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Popular users: why and how innovation research started to consider users in the innovation process

Guest Editors

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The international journal *NOvation: Critical Studies of Innovation* was launched to contribute to the rethinking and debunking of innovation narratives in STS (Science, Technology and Society) and STI (Science, Technology, and Innovation). There is a need to critically examine studies of innovation and obtain a clearer portrait of innovation than the depiction this field has been accustomed to. The journal questions the current narratives of innovation and offers a forum for discussion of some different interpretations of innovation, not only its virtues, but also its implications. In this sense, NO refers to non-innovative behaviors, which are as important to our societies as innovation is. Failures, imitation and negative effects of innovation, to take just some examples of non-innovation or *NOvation*, are scarcely considered and rarely form part of theories of innovation.

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Editorial Presentation
Popular users: why and how innovation research started to consider users in the innovation process

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Users have become popular in innovation research, innovation policy, and innovation practice (cf. Bogers *et al.*, 2010). They are no longer considered simply as a passive mass of adopters or consumers, but as a more or less active agency in innovation processes. Innovation research, for instance, has long since distinguished between several adopter categories in the diffusion process: innovators, early adopters, early majority, late majority, and laggards. These categories can be mapped on the diffusion s-curve and indicate a temporal order along which user agency may be analysed. Concepts such as "reinvention" (Rice & Rogers, 1980) or "domestication" (Silverstone & Hirsch, 1992) subsequently put more emphasis on the ways in which users may transform an innovation in later stages of the adoption process. In these cases, innovations, i.e. new technologies, usually come from elsewhere (i.e., manufacturers), but users are credited with more creative potential than simply adopting novelties (Kline & Pinch, 1996). In this vein, the turn towards "user-driven" innovations (Hippel 1988) decidedly shifted the creative potential towards (specific) user groups, transgressing the traditional distinction between producers and consumers (Oudshoorn & Pinch, 2003).

Users in innovation processes have been addressed under different labels, for instance: user innovation, open innovation, or participatory design and from different fields such as: management and innovation research, science and technology studies, or social innovation studies (cf. Hyysalo *et al.*, 2016). The main gist of these approaches lies in reclaiming hitherto neglected aspects, perspectives, or sources of innovations, thus arguing against a top-down producer-centred models of innovation by emphasising bottom-up user-centred modes of innovation. These approaches reconfigure ideas about pushes and pulls, about the constellations and locales in which invention and diffusion occur, and about the transformations of innovations as

they emerge and evolve over time and space. Aside from innovation research, users have also become more popular in innovation policy and innovation practice, as the contributions to this special issue demonstrate in a variety of difference cases. For instance, mission-oriented innovation policies call for the active participation of citizens or users through processes of co-creation or responsible research and innovation (cf. Robinson *et al.*, 2020). Concrete innovation practices might nonetheless differ from the intentions of innovation policy and the assumptions of innovation theory (cf. Kuhlmann *et al.*, 2010).

In line with *NOvation*'s critical approach to innovation and innovation studies, the contributions to this issue highlight the promises, problems, and tensions of engaging users in innovation processes. Their critical perspectives challenge the "pro-innovation-bias" (Godin & Vinck, 2018) of mainstream innovation theory and policy. Users are not primarily considered as effective agents supporting innovative activities, like in open innovation approaches, but as transformative, sometimes unruly, agencies, putting up resistance as opposition or withdrawing as disinterested non-users. Indeed, resistance to both technical (Guille-Escuret, 1993) and social (Bartels, 2017) innovation and non-use are central phenomena when it comes to considering users in innovation research. Such thinking challenges inclusivist ideas of diffusion while pointing to the exclusions and inequalities that might follow from innovations. For instance, even though user-centred design advocates the participation and inclusion of users, several contributions show how adverse effects might contradict the initial idea.

We are extremely happy to have received so many high quality contributions. They provide key insights into the diversity and complexity of user involvement in innovation processes. Through their critical reflections on the role of users in innovation-making, the authors scrutinize, all from different analytical and disciplinary perspectives, the popularity of users in innovation process as well as innovation policies and practices. They shed light on the unanticipated and unintended consequence of user involvement and how involving users might reify asymmetries of power.

Gabriela Bortz and Hernan Thomas open the special issue with an inquiry into user theories through the lens of inclusion/exclusion. With a focus on technologies for inclusive development, the authors review innovation studies and science, technology and society studies literature in search of users and user inclusion and exclusion. Their extensive literature review is supplemented with four technologies for inclusive development cases. The paper is concluded with a typology of user approaches based on inclusion/exclusion, identifying five stylized types of user participation, tied to different normative assumptions about what user-centeredness

is for. Bortz and Thomas analyze how bringing the inclusiveness/exclusion dimension into the literature on users in innovation may help to reveal blind spots that need to be addressed and how unveiling user theory may contribute to deepen our understanding of inclusion in technology making.

The contribution by **Hadrien Macq** puts policy and policy expectations center-stage in an analysis of users and lay citizens involvement in innovation-making in Wallonia. Macq analyses participatory innovation as a mode of governance introduced in Wallonia to combat structural challenges. Based on his analysis of discourses, he finds that participatory innovation is used by public authorities to (re)invent themselves and the society they govern. Within this interplay between user innovators and policy making, power plays a central role. Macq shows why and how participatory innovation became fashionable in Wallonia and how the (regional) State instrumentalized the concept of participatory innovation.

Benjamin Lipp, subsequently, also puts a strong emphasis on policy and policy expectations and assumptions, but does so with a focus on European, rather than regional, policy discourses and by turning the attention towards user involvement specifically in the development of frugal robots. Focusing on healthcare robotics, Lipp investigates the interplay between broader policy assumptions in the European discourse on user-driven innovation and its practical performance. He finds that the assumption on user-driven innovation actually restrict the agency of users and may cause conflict and contradictory outcomes. Building on a concrete case of Public end-user Driven Technological Innovation (PDTI) in the development of healthcare robotics, Lipp concludes that user-driven innovation is not simply about users driving innovation but about what he calls interfacing users and their concerns with (robotics) developers and their technology. He therefore proposes an analytics of interfacing.

From healthcare robotics, we turn towards digital technologies for people in old age. **Cordula Endter, Sebastian Merkel and Harald Künemund** study the involvement of older users in two funding programmes and discuss how older people are configured as users in technology development. They do so from the perspective of user-centered design. The authors lay bare the complexities of involvement of older users in technology development and elucidate controversies in social science research on user participation in innovation. In doing so, they critically reflect on technology development strategies as well as funding practices.

Julia Stilke and Sandra Buchmüller approach the involvement of users (and non-users) within the innovation processes from a feminist STS perspective. Counterbalancing a technocratic approach to sustainable aviation, Stilke and Buchmüller combine feminist STS with methods from participatory design and practice-based ontological design to analyse human demands of sustainable aviation.

In discussions with users and non-users, they find that conceptualizations and categorisations of users and non-users are highly situated. With a critical reflection on the role of researchers and the power structures, methods, theories and values that are prevalent, the authors advocate for power-critical reflections on the performative effects of the knowledge making process in inter- and transdisciplinary research projects.

Moving away from 'lay' or 'citizen' users, Philip Roth and Nadine Diefenbach, focus on organizational users. Roth and Diefenach depict organizational users as a distinctly different type of users, deserving more explicit attention in (user) innovation literature. They draw on empirical findings on interorganizational knowledge exchange and build on practice-theoretical insights to elucidate how the embeddedness of organizational users in the knowledge transfer process structures their integration. They therefore show how organisational users are distinct from private users within an innovation process because of the situatedness of their knowledge, their integration in the process, and the structures of organizations and organizational boundaries.

As with all scientific endeavours, the final papers that reach the eyes of the audience are, of course, the result of hard work of the authors. At the same time though, the usually anonymous volunteer reviewers provide helpful suggestions to improve research papers. In line with *NOvation*'s strive to implement an open review process, in which the reviewers are informed about who wrote the paper, while the authors also receive the names of the reviewers, we are happy to able to announce and disclose the names of the reviewers that contributed to the development of this thematic issue. Finding willing reviewers is no easy feat. We are therefore particularly thankful to (in alphabetical order) Susanne Brucksch, Diego Compagna, Maximilian Fochler, Gérald Gaglio, Bob Jessop, Robert Jungmann, Alexander Peine, Bonno Pel, Bianca Prietl and Sebastian Pfotenhauer.

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User theory for inclusion or exclusion? Conceptual models to address the role of users for inclusive socio-technical change[1]

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ABSTRACT

Innovation Studies (IS) and Science, Technology and Society studies (STS) explored the role of users in socio-technological change: from their role as consumers, adopters or experimenters to maximize profit, to exploring the mutual shaping of users and technologies and the power relations embedded into the process of use. By the turn of the century, amidst broader claims to democratize Science and Technology, scholars and practitioners explored the ways technologies may contribute to overcome social, material, and political restrictions in structural inequality scenarios. While discursively praising user inclusion as a 'good practice', 'technologies for inclusive development' (TID) ranged from processes of distributed decision-making and empowerment to paternalistic schemes and unwanted effects that reinforce exclusion patterns. This paper aims to revisit user theories through the lens of inclusion/exclusion to explore user engagement in TID initiatives to understand the relation between user involvement and 'inclusive' outcomes. We argue that diverse theoretical views on user-centeredness, which we systematize in 5 types, are tied to different normative assumptions about what user-centeredness is for, with implications for technology practice and STS theory. In interaction between literature review and instrumental TID case studies (in water, health, nutrition, and recycling), we examine how these differences lead to differential outcomes in terms of inclusion (e.g., exclusion problem-solving, distribution of benefits, social learning). In turn, we analyze how bringing the inclusiveness/exclusion dimension may help to reveal user literature blind spots that need to be addressed, and how unveiling user theory may contribute to deepen our understanding of inclusion in technology making.

Keywords: User Theory; Technologies for Inclusive Development; Inclusive Innovation; Participation in Science and Technology; Technology Governance; Critical Studies of Innovation.

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INTRODUCTION

In the last 40 years, Innovation Studies (IS) and Science, Technology and Society studies (STS) explored the role of users in technological change. Linearly, early approaches sought to understand their role as consumers and adopters, their capacity to experiment and create (von Hippel, 1976, 1986, 2009; Schot *et al.*, 2016), or their interactions as learning processes to gain profit in capitalist firms (Lundvall, 1988). Meanwhile, critical literature increasingly brought power into the use, analyzing with what users do to technologies (how they reshape, reconfigure, and resist them) and what technologies do to users (how users emerge, become transformed or suppressed?) (Oudshoorn & Pinch, 2003; Kline & Pinch, 1996).

With the turn of the century, academic consensus to democratize technology gained momentum (Kleinman, 2000; Jasanoff, 2005; Invernizzi, 2020). On the practitioner side, rising trends on user-centered innovations in technology design (Norman, 1988; Abras, Maloney-Krichmar & Preece, 2004) tended to equate taking users into account as 'user inclusion'. Simultaneously, scholars and practitioners explored how technologies may contribute to overcome social, material, and political restrictions in structural inequality scenarios. While discursively praising user inclusion as a good practice, 'technologies for inclusive development' (TID) ranged from processes of distributed decision-making and empowerment (Carenzo, 2014; Bortz & Thomas, 2017) to user-excluding paternalistic schemes. Even when imbued in inclusive intentions (Heeks *et al.*, 2014), their outcomes ranged from participatory scaled-up technology policy programs (Bortz & Thomas, 2017) to their failed and unwanted effects that reinforced patterns of exclusion (Dias, 2013; Thomas *et al.*, 2017). TID initiatives as quasi-experiments become thus privileged settings to dive into the socio-technical relations between users, producers, and artifacts, where empowering actors and making technologies work to provide access to basic goods (health, food security, housing, energy supply, education) becomes most needed.

