does not find proper support on those issues even among university extensionists and/or research projects/programs planned to do precisely that: supporting cooperatives (Os, 2025).

Conclusions

As presented throughout this paper, the university can play a central role in supporting marginalized groups and counter-hegemonic initiatives, helping to develop sociotechnical solutions aligned with the knowledge, values, and practices of the communities involved. The Señoritas Courier case illustrates both the potential and the limitations of such engagement: while collaborative extension processes can generate new research questions, tools, and infrastructures tailored to the needs of solidarity-oriented organizations, they also expose structural and epistemic constraints that universities must confront.

Even well-intentioned extensionist teams may lack specific training to navigate complex socio-technical and ethical challenges. Moreover, the hegemonic neoliberal order has constrained many universities to prioritize corporate-aligned research outputs over socially engaged work, creating institutional, epistemic, and cultural/ontological barriers to meaningful dialogue with grassroots, counter-hegemonic actors. This tension is further reinforced by a widespread perception —shared even among scholars— that the current role of universities, the knowledge they produce, and the communities they serve are natural, unproblematic, and not in need of critical examination. Such acceptance of the status quo limits the potential for universities to actively support marginalized groups and counter-hegemonic initiatives, making reflective, intentional, and collaborative practices even more necessary, but very hard to find and to prove their worthiness.

This way, the Señoritas partnership demonstrates not only that such an alliance is possible but also that a university (re)founded on that commitment with marginalized or underrepresented communities is a fruitful pathway for the co-production of knowledge and innovation responsive to social and collective needs, values, ideals, and knowledge.

To strengthen support for the digital solidarity economy, such a university must address several dimensions: fostering institutional conditions that enable sustained participatory and empowering extension, developing methodologies that incorporate care, inclusion, and collective decision-making, and recognizing the value of practical, context-sensitive problem-solving as a legitimate and rigorous form of research.

Ultimately, the case underscores both the challenges and opportunities of reimagining the university as a space of social responsibility, experimentation, and co-creation. It highlights the importance of critically examining institutional norms, investing in capacity-building for engaged scholarships, and embracing collaborative and empowering processes that can expand the boundaries of what research and extension can achieve. Equally important, extension-based projects of this type open new horizons for professional and personal training: they enable students to develop not only technical expertise but also ethical, political, and relational skills necessary to act in solidarity economies and other counter-hegemonic contexts, as well as in mainstream society. In this way, the integration of research, training/teaching, and extension offers not only technical solutions but also pathways toward more equitable and democratic forms of knowledge production and professional formation.

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References

Alvear, Celso Alexandre de Souza (2014). Tecnologia e participação: sistemas de informação e a construção de propostas coletivas para movimentos sociais e processos de desenvolvimento local [Tese de doutorado]. Rio de Janeiro: Universidade Federal do Rio de Janeiro.

Alvear, Celso Alexandre de Souza, Neder, Ricardo, & Santini, Daniel (2023). Economia solidária 2.0: Por um cooperativismo de plataforma solidário. P2P e Inovação, 9(2), 42-61. DOI: https://doi.org/10.21721/p2p.2023v9n2.p42-61.

Antunes, Ricardo (2020). O privilégio da servidão: O novo proletariado de serviços na era digital (2. ed.). São Paulo: Boitempo.

Araújo, Fernanda & Rufino, Sandra (2021). Rede de Engenharia Popular Oswaldo Sevá. In Celso Alexandre de Souza Alvear, Cristiano Cruz & John Kleba (Orgs.), Engenharias e outras práticas técnicas engajadas – Vol. 1: Redes e movimentos (41–74). EDUEPB. DOI: https://doi.org/10.5281/zenodo.4908523.

Araújo, Fernanda Santos, Nepomuceno, Vicente, Henriques, Flávio Chedid, Sígolo, Vanessa Moreira, Pompeu, Lucca Pérez, & Atolini, Tarcila Mantovan (2019). Dialética da autogestão em empresas recuperadas por trabalhadores no Brasil. Lutas Anticapital.

Beck, Kent (2000). Extreme programming explained: Embrace change. Addison-Wesley Professional.

Beck, Kent, Beedle, Mike, van Bennekum, Arie, Cockburn, Alistair, Cunningham, Ward, Fowler, Martin, Grenning, James, Highsmith, Jim, Hunt, Andrew, Jeffries, Ron, Kern, Jon, Marick, Brian, Martin, Robert C., Mellor, Steve, Schwaber, Ken, Sutherland, Jeff, & Thomas, Dave (2001). Manifesto ágil. Manifesto Ágil. Available at: https://agilemanifesto.org/iso/ptbr/manifesto.html.