This paper aims to revisit user theories through the lens of inclusiveness/exclusion and to explore user engagement in TID initiatives to understand the relation between user involvement and 'inclusive' outcomes. We argue that diverse theoretical views on user-centeredness are tied to different normative assumptions about what user-centeredness is for, with implications for technology practice and STS theory. We examine how these differences lead to differential outcomes in terms of inclusion (e.g., exclusion problem-solving, distribution of benefits, social learning) and, in turn, how bringing the inclusion/exclusion dimension may help unveil user literature blind spots that need to be addressed.

Research is based in a qualitative methodology of literature review and instrumental case studies. First, we present the problem of users for social inclusion. Second, we review IS and STS user theories through an inclusion/exclusion light, under the dimensions of power, gender and knowledge flows. Third, we present four TID case studies (in water, health, nutrition, and recycling sectors) that will allow testing and critiquing existing approaches, understanding users in and beyond market dynamics in a territorially grounded basis. In interplay between theory and practice, the discussion presents a typology to understand exclusion and inclusiveness in user theory. The paper ends presenting six critical implications that may serve to expand user theory and inclusive practice towards more meaningful socio-technical citizenships.

METHODOLOGICAL APPROACH

Research is based on interplay between literature review and instrumental case studies. Since 2010, we surveyed over 100 cases of TID in the health, water, food, waste, energy, and housing sectors in Argentina (Thomas *et al.*, 2017), and 66 cases specifically in biotechnology (Bortz, 2017).

We selected four cases in the fields of water, health, nutrition, and recycling, showing an incremental path in user involvement in technology design. These allowed testing user theories along extensive empirical trajectories, mapping changes in the user-producer-technology interactions, and their implications for inclusion/exclusion.

The case studies involved:

a) Identification of relevant actors through snowball techniques.

b) In-depth interviews with researchers, technicians, users, policy-makers, and producers: Case 1, 3 interviews supplemented with audiovisual material developed by the research group; Case 2, 10 interviews; Case 3, 13 interviews; Case 4, based on secondary sources that account for an over 10-year research-action ethnographic work (published in Carenzo, 2014, 2017), supplemented with an additional interview.

c) Documentary analysis based on primary and secondary sources (projects, government documents, news, papers, etc.).

d) Participant observation in meetings and kick-off workshops (Case 2, 4), non-participant observation in laboratory and governmental facilities (1, 2, 3), exhibits (3, 4), and schools (3).

Results presented in this work originated in an inductive process, in iterative feedback between empirical data and TID and user theory contributions.

Users in technologies for inclusive development

Since the 1960s, scholars and activists experimented with alternative technological dynamics towards diverse understandings of socially inclusive and environmentally sustainable societies. These experiences can be collectively addressed as 'technologies for inclusive development' (TID). They involved a range of actors (R&D units and universities, social movements, cooperatives, NGOs, governments, development agencies, companies, foundations) to develop responses to poverty, mainstream patterns of industrialization and mitigating its unwanted effects.

From a critical stance, Mumford's 'democratic' or 'authoritarian' techniques (1964) linked technology design, exertion of governance and control, technology production, appropriation, and use, and how they enable certain human alternatives. In the 1970s, new grassroots movements emerged articulated with activist scholarship (Fressoli *et al.*, 2014). Naming themselves as 'appropriate', 'intermediate' (Schumacher, 1973; Willoughby, 1990; Herrera, 1981), 'alternative' technologies (Dickson 1974) or, in the 21st century, 'grassroots innovations' (Gupta *et al.*, 2003), 'social technologies' (Dagnino, 2010), they aimed to respond to community development problems, through goods, services and technological alternatives to scenarios characterized by poverty and lack of access to basic goods in rural, urban and peri-urban areas (Fressoli *et al.*, 2014).

In the early 2000s, the innovation imperative (Pfotenhauer *et al.*, 2019) sprung up into scene, introducing a managerial gaze into creating and scaling-up technologies for social inclusion, shaping the notion of inclusion in turn.

Presented as remedies for the undesired exclusive effects of innovation, 'X-innovations' (Gaglio *et al.*, 2019) permeated development policies, traveling across developing countries: 'social innovation', diverse alternatives based on (social) entrepreneurship, NGOs, foundations, and corporate responsibility; 'bottom of the pyramid' (BoP, Prahalad, 2010), focusing in large companies developing and distributing products for the poor; 'frugal/Jugaad innovation', creating affordable goods with substantial cost reduction (Soni & Krishnan, 2014); 'below-the-radar innovation', focusing on local small and medium companies developing BoP markets in informal settings (Kaplinsky, 2011; Chataway *et al.*, 2014). In Latin America, especially in Argentina, Brazil and Uruguay, socially oriented public R&D prevailed, based on the commitment of public universities and research institutions within their territorial context (Bortz, 2017).

However, the way users are visualized, in what capacities they engage in TID, and how this shapes the outcomes of TID initiatives and -ultimately- what 'inclusion' might be, has not been addressed. We show that the normative assumptions on the role of users and how they are to be engaged, leads to different paths in terms of

inclusion outcomes (the possibilities for adopting and using the 'inclusive' technologies, the distributional of benefits from situated technology development and social learning). These enquiries lay within a broader concern on the relation 'participation–inclusion' in TID and broadening the governance over technological decision-making as a dimension of our world-making.

In previous works we stylized a background tension between the two ways the 'participation–inclusion' relation has been addressed in TID initiatives (Bortz & Thomas, 2017). These disclose the orientation and object as framed by policy actors, scholars, and activists:

(a) *Inclusion as a result*. They aim to give access to goods and services by broadening consumption capacities, expecting a positive impact in the livelihoods of excluded groups. From solar panels in rural locations, cell phones for financial inclusion, to functional foods to prevent starvation, these projects are conceived as top-down specific technological fixes for specific deficits (Fressoli *et al.,* 2014; Thomas *et al.,* 2017; Hanlin & Murguri, 2009; Foster & Heeks, 2013). Users are considered beneficiaries or end-of-pipe consumers (usually framed as those living below X-income level); technology is developed by experts and transferred to users. Even when discursively praised, actor involvement beyond expert authority tends to tokenism, limited to being a source of information on their needs for producers, or circumscribed to late stages of technological development (testing, using, adapting, repairing, brokering), hindering more substantial capacity building. Their decision-making stays limited to a consumer framing (mainly, using, purchasing and rejecting options). As the focus is placed on producing and giving access to goods, this approach enabled scaling-up TID policy programs (Dias, 2013; Bortz & Thomas, 2017; Benitez Larghi, 2020).

(b) *Inclusion as a process*. They aim to generate inclusion by involving neglected actors and communities in the processes of problem framing, technology design, development, and solution delivery, promoting distributed technology governance. The focus is not on specific artifacts, as they serve as a driver to engage these actors, foster local capacity building, and build technological situated adequacy (Thomas *et al*., 2017). As socio-economic exclusion intersects with epistemic inequality, user inclusion aims to facilitate territorially embedded social learning, and to empower actors to shape the living conditions that matter for their own well-being. This type presents many forms, from the recovery of indigenous knowledge, user participation in problem framing to co-design initiatives (Peyloubet, 2011). Here *inclusion* gains a broader scope, understood as 'equalizing rights, dignifying the conditions of human existence, generating new spaces of freedom and justice, improving the quality of life, and equitably distributing wealth' (Thomas & Santos, 2016).

This assumes the co-construction of users and technology as two sides of the same socio-technical relation (Oudshoorn & Pinch, 2003; Thomas, 2008). We explore the role of users in TID, their involvement in technology governance, and how this shapes TID in turn, the relations of epistemic authority they entail, and their inclusive/exclusive outcomes (Jasanoff, 2005). We understand participation as praxis in a contested ground, where 'the ability to influence techno-cognitive decision making' is at play (Bortz & Thomas, 2017). Actors exert their agency according to their interests, motivations, capacities, ideologies and possibilities in a territorially situated interplay with other involved actors (Bortz & Thomas, 2017).

Far from linear and a-conflictive visions, we will see how tensions, power asymmetries and the assumption of who the user is (or should be) becomes embedded into TID designs, shaping users and modifying the distribution of benefits and privileges. 'Users' are not understood as an abstract fixed category, but as a locally embedded contested one, assigning roles, self-attributing roles and marking who and how makes the decisions when inclusion/exclusion dynamics are at stake.

UNDERSTANDING USERS AND NON-USERS: A REVIEW

Users in innovation studies

Traditionally, technology analysis, focused on its design and production, rarely analyzed what users did with it. Actors and contexts of production and of use appear polar opposite, at each end of the development pipe (Oudshoorn & Pinch, 2003; Stewart & Hyysalo, 2008), limiting users' agency to a use/reject choice.

In the '1980s, the urge to maximize profit through user adoption rates, Innovation Studies started to analyze users-consumers, seeing knowledge on their needs as new technical opportunities (Lundvall, 1988). Von Hippel's (1976, 1986) pioneer works found that the more novel and useful innovations were developed by users to solve their daily practice problems. These 'lead users' (von Hippel, 2009) emerge in 'sticky information' contexts. The information asymmetry between users and producers results in user innovation to be more useful when problem-solving takes place in the same context where problems occur (1994).

This scholarship focused in design stages, disregarding how users use technologies. Users were praised for the knowledge they possess on their own needs and problem-solving capacity. Conversely, 'user-producer' relations (Lundvall, 1988; Johnson, 2011) sustained the division between users and the firm. It observed users, their needs and skills for product improvement and subsequent adoption. These works preserve users in their consumer role (attributing them knowledge on their needs),

but transcends into late stages of technology development, monitoring changes and new opportunities through user-producer interactive learning. Later works studied how knowledge from multiple actors (intermediaries, intermediate, final users) flowed into iterative and gradual innovation process (Kline & Rosenberg, 1986; Stewart & Hyysalo, 2008) through learning by using and interacting (Lundvall & Johnson, 1994).

From the design's end, new trending concepts arose, such as 'user centered design'. This focused on 'proxy users' (representing an average end-user and their needs), neglecting actual users and their contextual specificities. Focusing on later stages of technological development, concepts as 'innofusion' (Fleck, 1988) gained traction, depicting what happens on user-sites, where user-producer relations are not necessarily collaborative or coordinated. This concept was applied by inclusive innovation literature to depict the link between an invention and its widespread adoption by low-income consumers (Foster & Heeks, 2013). With the increased interest in citizens as renewable energy end-users, concepts such as 'active/inventive users' stressed the do-it-yourself (DIY) variations and adaptions conducted in user's homes (Hyysalo *et al.*, 2013).

Recent works explored how users create spaces and opportunities for technology appropriation. Assuming knowledge asymmetries, 'innovation intermediaries' or 'intermediate users' (Stewart & Hyysalo, 2008) serve as gatekeepers, configuring and facilitating technologies (e.g., learn, filter, translating information), and brokering between users and suppliers, and therefore reinforcing the use-side vs. supply-side analytical divide.