Becker, Marcio & Bertolini, Geysler Rogis Flor (2022). Panorama do debate sobre economia solidária e políticas públicas ligadas à coleta seletiva de resíduos sólidos: Exercício de revisão sistemática. DRd – Desenvolvimento Regional em Debate, 12(ed. esp. 2, Dossiê Cooperativismo), 121-138. DOI: https://doi.org/10.24302/drd.v12ied.esp.2(DossieCooperativismo).3557.

Bijker, Wiebe E., Hughes, Thomas P., & Pinch, Trevor (1987). The social construction of technological systems: New directions in the sociology and history of technology. Cambridge: The MIT Press.

Bosi, Antônio de Pádua (2007). A precarização do trabalho docente nas instituições de ensino superior do Brasil nesses últimos 25 anos. Educação & Sociedade, 28(101), 1503–1523. DOI: https://doi.org/10.1590/S0101-73302007000400012.

Brasil (2001). Lei n. 10.172, de 9 de janeiro de 2001. Aprova o Plano Nacional de Educação e dá outras providências. Diário Oficial da União, Brasília, DF, 10 jan. 2001. Available at: http://portal.mec.gov.br/arquivos/pdf/L10172.pdf.

Brasil (2014). Lei n. 13.005, de 25 de junho de 2014. Aprova o Plano Nacional de Educação – PNE e dá outras providências. Diário Oficial da União, Brasília, DF, 26 jun. 2014. Available at: http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2014/lei/l13005.htm.

Brasil. Ministério da Educação. Conselho Nacional de Educação. Câmara de Educação Superior (2018). Resolução n. 7, de 18 de dezembro de 2018. Estabelece as diretrizes para a extensão na educação superior brasileira e regimenta o disposto na Meta 12.7 da Lei nº 13.005/2014. Diário Oficial da União, Brasília, DF, 19 dez. 2018. Seção 1, p. 49. Available at: http://portal.mec.gov.br/index.php?option=com_docman&view=download&alias=104251-rces007-18&category_slug=dezembro-2018-pdf&Itemid=30192.

Campos, Luiz Augusto & Lima, Márcia (2025). O impacto das cotas: Duas décadas de ação afirmativa no ensino superior brasileiro. Belo Horizonte: Autêntica.

Constitution of the Federative Republic of Brazil (2022). Federal Supreme Court. Avalaible at: https://www.stf.jus.br/arquivo/cms/legislacaoConstituicao/anexo/brazil_federal_constitution.pdf.

Cortés-Rico, Laura & Piedrahita-Solórzano, Giovanny (2015). Participatory design in practice: The case of an embroidered technology. In Joaquim Abascal, Simone Barbosa, Mirko Fetter, Tom Gross, Philippe Palanque, and Marco Winckler (Eds.), Human-

Computer Interaction – INTERACT 2015 (518–525). Springer. DOI: https://doi.org/10.1007/978-3-319-22698-9_35.

Cruz, Cristiano (2019). Engenheiro educador: Experiências brasileiras de formação do perfil técnico capaz de praticar engenharia popular. Revista Iberoamericana de Ciencia, Tecnología y Sociedad, 40(14), 81-110. Available at: https://ojs.revistacts.net/index.php/CTS/article/view/95.

Cruz, Cristiano (2021a). Decolonizing philosophy of technology: Learning from bottom-up and top-down approaches to decolonial technical design. Philosophy & Technology, 34, 1847-1881. DOI: https://doi.org/10.1007/s13347-021-00489-w.

Cruz, Cristiano (2021b). Brazilian grassroots engineering: A decolonial approach to engineering education. European Journal of Engineering Education, 46(5), 690-706. DOI: https://doi.org/10.18260/1-2--34223.

Dagnino, Renato (2023). Solidary technoscience: A concept for the philosophy of technology. In Helena M. Jerónimo (Ed.), Portuguese philosophy of technology, philosophy of engineering and technology (pp. 305–320). Springer. DOI: https://doi.org/10.1007/978-3-031-14630-5_17.

Dagnino, Renato (2024). Novas brechas para a reindustrialização solidária. Outras Palavras, 18 de dezembro. Available at: https://outraspalavras.net/descolonizacoes/novas-brechas-para-a-reindustrializacao-solidaria/.