Either focusing on the design or adoption, these theories reinforce market assumptions on the ontological and spatial divide between suppliers and users and the linearity of technology development. They show how users modify technologies, not depicting how they are shaped in turn. Users' specificities remain blackboxed, hindering knowledge asymmetries, and context-sensitive features, including gender and intersectional power asymmetries.

Transition theory

Drawing upon IS and history of technology, transitions theory (TT) seeks to explain large-scale and long-term socio-technical change, as the result of the coevolution of elements in three levels: niche, regime and landscape (Geels & Schot 2007). It explored the biases in users' choices to unsustainable energy practices and their role towards sustainable transitions (Smith *et al.*, 2010; Schot *et al.*, 2016).

Initial works analyzed users in niche markets, where deep learning takes place (Truffer, 2003). Schot, Kanger and Verbong (2016) systematized diverse types of users in transitions: 'user-producers' and 'user-legitimators' creating technological and

symbolic alternatives in early stages, experimenting with radical technologies, and shaping the values and worldviews of niche actors, respectively. To accelerate niches, 'user-citizens' (e.g., activists and grassroots movements) mobilize against existing regimes, to scale-up alternative niches (Smith *et al.*, 2010). Meanwhile, 'user-intermediaries' broker between actors, building networks and conditions for technology appropriation (Stewart & Hyysalo, 2008). As regimes stabilize users become passive, narrowing decision-making to consumption ('user-consumers') (Truffer, 2003).

This approach places the creation and reproduction of collective routines at the center of the analysis, in a co-evolutionary process driven by endogenous interactions between technologies, user preferences and institutional frameworks. User's agency becomes critical for niche building, to the point of blurring the supply/demand divide but remains constricted by structural power in stabilized regimes. The innovation studies imprint in transitions theory preserves its universal user framings, linear trajectories, and oversees the way users are transformed by technology. The approach tends to neglect inclusion/exclusion dynamics, gendered and class biases, even assuming certain purchasing power and taking for granted the possibility of (not) choosing between competing technologies.

The gendered 'user turn' in STS

In the early '70s, early socio-historical STS studies questioned the role of users in technology. From a gendered perspective, Schwartz Cowan (1976, 1987) spotlighted neglected spaces (the household), actors (users, women, mothers) and technologies (domestic appliances) to explore the effects of technological change in household dynamics and gender roles. The 'consumption junction' (1987) brought out the adoption site, consumers' agency and networks, and how they negotiate practices and meaning in ordinary technology use.

Feminist studies aimed to capture user diversity and power relations in technological development (Oudshoorn & Pinch, 2003), departing from dichotomous sides (user-producer) towards multiple perspectives in contested sites. Bringing specificity into this multiplicity defies 'default user' approaches and stresses power asymmetries in user roles: e.g., differentiating 'end users', affected downstream by innovation, 'lay end-users', excluded from expert discourses, and 'implicated actors', whereas absent but targeted by others or physically present but silenced/ignored (Casper & Clarke, 1998).

Early feminist user studies emphasized women's absence in traditional technological accounts. They contest their focus on design and production, the gendered division of labor, and how the adoption of technologies for disempowered groups relies on the acceptance by actors in power, disregarding its convenience for

end-users (Schwartz Cowan, 1987; Casper & Clarke, 1998; Maines, 2001). They also heighten neglected women roles in socio-technical change: as technology appropriators, silenced as 'implicated actors', through scholarship on neglected quotidian objects (from home appliances to reproductive technologies), or new politicized entities where user emerges as a hybrid of machine and organisms (Haraway, 1995).

Semiotic approaches: configuration and (gender) scripts

Since the 1990s, semiotic approaches have drawn attention to the ways designer's representations on users became imprinted into technological objects. Woolgar's 'user configuration' (1991) showed how designers constrain user's agency through design. Despite acknowledging power relations, this depicts expert governed one-way flows and oversees that designer's agency is also restricted by wider power dynamics.

Latour (1998) and Akrich (1992) deepen how designers define users; anticipate their interests, abilities, motivations and behaviors, 'programming' a set of (power) relations are into technologies. These 'scripts' inscribe designer's visions and delegate responsibilities to users and artifacts, defining courses of action between actors, spaces and technical objects. If users' action 'program' conflicts with the designers' program (or contrariwise), resistance or 'anti-programming' actions make take place (Akrich & Latour, 1992).

Contributions by feminist scholars elaborated on 'gender scripts', the inscription and de-scription of gender representations in technology as enabling/inhibitors of gender relations and practices, inscribing these power relations of inclusion/exclusion (van Oost, 2003). They showed that when building gender-neutral technologies ('user-as-everybody'), the designers unconsciously inscribe their own, masculine biased preferences ('I-methodology'). Masculine gender scripts limit users' choices creating unequal distribution of benefits and privileges (Rommes *et al.*, 1999; Oudshoorn *et al.,* 2004).

These frameworks envisage users as active participants, in a reciprocal object-subjects relationships. However, they were questioned for sustaining the design/use divide, preserving the innovation linearity, and by its focus on 'experts', representing users as 'disempowered' (Oudshoorn and Pinch, 2003). For instance, the notion of 'anti-program' opposed to the designers' will, fail to capture users' repertoires and sense-making (Sørensen, 2016).

The social construction of users and non-users

Social constructivism conceived users as a relevant social group shaping technology in early stages of design – even as resisters (Pinch & Bijker, 1984; Bijker, 1995). Later works on users as agents of socio-technical change reopened interpretive flexibility after closure and in users' context, defying designers' constraints. These deepened the way user's identity became transformed in use, along with social and power relations (using practices, gender roles, territories, economic structures) (Kline & Pinch, 1996; Pinch, 2003).

Deepening on choices of resistance and non-use as essential for socio-technical change, this scholarship questions the rhetoric of progress that assumes the desirability of new technology adoption (Kline, 2003; Kline & Pinch, 1996). Drawing from Bauer (1995), Wyatt's (2003) typology of 'resistant', 'rejecters', 'excluded' and 'expelled' opens the black-box of 'non-use' beyond deprivation ('non-access' or exclusion), including choices of 'passive avoidance' and active resistance as self-affirmation.

Cultural studies: consumption and domestication of technology

Focusing on the user-consumer, cultural studies (CS) addressed the role of consumption in shaping cultures and identities. With 'domestication' practices (Silverstone *et al.*, 1992; Lie & Sørensen, 1997) this approach captures the symbolic, material, and cognitive dimensions of selecting, adapting, resisting and/or integrating new technologies into daily routines (Sørensen *et al.*, 2000), transforming users, power relations and technical objects in turn (Oudshoorn & Pinch, 2003). Even when sustaining a user-producer divide, CS contests designer's epistemic authority and control over users' agency, focusing on users' spaces (home, work, leisure) as analytical loci.

They criticize IS understanding of learning as 'honing of skills', as it conceals power and conflict relations. Here 'social learning' as a mean for technology domestication becomes the basic element of sociotechnical change (Sørensen, 1996), driver and outcome of sense -making and changes in political structures (Lie & Sørensen, 1996).

Opposed to universalist understanding of users and designs, CS stress the spatiality and timeliness of using and learning practices, exploring trajectories, and how technologies are made to work (or not) when being displaced to new local contingencies. This dismantles the linear concepts of 'diffusion' as a 'passive act of adaption and adoption' (Sørensen, 1996, p. 6) and 'technology transfer', arguing the insufficiency of disembodied knowledge ('knowledge has either to be embodied – transfer of people as well as technology – and/or to be developed locally through

learning') (Sørensen, 1996, p. 6). 'Local experts' in social learning are thus essential to build competence and enthusiasm in context-sensitive implementations (Faulkner & Lie, 2007).

Acknowledging the multidimensionality of exclusion and the importance of local specificities, CS reckons that inclusion strategies require 'effective tailoring' with heterogeneous measures package, beyond 'making technology available', and awareness of the specificities of excluded groups, their needs, and how to reach them (Faulkner & Lie, 2007, p. 173).

Activist streams: Design Justice

Design Justice (DJ) brings together semiotic approaches, feminist scholarships with co-design and participative research-action approaches. As an analytical approach, it focuses on how designs manifest/reproduce/challenge the 'matrix of domination', i.e. intersecting inequalities (race, class, and gender) as interlocking systems of oppression that exclude disadvantaged populations. As a social movement, it seeks a more equitable distribution of the risks, benefits and burdens of design, meaningful participation in design decisions, and recognition of community-based design traditions, knowledge, and practices.

DJ criticizes universalist designs as they erase certain groups and the bias of 'inclusive' designs structured around a single-axis framework (race/class/gender). They explore how designs encode particular value sets and uses ('affordances'), what uses they hinder ('disaffordances'), and how they force users to alter their identity to enable access ('dysaffordances').

DJ claims for participatory design as a driver for community empowerment and an equitable distribution of benefits. This requires (a) prioritizing the voices of those affected by the design over the designers' intentions; (b) decentering 'experts' as facilitators; (c) broadening the understanding of expertise, including experiential knowledge, seeing 'designers' in people and forms of expertise mainstream theory has erased; (d) keep design collaborative and accountable, controlled by the community, aiming at 'the full inclusion of people with direct lived experience of the conditions the design team is trying to change' (Constanza Chock, 2018, p. 9-10); (e) seeking local adequacy, looking at working solutions within the community, recovering indigenous, and local knowledge and practices (Constanza Chock, 2018). DJ is thus procedural and distributive, observing inclusion as justice in the processes and results of design. This includes matters of equity, beneficiaries, values, design sites, ownership and accountability.

Systematization

Table 1 systematizes the literature review, presents its key concepts. It focuses on the phases of technological development they pivot from, the shaping of user-technology relations, their understanding of power relations, their uptake into gender perspectives, and basis for inclusion/exclusion.

Table 1. Systematization of IS and STS user theory approaches

Theoretical approach	Authors	Key concepts	Phase of technology development	User-Technology Relation	Power relations	Gender perspective	User Inclusion/ Exclusion
Innovation Studies	Lundvall	User-Producer relations	The whole process	User → Technology	No (conflict suppression)	No (universal male)	Profit from knowledge on user's needs
Innovation Studies	von Hippel (1976, 1986, 2005)	User innovation / Lead users / Democratization of technology	Iteration until design stage	User → Technology	No (conflict suppression)	No (universal male)	Profit from knowledge on user's needs due to information asymmetries
Innovation Studies	Hyysalo, Juntunen, Freeman (2013), Stewart & Hyysalo (2008)	Active / Inventive users, Intermediate users	Design and adaption	User → Technology	No (conflict suppression)	No (universal male)	Facilitate technology appropriation
Transition theory	Geels & Schot (2007), Truffer (2003), Schot, Kanger & Verbong (2016)	User-producers, user-legitimators, user-intermediaries, user-citizens, user-consumers	Niche building User-consumers in the regime	Users → Technology (transition) Technology → Users (Acknowledged, not explored)	Yes (Structural power in the regimes, agency and micropolitics in niches)	No (universal male)	Technology experimenters and niche builders

History of Technology	Schwartz Cowan (1976, 1986, 1987)	Consumption junction	In consumption/use	(1976) Technology → Users (users do not modify tech) (1987) Technology ↔ Users (users modify technology through consumption choices)	Yes (micropolitics)	Yes	Recover neglected spaces, actors, and technologies
Symbolic interactionism/ Gender studies / 'Arena analysis'	Casper & Clarke (1998)	End users (patients), and 'implicated actors'	Use and adoption	Users ↔ Technology (multiple arena-shaping)	Yes (power asymmetries, gender division of labor)	Yes	Stress diversity and power asymmetries
Actor Network Theory / Semiotic Approaches	Latour (1990) & Akrich (1992)	Programming / Scripts Anti-programming	Design Use, constrained by designers	Users ↔ Technology (co-construction)	Yes (semiotic power)	No	Power relations inscribed into material designs, Actions of resistance
Semiotic Approaches / Gender studies	van Oost (2003), Oudshoorn, Rommes & Stienstra (2004)	Gender scripts, I-Methodology, 'user-as-everybody' / 'man by default'	Design	Users ↔ Technology (co-construction)	Yes (semiotic power)	Yes (gender inscriptions, gender roles)	Gendered power relations inscribed into material designs
Social Construction of Technology	Pinch & Bijker (1984) Kline & Pinch (1996)	Users as Social Relevant Groups (1984) Users as agents of technological change (1996)	Interpretive Flexibility and Closure The whole process (especially, after closure)	Users → Technology Users ↔ Technology (co-construction)	Yes (micropolitics and semiotic power)	Partially Yes (gender roles)	Drivers of socio-technical change, questioning 'progress' as adoption
Social Construction of Technology	Sally Wyatt (2003)	Non-use(rs): resisters, rejecters, excluded, expelled. Have-nots, Want-nots.	Use and consumption	Users ↔ Technology (co-construction)	Yes (micropolitics and semiotic power)	Yes (user diversity, gender roles)	Questioning 'progress' as adoption, non-use as exclusion or self-affirmation

Cultural and media studies	Lie & Sørensen (1996), Sørensen (1996), Faulkner & Lie (2007)	Domestication, Local experts, Social learning	Consumption and use, secondarily design	Users ↔ Technology (sociotechnical change by domestication/social learning)	Yes (multi-dimensional inclusion/ exclusion, local conflict)	Yes (intersectionality)	Transformations in culture and sense-making, local appropriation
Gender studies / Semiotic studies / Co-design	Design Justice (Constanza Chock 2020)	Affordances, disaffordances y dysaffordances	Design (as iterative process)	Users ↔ Technology	Yes ('matrix of domination': patriarchy, racism, colonialism, capacitism in design)	Yes (intersectionality)	Inclusion as justice: equitable distribution of the benefits and burdens of design, equitable participation in decision-making, values accountability

Source: own elaboration (Bortz & Thomas 2022).

SHAPING USERS IN TECHNOLOGIES FOR INCLUSIVE DEVELOPMENT

In the following sections we will present a set of four TID case studies, showing how users/non-users shape/are shaped in technology development.

Case 1: Biosensor for arsenic detection in water

In 2013, an interdisciplinary group at the University of Buenos Aires intended to develop a low-cost biosensor to detect arsenic in groundwater. Being one of the main deficits of access to basic goods in Argentina, limited access to safe water is associated with chronic disease and food contamination.

An interdisciplinary 16-people group of chemistry, biology, IT, and physics researchers and students from a public university gathered to develop a project for a synthetic biology competition. The actors aimed to promote open and collaborative technological production as part of their social commitment. Based on a literature review the technologists framed the problem as the presence of arsenic in consumption water and the high exposition of Argentina's population (10%, 4 million people) to the pollutant. Built on epidemiological data, end-users were conceived abstractly and in universal terms (addressed in the interviews as 'affected population', 'the people', 'people who consume water with arsenic', 'general public' or 'people who need it'), detached from territorial context (Bortz, 2017).

Working with synthetic biology, the designers prototyped a detection kit based on the genetic modification of *E.coli* bacteria. The project was awarded the competition's gold medal. In 2014-2015 they attempted to build a second prototype, incorporating a team of industrial designers, considered key to 'start thinking about users' (interview).

Since 2014, the team attempted to build the viability of the biosensor 'outside the lab'. First, they sought funding to develop the prototype and increased its visibility through innovation awards, grants and media coverage. Second, they explored new management alternatives that may allow a scaled-up production. Third, they looked for water samples to test the prototype. This activity let some informal approaches to potential users and affected population. Here, contact with users, whether individuals (end users), municipalities, or NGOs (potential intermediate users or adopters), manifested as sporadic and informal conversations. These broadened the understanding of the researchers of the arsenic problem but did not modify the design. Gender roles related to water management (Cleaver & Hamada, 2010) did not appear into consideration.

In 2015, the core-group tried to become a start-up. This redefined the participants: many volunteers left, the group narrowed to a 3-people team led by the main researcher, an industrial designer and a biologist. In recent years, new alliances

were forged, exploring the device's potential to detect other metals in water. Despite this trajectory, even when the biosensor managed to gain visibility 'outside the laboratory', it has not been manufactured, scaled-up nor adopted by end-users nor by intermediate-users (firms, water suppliers, etc).

This case shows a TID trajectory framed under an 'inclusion as a result' approach. It emerged with a participatory discourse but remained an experts' design. The solution was framed as a specific technology fix, designed in universal terms for an undefined territory and abstract users. Users, affected population (potential 'user-consumers') or industry/governmental allies ('intermediate users', 'adopters') were not contacted until the late stages, having no influence over technological design. User-producer relations (Lundvall 1988) were hardly established, in a classic linear innovation scheme. The design was set under an 'I-methodology', configuring the 'user as everybody' (Oudshorn, Rommes and Srienstra 2004). The project overlooked the socio-technical complexities and conflicts of the water access, from governance and regulation to exclusion questionings (e.g., in case the device detects arsenic, what would be user's accessibility to alternative water solutions, do they knowingly remain drinking polluted water?). The biosensor was also detached from processes and organizations that could lead to its ultimate production, distribution, adoption, and use.

Case 2: Chagas Molecular Diagnostic

In 2011, a public-private consortia developed a Real-Time PCR kit to detect the parasite *Trypanosoma cruzi*, etiologic agent of Chagas disease (Bortz & Thomas, 2019). Considered a symbol of structural poverty, Argentina presents the highest Chagas infection rate worldwide: over 1.5 million people, representing 3.65% of its population. New cases emerge annually by vector transmission and mother-child transmission. In recent decades, while biological R&D efforts in the disease increased, public health actions and institutions (prevention, vector control, epidemiological statistics) were weakened (Zabala, 2010; Ministry of Health, n.d.).

The Sectoral Technology Innovation Fund made a call for competitive grants. Framed under an innovation systems approach, the instrument aimed to foster public-private partnerships for R&D on priority socio-productive issues, overcoming the restrictions of science-push linear technology development (cf. Case 1).

The partnership gathered three relevant actors: (a) the main public R&D laboratory specialized in Chagas molecular diagnostics, (b) the lead diagnostic kit manufacturing company, and (c) a public health institute dependent from the Ministry of Health in charge of the national guidelines and validations for Chagas control. The inclusion of the latter became essential for project development: being inserted within

the Ministry of Health allowed recruiting key actors in several maternity wards in endemic areas to conduct an extensive validation study, quality control and patient follow-up. It also permitted to gather blood samples required to validate a diagnostic kit (Bortz & Thomas, 2019).

The inclusion of the public health institute as a project sponsor blurred the user-producer divide, playing multiple roles: as 'lead user' (von Hippel, 1986), 'intermediate user' (Truffer 2003), as a 'user legitimator' (Schot *et al.*, 2016), but also as a 'user regulator' (fixing national standards) and 'network builder', gatekeeper of a territorially embedded new user network. Maternity ward representatives also became 'intermediate users', with low decision-making level (mainly, clinical data collection and processing) but integrated into the Congenital Chagas Disease Study Group. The focus the local setting where congenital transmission takes place was included, coming to the birth-givers to breach data gaps, build local adequacy and provide follow-up treatment. The patients/mothers (end-users) are 'implicated actors', targeted but absent from the accounts (Casper & Clarke, 1998).

The kit was finally approved in 2020 and became available in 2021. Collaboration between the three parties in user-producer relations (Lundvall, 1988) seems to endure, also with the aligned maternity wards (Benatar *et al.,* 2021) and mutated into a recently approved technology transfer project to be implemented in maternities and public health units (WHO-TDR, 2021).

This case shows a TID trajectory framed under an 'inclusion as a result' approach. Two main technologies are at stake: the diagnostic kit, initially framed as a technology fix for Chagas transmission, and the policy instrument, also implemented as a technology fix. Both initiatives overlooked the social and technical complexities of the structural problems they are inserted into (poverty, endemic Chagas, lack of access to healthcare on one end, the structural decoupling of scholar production and socio-productive needs on the other). In recent years, it shifted its focus towards a more territorially grounded initiative, including intermediate locally grounded users, as key inputs to improve the product, its adoption and implementation.

Case 3: Probiotic School Yoghurt 'Yogurito'

The 'Yogurito Escolar' is a probiotic yoghurt designed to prevent respiratory and gastrointestinal diseases caused by malnourishment by enhancing the immune system. It was developed by a public R&D institute in Tucuman province, the Reference Centre for Lactobacilli (CERELA), with governmental agencies and local producers.

In 2001, a deep socio-economic crisis shook Argentina, driving 50% of the population under poverty, reaching over 60% of households in Tucuman. CERELA

researchers developed a probiotic product for children with unmet nutritional needs. In 2004, they took the idea to a regional multi-actor participatory workshop arranged by the national STI Secretariat, which gathered scientists, local producers, NGOs, and policymakers. In subsequent conversations the idea turned into a first draft for developing a probiotic yoghurt for malnourished children.

By 2006, the CERELA completed the in-lab product set up. Assessing the probiotic effects on children's immune system required conducting a clinical study. This urge to get the product 'out of the laboratory' led to engaging the Ministry of Social Development (MSD) as 'local expert' (Sørensen, 1996) and 'intermediate user' (Truffer, 2003). The implementation in 2007-2008 of a double-blind trial with 298 children in community kitchens in peri-urban Tucuman involved a user-producer interaction (Lundvall, 1988) by an over 150-people team led by CERELA researchers. Local experts were engaged (Sørensen, 1996), from MSD officers, nutritionists, community-kitchen staff, social workers, dairy manufacturers, to physicians. The latter discussed the initiative with parents (intermediate users) and surveyed children's health, monitoring the results of probiotic intake. The trial also allowed surveying children's (end users, user-consumers) social and sanitary living conditions and adjusting the yoghurt to their taste preferences. This joint work initiated a locally embedded social learning process (Lie & Sørensen, 1996).

The clinical trial's results in terms of strengthening children's immune system gained public resonance through regional media coverage. In 2008, the MSD adopted the 'Yogurito' as the central feature of a provincial social policy. They agreed with CERELA to mass produce it and deliver it triweekly to children in public elementary schools. In the same movement, the MSD became Yogurito's co-designer and implementer (mostly, in its organizational strategy), sponsor, and 'user-purchaser'.

While addressing nutritional and health deficiencies, the program designed a local development strategy to recover an impoverished provincial dairy chain. To design and scale up the program, the MSD brought together small/medium local dairy farmers to produce the yoghurt and sell it to MSD, and Education, Health and Productive Development Ministries (intermediate users) to coordinate the implementation of the Probiotic Program. The project required boosting productive infrastructure for a mass production. The distribution started with 56.000 children in 2008, reaching 200,000 in 2010. The implementation required creating the conditions for the project's adequacy by coordinating with other intermediate users, such as teachers and school principals to deliver it at school, and physicians in primary healthcare centres.