Evangelista, Maísa Beatriz A. & Bruno, Ricardo (2025). Economia solidária: Regulamentação e fragilidades. Martinelli Updates, 12 de fevereiro. Available at: https://www.martinelli.adv.br/economia-solidaria-regulamentacao-e-fragilidades/.

Fairwork (2023). Fairwork Brazil Ratings 2023: Still pursuing decent work in the platform economy. Fairwork. Available at: https://fair.work/wp-content/uploads/sites/17/2023/07/Fairwork-Brazil-Ratings-2023-report-EN-red.pdf.

Fals Borda, Orlando (2009). Una sociología sentipensante para América Latina. Bogotá: Siglo del Hombre Editores & CLACSO. Available at: https://secretariaextension.uner.edu.ar/wp-content/uploads/2021/08/Una-sociologia-sentipensante-para-America-Latina.pdf.

Feenberg, Andrew (2010). Between reason and experience: Essays in technology and modernity. Cambridge: MIT Press. DOI: https://doi.org/10.7551/mitpress/8221.001.0001.

Feenberg, Andrew (2017). Technosystem: The social life of reason. Harvard University Press. DOI: https://doi.org/10.4159/9780674982109.

FORPROEX (2006). Extensão universitária e a flexibilização curricular. FORPROEX/MEC/UFRGS.

Fraga, Laís (2024). Extensão universitária e educação popular: A perspectiva da extensão popular. Revista da FAEEBA - Educação e Contemporaneidade, 33(76), 156–173. DOI: https://doi.org/10.21879/faeeba2358-0194.2024.v33.n76.p156-173.

Fraga, Laís, Alvear, Celso Alexandre de Souza, & Cruz, Cristiano (2020). Na trilha da contra-hegemonia da engenharia no Brasil: Da engenharia e desenvolvimento social à engenharia popular. Revista Iberoamericana de Ciencia, Tecnología y Sociedad, 43(15), 209–232. Available at: https://ojs.revistacts.net/index.php/CTS/article/view/95.

Freire, Paulo (2000). Pedagogy of freedom: Ethics, democracy, and civic courage. Rowman & Littlefield Publishers. DOI: https://doi.org/10.5771/9781461640653.

Freire, Paulo (2005). Pedagogy of the oppressed. Continuum.

Gonçalves, Gustavo Nicolau (2024b). Os caminhos das Señoritas: Estudo sobre metodologia de desenvolvimento de software com valores solidários numa cooperativa de ciclo entregas. [Dissertação de mestrado]. Campinas: UNICAMP. Available at: https://repositorio.unicamp.br/acervo/detalhe/1490034.

Gonçalves, Gustavo Nicolau, Attux, Romis, & Cruz, Cristiano (2023). Desenvolvimento de algoritmo gerador de rotas com valores solidários. Anais dos Encontros Nacionais de Engenharia e Desenvolvimento Social, 18(1), 1-17.

Gonçalves, Gustavo Nicolau, Attux, Romis, & Cruz, Cristiano (2024a). Cooperativismo de plataforma e pesquisa operacional baseada na tecnociência solidária: Desenvolvimento de um algoritmo evolutivo de roteamento para uma cooperativa de ciclo entregas de São Paulo. Anais dos Encontros Nacionais de Engenharia e Desenvolvimento Social, 19(1), 1-22.

Graça, Ricardo Jullian da Silva (2024). Por uma educação extensionista: A experiência do Laboratório de Informática para Educação (LIpE) da UFRJ. Available at: https://cos.ufrj.br/uploadfile/publicacao/3186.pdf.

Grohmann, Rafael (2022). Plataformas de propriedade de trabalhadores: Cooperativas e coletivos de entregadores. Matrizes, 16(1), 209–233. DOI: https://doi.org/10.11606/issn.1982-8160.v16i1p209-233.

Holland, John H. (1992). Adaptation in natural and artificial systems: An introductory analysis with applications to biology, control, and artificial intelligence. Cambrige: MIT Press.

Hui, Yuk (2016). The question concerning technology in China: An essay in cosmotechnics. Urbanomic Media Ltd.

Hui, Yuk (2017). On cosmotechnics: For a renewed relation between technology and nature in the Anthropocene. Techné: Research in Philosophy and Technology, 21(2–3), 319-341. DOI: https://doi.org/10.5840/techne201711876.