These exchanges, built upon the participation and problem-solving interaction developed during the clinical study (2007-2008), led to a multi-actor local

management board as a user-producer space for action coordination (Lundvall, 1988). This allowed designing and adjusting the technology and its policy implementation based on a wide understanding of local expertise (Lie & Sørensen, 1996; Constanza Chock, 2020). This involved negotiation between different actors, expertise and interests to build the project's on-site working: scientists (R&D), MSD (policy praxis and logistics), farmers and manufacturer (dairy production and distribution), Ministry of Productive Development (livestock policies), Health, and Education (educational skills). The latter channelled the voices and conflicts of on-site education and healthcare workers (intermediate users), and even children (users-consumers), adjusting the product to their preferences. These adjustments were based in a continuous monitoring of effective users and their practices, preferences, objections and needs.

The local management board deepened and stabilized interactive social learning. These problem-solving dynamics gradually improved the product, processes, and the organisational scheme (Lundvall, 1988). This allowed locally grounded adequacy, building its working amidst interpretive flexibility (Kline & Pinch, 1996), scaling-up the program, diversifying the probiotic portfolio to reach isolated provincial areas, accumulating new local techno-productive capacities (Lundvall, 1988) and promoting its domestication. In the interaction, participants were shifted from their background expertise(s) and challenged into developing new skills through social learning (Sørensen, 1996; Constanza Chock, 2020).

As a result, the Health and Social Development ministries identified improvements in children's health; the Education ministry emphasized better school attendance and performance. Concurrently, for Tucuman's dairy farmers the program prompted the valorisation of the provincial dairy sector, in crisis since the 1990s due to economic deregulation and land concentration. Since 2006, sectorial actors had self-mobilized to gather atomized farmers and promote recovery activities, leading to the creation of the Dairy Board of Tucuman. In 2008, the beginning of 'Yogurito' required large-scaled coordinated provision milk, encouraging the creation of the Dairy Farmers Association (APROLECHE), which became part of Yogurito's coordination team.

In subsequent years, the farmers' identity was shaped by Yogurito's development (Kline & Pinch, 1996), being reinforced as a collective actor geared by the growing state demand to implement the Probiotic Program. This was not only achieved through their milk provision but under an organizational scheme where they coordinated the production, from raw material to value-added finished product. This capacity building dynamic stimulated the creation of Tucuman's Dairy Technological Hub in 2011 (running to this date), shaping the dairy farmers collective identity and

growing influence in decision-making. This also marked their transformation from milk farmers to Yogurito's co-designers and key users of the Yogurito's public-policy, all at once.

The 'Yogurito' emerged as an 'inclusion as a result' approach: delivering a technology fix to solve (structural) malnutrition problems. Children were initially conceived as abstract 'user-consumers'. The challenges to implement the device 'in the field' gradually turned the project into an 'inclusion as a process' initiative, stirring local development process, social learning and the self-mobilization of neglected groups. This shift was led by the alignment of heterogeneous actors (scientists, ministries, farmers, manufacturers, teachers, children, physicians), local experts (Sørensen, 1996) to build the local adequacy of Yogurito and the social policy. Being a mostly women-led initiative, Yogurito shows strong 'care' inscriptions, shaping its patterns of use and access, such as the focus on children, families, and household dynamics[2] (Akrich, 1992; Oudshoorn *et al.*, 2004; Schwartz Cowan, 1976).

Children and families (user-consumers), and community kitchen staff and teachers (intermediate users) were included in early stages but in a subordinate role. However, design and implementation of Yogurito as a public policy, allowed broadening other user's governance in technology development and a reconfiguration of the user/producer divide, into 'user-producers' (Schot *et al.*, 2016) or even 'co-designers' (Constanza Chock, 2018) (e.g., MDS and dairy farmers). This fluidity favored both artifact and policy to be continuously shaped by their on-site 'users' and local experts, framing problems and experimenting with solutions from early stages. This participation and role fluidness emerged as a practical response to territorially grounded implementation challenges, transforming actors' identities in turn. The continuity of the project since 2003 enabled enduring learning trajectories that lead to further associative projects between the parties involved.

Case 4: Recycling Cooperative 'Recycling Dreams'

The Recycling Dreams Cooperative emerged in 2003 in La Matanza district, the most populated district of peri-urban Buenos Aires, during the 2001 Argentinean crisis reached 40% unemployment rates (INDEC, 2017; Carenzo, 2017). A group of social movement leaders with a metalwork background started to organize the growing population of waste-pickers in the area, recently unemployed males that collected recyclables from street garbage to make a living (*cartoneros*, collectors of cardboard

[2] Sanbonmatsu (2017) and Blaxill and Beelen (2016) show that women are more likely to make bills dealing with women's issues and children and family issues a priority.

material). Gathering as a cooperative allowed them to improve their income through large-volume sale to improve prices (Carenzo, 2014).

The cooperative stimulated the development of socially just waste management, through collaboration between waste-pickers and waste producers. This has materialized in the innovative project 'Recycling garbage, recovering jobs' (2006-2011) in middle-class neighborhoods, encouraging household recyclable sorting.

However, one of the cooperative's most striking features is their ability to design, build and systematize machinery, tools and processes that allowed its economic viability, processing recovered and classified materials to market them as value-added inputs for manufacturing processes. Cooperative work allowed upgrading their activity through material experimentation and developing an indigenous classification technology. This not only allowed improving their skills to manage materials with a preexisting market but also creating new markets for elusive materials, pushing the limits of their capacities (Carenzo, 2017).

This everyday grassroots experimentation by actors without any formal education was detached from scientific categories, tinkering with materials through sensory deployment. Knowledge was socialized collectively, through oral records of the shared work experience. Cooperative leader's background on metalworking and activism imprinted into technology experimentation and development male-gender script (Akrich, 1992; van Oost, 2003), differentiations between man and women roles and organizational leadership (Kline & Pinch, 1996).

Through trial-error prototyping, a second set of technologies were developed, to press, grind, dry and wash plastic and cardboard, reusing objects recovered from the street. Subsequent improved press models allowed reducing the volume of the classified material. This had economic advantages: cutting-down operational costs and better selling terms. But above all granted a sense of 'professionalization', an understanding of waste-picking as 'work' (no longer a last resort precarious occupation), and their self-affirmation as '*cartonero* workers' (Kline & Pinch 1996). These designs contributed to their political struggle for their activity to be recognized not as 'informal work' but as a socio-environmental 'public service' (Constanza Chock, 2020), within a broader effort made since 2003 by the Latin American Network of Waste Pickers (LACRE Network) (Carenzo, 2014).

The cooperative's technological developments, with a strong *cartonero*-identity affordance imprint, gained regional scale through Red LACRE. The cooperative was granted as 'innovators' with a basic waste-picking technology kit (mill, washer, dryer and press). This involved revising the prototypes, systematizing them through drawings and renders in interaction with engineers and industrial

designers, to make them available to other organizations through open licensing (Carenzo & Schmukler, 2017).

This case shows a grassroots trajectory of 'inclusion as a process'. Recycling Dreams became a regional reference in the waste management realm, as expert actors in the sustainable management and treatment of industrial waste (Carenzo & Schmukler, 2017). The organization defies expert/inexpert and user/producer silos with grassroots 'expert' knowledge that promotes collaboration, collective socialization and co-design. Categories such as 'lead users' (von Hippel, 1986), 'inventive users' (Hyysalo *et al.*, 2013), 'user-producers' or 'users-citizens' (Schot *et al.*, 2016) fall short: it tears apart the user/producer binary, being design imbricated in cooperative's everyday practice of undivided design-fabrication-use-adjustment and political struggle. The cooperative resists the idea of being 'users' of exogenous generated technologies, reinforcing their 'making' and developing bottom-up technology as part as a collective action repertoire that politicize technological design as (at first) practices of resistance or (later) self-affirmation (Carenzo & Schmukler, 2017; Constanza-Chock, 2020).

DISCUSSION

A typology of user approaches based on inclusion/exclusion

Literature review and the empirical cases follow a progression in addressing the user(s)-technolog(ies) relationship through an inclusion/exclusion lens that allowed to identify five types. We stylize below which type of users are framed by theory, their analytical contributions and omissions (summarized in Table 2). Underlying these types is an understanding of the problem of user participation, and how these theories abide/encourage their 'ability to influence techno-cognitive decision making' (Bortz & Thomas, 2017).

Type 1: *Universal users-consumers*. The pioneering IS opened the user agenda, with a central concern to create market advantages through user's input, focusing on their needs and skills. Although different user roles are recognized ('lead', 'intermediaries', 'active', etc.), they are ultimately seen as consumers, sustaining the user/producer divide. These approaches configure unidirectional knowledge flows where users mold technology but not the other way around. These approaches suppress conflict, building universal users (in terms of time, place, gender, income) and neutral

technologies. It assumes a user with (economic, symbolic, cognitive) resources and options to experiment and choose between alternatives for technological change[3].

Transitions theory also falls into Type 1, though some works under this framing included niche' micropolitics (Seyfang & Smith, 2007; Smith *et al.*, 2010) and structural views on power in the regime. This approach does include an understanding of economic accumulation trajectories and a problem-solving view towards an environmental concern that other IS precludes.

Type 2: *Diversity of users-consumers.* These are the pioneering socio-historical studies, drawing from a gender critique. Despite their linearity (sustaining the user/producer divide, users persisting as consumers at the end of the innovation process), these studies brought to light the mutual shaping between users and technologies. They identify micro-power dynamics (power asymmetries, gendered division of labor) in specific domains. Even when they did not address broader power configurations, they introduced the focus on user diversities and specificities, users' spatiality (the home, work, medical consultation), and a first understanding of exclusions within user theory. The 'gender' variable remains unidimensional, disentangled from other exclusion forms.

Type 3: *(In)scripted-(de)scripted users*. Drawing from semiotic and gender perspectives, these studies pioneered the co-construction of users and technologies. Here the visions of the designers are inscribed into the artifact's design, shaping users' actions, which can either abide the scripts or resist them. Here 'users' agency starts taking on more fully, beyond the 'consumer' role. Power comes at the forefront as micro level inscriptions and translation. However, it overlooks the dynamics of economic accumulation, a theoretical bias that is transferred to its case studies. Gender is also inscribed into artifacts, usually as a one-dimensional variable, dissociated from other exclusions. This approach recovers the option of 'resistance'. However, 'de-scription' and 'anti-programming' concepts focus on the designer's gaze, who retains the power in a user/producer binary conception. Although the notions of 'inscription' dismiss the neutrality of the technologies, linearity persists, positioning the analysis at the beginning of the process, the rest being a consequence of the 'design'.

Type 4: *Localized adequacy-building users*. Drawing from social constructivist studies, this type tended towards a full understanding of the co-construction and mutual shaping of users and technologies. Gender is progressively incorporated as a driver

[3] Even in the case of transition towards sustainability theory, while those who suffer most from the environmental crisis are the intersectionally excluded population (Hardoy & Pandiella, 2009; Hoffman, 2021), many environmental solutions – from electric cars to house solar panels – are built as 'exclusive'.

to see broader inclusion/exclusion processes (though in a unidimensional way), changing identities and roles. Power is incorporated both in agency (micropolitics) and structure (semiotic power). Users get involved in technology-making as adequacy builders, exploring these adaptations in specific user-sites, but not as producers from early stages of technological development. Thus, the user/producer binary divide persists. These approaches allow deconstructing the uniqueness of the artifacts, through interpretive flexibility and meaning attributions that occur during use. However, the identity of the artifacts remains constant as the material framing, set by the designers, remains stable.

Type 5: *Situated conflict-embedded users*. This last type gathers the contributions by Cultural Studies and Design Justice approaches, acknowledging their diversities. They converge in the co-construction of user and technologies, emphasizing the multidimensionality of inclusion/exclusion processes, local specificities and conflicts. These approaches emphasize the intersectionality of exclusion, converging gender, class, ethnicity, geography, (dis)abilities dimensions, among others. This type tears apart user-technology universality, whereas centering on their specificities (CS) or advocating for their early inclusion in the design (DJ). While CS holds the user/producer divide, from its trans-feminist origins DJ abolishes this binarity as an enduring asymmetric decision-making process. When 'users' or 'affected people' become present in early design phases, they cease to be 'users' and become 'co-designers', in egalitarian processes of technological development.

Cultural studies remain more subjectivist than objectivist and more symbolic than artefactual, seeing disputes in meaning attribution, but not tackling the material basis of affirmations and sanctions. This material base of punishments and rewards is precisely what Design Justice aims to transform, one artifact at a time. At this point, Design Justice remains as a micro, focal approach, whose scalability is given by activism and expanding their network, but how can it 'transition' from its 'niche' to become a counter-hegemonic alternative?

Table 2. Typology of user approaches under an inclusion/exclusion lens

Type	Approaches	Role of users	Knowledge flows	Deterministic residues/	Governance	Inclusion/Exclusion approach
1. Universal users-consumers	Innovation Studies incl. Transition Theories and Inclusive Innovation ('as a result')	Users-consumers. Sustains user/producer divide.	Unidirectional. User → Technology	Universal users Neutral technologies Linearity (users at the end of the process)	Users as inputs to maximize technology adoption and profit. Process is governed by the designers.	Conflict suppression. Assumes users with resources and capacity to choose. Incl. Innovation: non-problematized unidimensional exclusion (income-based).
2. Diversity of users-consumers	Socio-historical S&T + gender studies	Users-consumers. Sustains user/producer divide.	Incipient mutual shaping of users and technologies. Technology → User	Specific users, user diversity. Linearity (users at the end of the process).	Users reveal patterns of (gender-based) exclusion. Process governed by the designers. Users' agency restricted to consumption.	Micropower dynamics. Unidimensional exclusion (gender based).
3. (In)scripted-(de)scripted users	Semiotic approaches + gender studies	Users-consumers. Sustains user/producer divide.	Pioneer the mutual shaping of users and technologies.	'Inscriptions' dismiss technology neutrality. Linearity (users at the end of the process).	Microlevel inscriptions and descriptions. Governance lies in the designer's gaze. User's agency allows abidance/resistance.	Scarce attention to exclusion. Unidimensional exclusion in semiotic gender studies.
4. Localized adequacy-building users	Social constructivist studies	Users as agents of socio-technical change. Sustains user/producer divide, users as adequacy builders.	Co-construction of users and technology.	Deconstruction of artifacts through interpretive flexibility. Linearity (users as adaptors at the end of the process).	Material framing set by the designers. Users adapt and resignify technologies.	Unidimensional exclusion (gender based). Power in mutual shaping of agency (micropolitics) and structure (semiotic power).

5. Situated conflict-embedded users	Cultural Studies Design Justice	CS: Sustains user/producer divide. DJ: abolishes binarity (users as producers)	Co-construction of users and technology.	Situated users and technologies. CS: users as symbolic world-makers. DJ: users as material world-makers.	CS: governance over social learning (full governance in a late stage). DJ: co-design (full governance since an early stage).	Intersectionality in inclusion/exclusion processes. Acknowledgment of local specificities and conflicts.

Source: own elaboration (Bortz & Thomas 2022).

Implications for inclusion/exclusion dynamics

Empirical analysis showed that none of the user theory approaches as a closed package allowed a deeper understanding on user-technology relations in TID: how they work, who benefits, to what extent they brought inclusive outcomes, enhanced participation, or perpetuated asymmetries and inequalities. The empirical analysis required triangulating multiple analytical tools, simultaneously putting in tension preexisting closed categories. From the review and application of these categories for TID analysis, a set of theoretical-methodological considerations emerge:

a) Market economy inscriptions in user theory and practice

Passive 'end-of-pipe' user-consumers, dissociated from the production, result from the co-construction between economic theory and the capitalist socio-productive model. In historical terms, the user/producer divide began with the trades and consolidated with capitalism and market economy. Since the '1970s, IS's concern on users emerged from the need to build competitive advantages in firms (Schumpeter, 2017 [1934]; von Hippel, 1976). The origins of user theories fall on the producer's side: i.e., the user as an input, resourcing to their knowledge and needs to inform design-production-commercialization processes to maximize profit.

'Inclusive innovation' initiatives focused on accessible goods or technology fixes for lower-income sectors ('inclusion as a result' framing), participates in this vision. Observing their 'inclusive' outcomes, distributive effects (in terms of knowledge, extended governance, use, transformation of innovation trajectories, etc.) remain unchanged: in structural poverty situations it is hard to affirm that gaining access to one specific good (a cell phone, a solar panel, a home appliance) implies an 'inclusive' gain for the intended user-consumers. However, there is a greater pattern of accumulation by the companies that supply goods for the 'bottom of the pyramid' (Prahalad, 2010; Kaplinsky, 2011).

The cases showed the limitations of these inscriptions in TID design. In Case 1 (arsenic biosensor), the product was not manufactured nor used by their intended, undefined and abstractly built users. Case 2 (Chagas kit) included users-intermediaries and users-legitimators in technology design, improving the kit and its field implementation. However, local 'brokers' were involved in a subordinate role (as informants, data collectors and processors). This intervention persists as a technology-fix facing intersectional and structural inequality (gender, poverty, geographic, ethnic). Yet, the excluded populations (women, in childbirth/puerperium situation, with scarce access to health services), remained absent and these broader inequalities remain unaddressed.

b) Determinist inscriptions in user theory and practice

In the user/producer demarcation, the inscriptions of the determinist science-push innovation model persist: linearity, including users at the end of the process, the neutrality of the artifacts, and their universality. The theoretical review showed the persistence of neutrality in Types 1-2 (overthrown by semiotic studies), of universality in Types 1-3 (deposed by constructivist and Type 5 approaches) and linearity in Types 1 to 4 (with end-of-pipe users).

Cases 1 and 2 showed the inadequacy of linear, neutralist and universalist premises for TID design, as they end up not being manufactured or adopted, perpetuating exclusion patterns. Case 3 (Yogurito) showed a transition of a TID project, from a deterministic conception (linear, neutral, universalist) towards non-linear models of design and implementation, including broad users and local expertise. As users increase their influence in decision-making, becoming 'co-designers', user/producer dichotomies are dissolved. Case 4 (Recycling Dreams) overthrew linear assumptions, building iterative, highly contextualized, and political technological development processes.

c) Binary endurance

Types 1 to 5 show the cognitive exploration of the B-sides of capitalist production, its material and symbolic consequences and interconnected exclusions, and 40 years of new concepts to address them. The literature showed the persistence of the user/producer dichotomy, a linear residue that persists as an external and pre-given categories derived from a 'residual realism' (Chilvers & Kearnes, 2020), difficult to fit into TID empirical trajectories. As the cases moved away from linear market-oriented innovation dynamics towards collaborative/co-design dynamics, with more 'fluid' user identities (Cases 1 to 4), these fixed categories became inadequate. In other words, in the transition from 'inclusion as a result' to 'inclusion as process' cases, the user/producer artificial divide –and its derived analytical categories- became diluted. TID analysis challenges this 'modern' dichotomy and demands new 'non-modern' analytical tools (Latour 1991), to capture multiple, diverse, and changing identities, which are 'users', 'producers', 'activists', 'citizen builders' – and many more – all at once.

d) Review of 'experts' categories

The progressive questioning of the user/producer divide in Cases 1 to 4 and Types 1 to 5, also enquires on the notion of 'expert' in standard linear terms (scientists, technicians, designers, people with higher education). Cases 3 and 4 and Types 4 and 5 showed the importance of including actors with diverse sources of expertise and knowledge negotiation skills. Case 4 (Recycling Dreams) and Type 5 (especially DJ), show how these knowledge negotiations occur in asymmetric power situations, reinforced by pre-existing material bases that distribute rewards and punishments.

In these negotiations, governance over problem-solving is at stake. While in Types 1 to 3 users are absent from problem-solving dynamics, in Type 4 they come in later stages (framing new concerns over use, adapting existing technologies), in Type 5 DJ users/affected actors are key. In Cases 1 and 2, user-beneficiaries were absent; in Case 3 they were progressively included (children in a subordinate way, the MDS and the farmers as co-designers). In Case 4, the expertise was co-built with the needs of its 'users' and their productive capacities.

Returning to our initial definition of participation, this endowment assigns asymmetric capacities to influence techno-cognitive decision-making, which requires the deployment of counter-hegemonic actions by excluded groups (from resistance to creating new models for the design-production-distribution of goods and services, as shown in Cases 3 and 4).

e) Artefact centrality

User theory (Types 1 to 5) focused mostly on products, disregarding services (maybe the Internet is the exception), processes or organizational technologies. Literature review conducted under the light of TID cases shows the need to open user analysis not only to products (consumer goods), but also to production machinery, processes and systems, public services, organization technologies and even public policies. In Case 3 these were critical issues to build the situated working of the Yogurito and the socio-productive policies that sustained it. Case 4 showed that 'inclusion as a process' initiatives, through territorially embedded social learning, which allow to transform identities and reverse socio-economic power asymmetries, requires a more detailed account on machinery, productive processes and systems.

f) One-dimensional exclusion/inclusion

Type 1-user theories do not account for any exclusion form. This bias extends to 'inclusive innovation' initiatives derived from this type, framing exclusion by reifying

poverty on a unidimensional income basis (Kaplinsky, 2011; Foster & Heeks, 2013; Chataway *et al*., 2014). This minimizes/neglects conflict and sustains the *status quo*. It expects to achieve the 'inclusion' of end-users through access to goods by the same system and rules that excluded them in the first place while, simultaneously, benefiting accumulation dynamics in firms.

Types 2 to 4 showed exclusions in a one-dimensional manner, either by gender (Schwartz Cowan, 1976; van Oost, 2003; Oudshoorn *et al*., 2004) or by access ('have-nots', Wyatt, 2003). However, TID Cases 1 to 4 show the structural intersection of exclusion dynamics, not only in income/access to goods, but also to life-enabling services, cognitive asymmetries, gender, ethnic-racial and geographic factors. While Type 5 includes an intersectional approach to exclusion dynamics (and consequent inclusion challenges), its counter-hegemonic action remains oriented towards including users one artifact at a time, not addressing the socio-technical ensemble as a whole, towards a systemic transformation.