Lambora, Annu, Gupta, Kunal, and Chopra, Kriti (2019). Genetic algorithm – A literature review. In 2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon) (380–384). IEEE. DOI: https://doi.org/10.1109/COMITCon.2019.8862255.

Lopes, Soraya Cardoso Pongelupe, Andrade, M. L., Oliveira, O. M., & Matos, E. D. O. (2024). Desafios e perspectivas na gestão de empreendimentos de economia solidária

na RMBH: Um estudo sobre práticas gerenciais e impactos do perfil dos empreendedores. In Anais do CACES - Congresso de Administração, Contabilidade, Economia e Sustentabilidade. PUC Minas. DOI: https://doi.org/10.29327/caces.804731.

Mignolo, Walter D. (2012). The darker side of western modernity: Global futures, decolonial options. Duke University Press. DOI: https://doi.org/10.1515/9780822394501.

Nascimento, Shesby André Medeiros do (2017). A utilidade das informações contábeis para a gestão das cooperativas de agricultura familiar na CECAFES/RN. Trabalho de Conclusão de Curso. Natal: Universidade Federal do Rio Grande do Norte. Available at: https://repositorio.ufrn.br/handle/123456789/41065.

Novaes, Henrique Tahan (2022). Da universidade necessária à universidade para além do capital. Editora Lutas Anticapital. DOI: https://doi.org/10.36311/2022.978-65-5954-275-8.

Os, Aline (2025). Some challenges faced by Señoritas Courier nowadays. Entrevista conduzida por Gustavo Gonçalves, 7 de abril.

Reck, Yasmin (2022). Mulheres e cicloentregas: Um estudo de caso sobre o coletivo Señoritas Courier. In Desafio: Estudos de Mobilidade por Bicicleta 5 (129–156). Curitiba: UFPR.

Rubim, Emanuele & Milanez, Lucas (2024). Economia solidária digital: Caminhos para potencializar políticas e ações baseadas em cooperação e solidariedade. Fundação Rosa Luxemburgo & DigiLabour. Available at: https://rosalux.org.br/livro/economia-solidaria-digital/.

Rufino, Sandra (2025). The main challenges that solidarity economy enterprises face in Brazil today. Entrevista conduzida por Cristiano Cruz e Gustavo Gonçalves, 20 de março.

Schuler, Douglas & Namioka, Aki (1993). Participatory design: Principles and practices. CRC Press.

Schwarcz, Lilia M. & Starling, Heloisa M. (2018). Brazil: A biography. Penguin.

Singer, Paul (2002). Introdução à economia solidária. Fundação Perseu Abramo. Available at: https://fpabramo.org.br/wp-content/uploads/2018/04/Introducao-economia-solidaria-WEB-1.pdf.

Smith, Adrian, Fressoli, Mariano, Abrol, Dinesh, Arond, E., & Ely, Adrian (2017). Grassroots innovation movements. Routledge. DOI: https://doi.org/10.4324/9781315697888.

Spatti, Ana Carolina, Serafim, Milena Pavan, & Dagnino, Renato Peixoto (2021). Evidências de anomalia e atipicidade da política de ciência e tecnologia nos discursos de gestores de agências de inovação. Sociologias, 23(56), 336-365. DOI: https://doi.org/10.1590/1517-4522-104160.

Supremo Tribunal Federal (2022). Constituição da República Federativa do Brasil. Available at:

https://www.stf.jus.br/arquivo/cms/legislacaoConstituicao/anexo/brazil_federal_constitution.pdf.

Sutherland, Jeff (2014). Scrum: A arte de fazer o dobro de trabalho na metade do tempo. Leya.

Srnicek, Nick (2016). Platform capitalism. Polity Press.

Thomas, Hernán (2009). De las tecnologías apropiadas a las tecnologías sociales: Conceptos, estrategias, diseños, acciones. Primeras Jornadas de Tecnologías Sociales. Programa Consejo de la Demanda de Actores Sociales. Buenos Aires: MINCYT.

Toth, Paolo & Vigo, Daniele (2002). The vehicle routing problem. Society for Industrial and Applied Mathematics. DOI: https://doi.org/10.1137/1.9780898718515.

Trevisol, Joviles Vitório & Garmus, Ricardo (2024). A nova direita e os ataques à autonomia das universidades no Brasil. Educação & Sociedade, 45, e277388. DOI: https://doi.org/10.1590/ES.277388.