More broadly, Types 2 to 5, show a progression on the exclusion critique (e.g., reporting passivized or victimized users, biased 'universal' users/technologies, exclusions and resistances). This allows reviewing the accumulation of power. It is not only about the exclusion/non-participation of 'the poor' or 'women and diversities', but about also the condition of passive consumer/alienated user of the middle sectors. Therefore, the user agenda 'for inclusion' is not only a problem of the 'excluded' or 'developing countries'; it becomes a questioning on our 'socio-technical citizenships' as a whole.

At this point, while Type 1 approaches tend towards a *status quo*, the progression to Type 5 leans to counter-hegemonic proposals. Their scaling-up may change the forms of design-production-use. The critical review of Types 1 to 5 and of Cases 1 to 4, account for these overlapping exclusions and conflict arenas as well as incremental processes of expansion of socio-technical rights and participation in decision-making.

CONCLUSION

This work and its literature review was motivated by the theoretical constraints we faced while analyzing user(s)-producer(s)-technologie(s) relations in TID cases (Thomas & Bortz, 2017; 2019; Thomas *et al.*, 2017). As users/producers of theory we explored the 'inscriptions' (Akrich, 1992) in user theories as analytical devices through an inclusion/exclusion lens. We aimed to understand the relation between approaches to user involvement, inclusion framings (as a result or as a process), and

their 'inclusive' outcomes (as access to specific consumption, or as broadening rights, governance and more equitable distribution of the benefits of innovation).

This allowed stylizing five user theory types, ranging from passivized users – as inputs to the innovation process-, identifying neglects and recovering user's agency, from its symbolic attribution to the co-design of the material bases that shape their living. As we approach these last types, user/producer dichotomies derived from 'modern' (Latour, 1991) deterministic and market-oriented residues becomes diluted. This expands the understanding of expertise, emphasizing knowledge negotiation and social learning. In reflexive turn, the mutual nurturing between TID literature and case studies, user theories and intersectional gender studies that lead to the five user theory types also helped broadening our original dichotomous distinction of inclusion framings (as a result/as a process), towards an augmented, multidimensional understanding of user inclusion/exclusion. There is a need to advance further on analytical perspectives that may capture new multi-stakeholder, multi-role, pluri-cognitive units of analysis.

User theory showed a profuse development both in the understanding of 'users as inputs' (Type 1) and in the criticism of successive exclusions and subordinate counter-hegemonic actions (Type 2 to 5). However, this leads to only partial or isolated solutions facing a structural problem: critical works that address privileged consumers and hegemony building through production and use are scarce. Todays' great global challenges (from the climate crisis, ecosystem degradation to the COVID-19 pandemic) show the need for a complete and systemic transformation of design-production-use circuits. The theoretical overcoming of 'modern' dichotomies, also in this matter, is crucial to improve our socio-technical rights, getting involved in the material bases of affirmations and sanctions that shape our viable/non-viable livelihoods and sustainable/non-sustainable development paths.

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Cultivating the Innovative Region Participatory Innovation, Citizens and Statehood in Wallonia[1]

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ABSTRACT

Innovation is becoming more and more participatory. Discourses insisting on the desirable involvement of users and lay citizens in innovation-making processes are burgeoning around the globe. This burgeoning is often fostered and supported by innovation scholars whose studies on, and calls for more open and participatory forms of innovation have recently gained traction among public authorities. However, as the appropriation of such scholarly work by public authorities is a recent phenomenon, much remains to be discovered about the interactions between participatory innovation models and the political contexts in which they emerge. In particular, this article offers an analysis of the relationships and allocation of power between the State and citizens that develop through participatory innovation policies. By developing a context-sensitive approach to study the case of Wallonia, one of the federal regions of Belgium, I analyze participatory innovation as a particular mode of government through which public authorities (re)invent themselves and the society they govern. I show that what matters for Walloon public authorities when they promote and set up participatory innovation practices is not only the results of such practices in terms of innovation products, but also and perhaps more importantly the shaping of entrepreneurial citizens as well as the Region that is expected to develop accordingly. Ultimately, this approach allows for critical scrutiny of the politics of innovation and the democratic order it contributes to produce in an economically peripheral region looking for quickly (re)developing itself in order to exist in the global economic competition.

Keywords: Participatory Innovation; Innovation Policies; Public Participation in Science, Technology and Innovation; Regional Innovation; Wallonia.

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INTRODUCTION

1933. In the midst of the Great Depression, the Chicago World Fair showcased a utopian future made of bright technologies and driven by innovation. The motto of this World Fair was as follows: "Science Finds, Industry Applies, Man Adapts". This motto synthetized a widely shared conception of innovation: a linear process which implies a restricted number of actors and which leaves the major part of society (hereby called 'Man') no other role but to adapt itself to technological development. For a long time, this vision gradually evolved through the emergence of different innovation models that insisted on the multiple interactions between academia and industry, as well as on the role of the State in fostering these interactions. However, the basic assumption that innovation-making involved a restricted number of actors, leaving society at bay, remained influential for a long time.

At the beginning of the 21st century, a range of new approaches opposed to this vision of society as exterior to innovation-making process. These approaches instead portrayed innovation as an "open" (Chesbrough, 2003), "distributed" (Lakhani & Panetta, 2007), "democratized" (von Hippel, 2005), or "participatory" (Buur & Matthews, 2008) process. At the turn of the 2010's, these approaches developed and gained traction as part of what was then described as an alternative discourse challenging the monolithic conception of innovation policies based on centralized innovation (Joly *et al.*, 2010). Indeed, their common ground, and what makes them departing from the 1933 World Fair's motto, is that innovation-making does not solely concern science and industry anymore, but now also involves actors outside of these spheres, such as consumers, end-users, or lay citizens.

Beyond scholarly work, these approaches were progressively taken up by public authorities and incorporated into public policies. The fact that these new forms of innovation today are far from being confined to a status of alternative to dominant innovation policies but are increasingly taken up and promoted at the political level (Macq *et al.*, 2020) calls for analyzes that critically unpack the endorsement of participatory forms of innovation by public authorities. In existing literature, terms such as 'open' innovation, together with 'social', 'responsible' or 'sustainable' innovation, has been grouped under the umbrella term of "X-Innovation", whose emergence is described as challenging "the hegemonic connotation of technological innovation" (Gaglio *et al.*, 2019). The recognition of the "active role of the user in co-production" is often seen as a means of broadening the invocation of innovation to non-economic purposes (Alcaud & Brillet, 2007). The opening of innovation processes to other actors is indeed supposed to be linked to an improvement in the quality of the decision-making process and the social robustness of innovative products (Bacqué *et al.*, 2005; Callon *et al.*, 2009). However, much is still to be discovered about

what drives public authorities in promoting and sponsoring forms of participatory innovation, and how the latter unfold when publicly-driven. In particular, this article offers an analysis of the relationships and allocation of power between the State and citizens that develop through participatory innovation policies. The main questions it tackles are as follows: why and how did participatory forms of innovation become fashionable as to get incorporated into state innovation policies? And what does it tell us about (re)configurations of the relationships between the State and citizens through innovation policies?

By focusing on a polity in which participatory innovation was integrated as a key component of economic and innovation policies (Wallonia, Belgium), I develop an analysis of participatory innovation as a particular mode of government through which public authorities (re)invent themselves and the society they govern. As I show, Wallonia promoted and enacted participatory innovation as both a tool and a goal in itself: this particular form of innovation has been seen as a way to both redevelop its economy – by turning it into a 'creative' one – and to construct the region's identity as a political space – by portraying it as innovative. In this framework, citizens were conceived as a resource to cultivate: because they became perceived as important providers of creative ideas that can be turned into innovative products and services, their creative and innovative mindset was to be nurtured. Public authorities therefore switched their traditional role in innovation policies to one of making the Walloon creative citizen emerge and putting him/her in the adequate conditions to realize its innovative potential.

In the following sections, I start by describing the approach to participatory innovation that guided this research. Then, I further introduce the case and the methods I used for collecting and analyzing the empirical material. In the empirical section, I locate participatory innovation policies in the broader history of innovation policies in Wallonia before zooming in into the specific conception of participatory innovation that was inscribed in regional policies. To look at how policies as associated visions of participatory innovation further evolved, I focus on the setting up of *Creative Hubs* as key sites of the enactment of participatory innovation in the region. Then, I engage in a discussion around two main points. The first relates to the critical analysis that can be developed by unpacking the links between participatory innovation, citizens and the State, while the second is related to the specificity and comparability of Wallonia as a particular context. Finally, I come back the main lessons of this article in the conclusion.

A CONTEXT-SENSITIVE APPROACH TO THE CO-PRODUCTION OF PARTICIPATORY INNOVATION AND STATEHOOD

STS scholarship has a long history of analyzing public participation in science and technology-related matters. Part of this literature insisted on the need to connect participatory processes to the political machine at large, in order to make sense of them in a wider context (Felt & Fochler, 2010; Jasanoff, 2011; Laurent, 2016; Lezaun *et al.*, 2017). These works highlighted the crucial importance of the questions of why participation is considered desirable, which publics is it expected to involve, what the object of participation is and how participation is organized (Delvenne & Macq, 2020; Macq *et al.*, 2020). Recent publications showed that participatory innovation practices are increasingly endorsed by public authorities as means for pursuing different objectives: (re)developing their economies and/or energy systems (Pallesen & Jacobsen, 2021), (re)shaping the way they govern through experiments (Tironi & Valderrama, 2021), or (re)configuring citizens' engagement with culture (Spronck *et al.*, 2021). In the same vein, Delvenne and Macq (2020) showed that participatory experiments are often organized as intense events seeking to extract as much value as possible from participants. Engels *et al.* (2019) noted that specific participatory experiments – test beds – are enacted to test and re-configure society on a local scale around a new set of technologies, envisioned futures, and associated modes of governance. These analyses provide precious insights on how different objectives shape participatory settings in specific ways.

However, this emerging literature tends to focus on *ad hoc* experiences of participation in innovation, with limited explicit link to how these experiences fit into wider coordinated policy programs and related conceptions of the role of the State in and through innovation policies. As noted by Pfotenhauer and Juhl (2017), the innovation policy literature has largely neglected how statehood is being envisioned, enacted, and operationalized through projects of innovation. Yet innovation is not only a mere tool to foster techno-economic development, "it is also a means of governing society through national projects, through the rationalization of state action, and through national identity formation" (Pfotenhauer & Juhl, 2017, p. 83; see also Jasanoff & Kim, 2015). In this paper, I therefore seek to develop an analysis that engages with the co-production (Jasanoff, 2004) of innovation and statehood in order to scrutinize the shaping of innovation agendas and the relationships and allocation of power between the state and its citizens.

To scrutinize the development of participatory innovation policies in Wallonia, I develop a 'context-sensitive' analysis that attends to "the ways situated actors perceive and envision particular policies" in a specific context (Haddad & Benner, 2021, p. 4). To do so, I look at different scales (Wallonia as a polity, its own location within global economies, but also the specific scales at which participatory innovation

practices unfold) and sites (through the analysis of so-called 'Creative Hubs' as privileged sites to see how policies translated into practice). Analyzing the multiple entanglements between sites and scales at play in participatory innovation allows for understanding how innovation and the contexts in which it is conceived and enacted relate. It is also a powerful resource to scrutinize how potentially divergent motivations and visions of innovation emerge through these entanglements and create 'frictions' between different visions held by different actors (Macq *et al.*, 2021). Ultimately, considering these frictions leads to paying attention to asymmetries of power between actors and institutions. A context-sensitive analysis of innovation therefore also allows for attending to which actors are able to shape authoritative definitions of desirable forms and practices of innovation, thereby providing crucial insights into the politics of (participatory) innovation (see also Haddad & Benner, 2021).

CASE AND METHODS

To develop this context-sensitive approach, I focus on Wallonia as a particular polity that, as soon as in 2010, developed a policy program dedicated to fostering participatory innovation. Wallonia is one of the three federal regions of Belgium, along with Flanders and Brussels-Capital. It received executive and legislative competences in 1980, when the Walloon Parliament and Government were created. Throughout the political decentralization of Belgium, Wallonia became competent for a large set of policy domains, including employment, energy, environment, economy, research and innovation, and health.

To collect and analyze the data used in the research, I used an inductive and qualitative research approach. The analysis presented in this article draws on an empirical material made of policy documents, direct observations in participatory innovation sites, as well as 29 semi-structured interviews with a total of 37 key actors (policy-makers and coordinators of participatory innovation sites) conducted between April 2017 and December 2018. Through these interviews, specific attention was paid to how actors make sense of policies and practices. Interviewees were therefore asked about what they considered as the purpose of (participatory) innovation, the publics to be involved, and the type of activities to be developed. They were also asked about how they see their activities fitting into the context in which they evolve, be it the region as a whole, as specific city, or a social community. These interviews were integrally recorded and transcribed *ad verbatim*.

All the data were analyzed with the Nvivo software using a combination of discourse (Fairclough, 2003) and thematic (Braun & Clarke, 2006) analysis. Interpretation is a complex process with various different aspects: it is partly a matter

of understanding what speakers or writers mean, but it is also partly a matter of judgement and evaluation (Fairclough, 2003, p. 11). To perform interpretation in this case, the data were first coded with a list of very descriptive terms in order to have an overview of how what the policies were about and how the actors described and made sense of their activities. These codes were rearranged through multiple re-coding phases: new ones were created and existing ones were modified as I gained deeper knowledge of the case. Through these re-coding phases, more interpretive codes were developed (Braun & Clarke, 2006) as the analysis gained in depth.

LOCATING PARTICIPATORY INNOVATION IN WALLOON POLICIES

As a result of Belgium's political decentralization process, Wallonia gradually received greater resources for technological development on its territory. As soon as the Walloon regional institutions were set up, public authorities produced speeches intimately linking economic progress and technological innovation. The evolution of research and innovation policies in the region allows highlighting the rise of a properly regional research and innovation policy and its embedment in an economic (re)development strategy presented as a central component of the Walloon political project. Since the birth of Wallonia, regional public decision-makers developed policies presenting Wallonia as a polity with strong ambitions based on innovation. Through these policies, important promises of future development are made, in a region that conceives itself as 'lagging behind' Flanders' (the other main region of Belgium) and international economies (van Oudheusden *et al.*, 2019).

The most salient example of this dynamics was the "Priority Actions for the Future of Wallonia", developed and presented by the Walloon Government in 2005. These actions were grouped within a global program, that was soon called by policy-makers and known in Wallonia as the "Marshall Plan". This nickname was a way for Walloon public authorities to link the situation of Wallonia in 2005 to the one of Europe at the end of World War II. In both cases, a major plan was perceived as needed to help society recovering from a critical situation. The Walloon "Marshall Plan" was therefore rooted in the fear of Wallonia's economic collapse after the federalization of Belgium (Accaputo *et al.*, 2006). It included a set of measures to promote economic growth, entrepreneurship and job creation through a focus on regional business innovation and the establishment of 'competitiveness clusters' fostering partnerships between universities and companies. The aim of these measures was to achieve a sustainable economic recovery in Wallonia, building on the region's assets to bring it back among the most competitive regions in Europe. As noted by Fallon and Delvenne (2009), the model of innovation developed was compartmentalized in an instrumental logic of innovation. Within this logic, innovation-making essentially depends on

collaborations between three types of actors: the academia, industries, and public authorities. "Society" was supposed to benefit from the innovations that were expected to be developed by these actors, but had no specific role in in this development. This situation further evolved at the turn of the 2010's, when the Minister in charge of Economy[2] (hereafter "the Minister") initiated a new framework programme for economy and innovation seeking to complement the Marshall Plan: *Creative Wallonia.*

The 'creative turn' and the involvement of citizens in innovation-making

As described in the introduction of the program, *Creative Wallonia* aimed to be "an additional stage in the transformation of Walloon industry in order to respond ever better to the challenges posed by a global and digital world whose only constant is permanent change" (Cabinet of the Minister of Economy, 2010, p. 11). In this framework, creativity and innovation were put "at the heart of the Walloon project, to the point of making it its trademark" (*ibid.*). This new program was designed against the backdrop of an important perceived challenge: in the aftermath of the 2008 economic crisis, the global economy was judged constantly changing at an increasingly rapid pace, making innovation an urgent need in order not to lag behind in the global competition between territories. The program was therefore designed as to be "the most appropriate response in the context of a global, open and constantly changing economy (...) where markets are constantly renewing themselves, where new actors are constantly appearing and where companies are now required to have the capacity for continuous regeneration" (Cabinet of the Minister of Economy, 2010, p. 8).

To complement previous policies, the main idea behind *Creative Wallonia* was the opening up of Walloon innovation policies to actors beyond academic research centers and companies. As the Minister recalled, this was linked to the expansion the scope of 'innovations' that were addressed through regional policies:

> When I became Minister for Economy in 2004, the objective was to reindustrialize Wallonia (…) We swiftly set up the competitiveness clusters policy, whose objective was to change the industrial basis of Wallonia (…) Very quickly, we noticed that there was a methodological bias in this, because we focused on technological innovation. But we know that non-technological innovation, creativity, represents between 70% and 80% of all innovations, and so we started thinking of a program that was released in 2009, *Creative Wallonia*. And *Creative Wallonia* is really about saying: 'we need to generate creativity'. (Personal interview, December 2018)[3]

[2] This Minister (Socialist Party) was in charge of Economy and other themes from 2004 to 2017. He became in charge of Economy and Employment in July 2004, a position he held until October 2005. In October 2005, his portfolio expanded to "Walloon Minister for the Economy, Employment and Foreign Trade". From July 2007 to July 2009, his portfolio turned into "Walloon Minister for the Economy, Employment, Foreign Trade and Heritage". From July 2009, he became "Walloon Minister for the Economy, SMEs, Foreign Trade and New Technologies". He was reappointed for the last time in July 2014, with the following portfolio: "Walloon Minister for the Economy, Industry, Innovation and Digitalization", a position he held until July 2017.

[3] All interviews were conducted in French. Translations are my own.

Creative Wallonia therefore originates from a will to activate a not-yet-exploited innovation reservoir: creativity, presented as 'non-technological' innovation. Creativity was envisioned as an indisputable asset in the global economic competition between territories. In the view of Walloon public authorities, creativity was a widespread resource held by every citizen. Consequently, the primary ambition of the program was to "involve as many Walloon citizens as possible in an innovative dynamic" (Cabinet of the Minister of Economy, 2010). As the then Minister's chief of staff sums up:

> The idea was (...) something like 'sowing the seeds of creativity to develop innovation throughout the territory', so it's about empowering people, this notion of empowerment, because everyone is creative, it's not just saying 'it's creativity for universities' or 'it's creativity for companies', it's about strengthening the creative capacities of Walloon citizens so that we can see the results in terms of producing innovation. (Personal interview, July 2017)

As this quote expresses, empowerment was recoded as giving citizens the capacity to be innovative. This particular vision was heavily influenced with scholar work in the 'management of creativity' field. In particular, it relied on the work of researchers at HEC Montreal – the Business School of the University of Montreal – that developed theories and good practices around the notion of 'creative economy', especially in urban areas. One of the main ideas of these works is that value creation must take place increasingly upstream of the processes, particularly at the ideation, conception and design phases. Organizations that manage to develop their creative capacity would then have a definite advantage in economic competition (Simon, 2009). The approach developed by Cohendet and Simon also aimed to question the actors of creative processes and the modes of transmission of creativity from the "fertile ground" of the city to the business world (Cohendet & Simon, 2008). In particular, Laurent Simon theorized the links between *Upperground*, *Middleground* and *Underground* in what he calls "creative cities". As he describes in one of his articles:

> Creative cities are structured in three active strata. Firms - *Upperground* - absorb the knowledge emerging from the city's creative activities while actors from the *Underground* explore and propose new creative avenues. In this context, the creative collectives of the *Middleground* assume a function of knowledge integration and transfer between the *Underground* and the *Upperground.* (Simon, 2009, p. 37)

When referring to this framework, a member of Creative Wallonia Engine, the entity in charge of coordinating the implementation of the program in the region, refers to the 'Underground' as composed of all Walloon citizens, and compares it to a "breeding ground" whose "potential" has to be "exploited" in order to generate value in the form of innovations (Personal interview, April 2017). The task of public authorities, in this framework, is both to cultivate the creative mindset and capacities of the

'underground' and to set up a 'middleground' that will allow creative ideas to make it to the market and develop the economy. To realize such a task, *Creative Wallonia* is divided into three main axes, each one corresponding to a specific temporality of the innovation-making process.

The first axis is called "Promoting the society of creativity" and is dedicated to spreading the culture of creativity among the population. It specifically aims at transforming training methods, both in compulsory education and in teachers' training, in order to open them up to creativity. It also includes measures dedicated to open up citizens to creativity beyond educational settings, for example through the creation of an annual 'Creativity Week', a public event dedicated to promoting the culture of creativity to a large audience of visitors.

The second axis, "Fertilizing innovative practices", is dedicated to enhancing innovation-making practices among creative individuals. It specifically promotes networking as a mode of work organization, particularly through the establishment of co-working spaces and innovators' clubs in the region. The general ambition here is to create the conditions for the emergence of "real innovative ecosystems[4]", based on the model of *Silicon Valley* (Cabinet of the Minister of Economy, 2010, p. 13). It also includes initiatives to as the creation of an 'Observatory of trends', with the aim of capturing trends abroad and reinjecting them into the Walloon economic fabric. Finally, in order to demonstrate the success of the culture of innovation in Wallonia, this axis also comprises the establishment of innovation awards, called "Zénobes"[5].

Finally, the third axis of the program is called "Supporting innovative production". It aims to extend the efforts undertaken by *Creative Wallonia* to the step where innovations are put on the market. In particular, this axis focuses on "supporting the transition from the status of innovative prototype[6] to that of marketed product or service, both in the technological sector and in the design sector" (Cabinet of the Minister of Economy, 2010, p. 14). To do so, this specific axis led to the setting up of multiple sites of participatory innovation, such as 'living labs', 'fab labs', and 'creative hubs'.

Through these three axes, the way *Creative Wallonia* articulates creativity, innovation, and participating publics is made even clearer. The program seeks to foster innovation-making through (1) the development of a specific culture – one of creativity and innovation – among the population, (2) the enrichment of innovative

[4] Bold in the text.

[5] The name of these awards is a direct reference to Zénobe Gramme, a Belgian – born in a region of Belgium that is now part of Wallonia – carpenter presented as particularly inventive, known for having created the Gramme Machine, an electrical generator that produced direct current. Through this name, policy-makers make a clear link with Wallonia's bright past, and affirms their will to promote inventiveness in the territory.

[6] Bold in the text.

practices among individuals within ecosystems, and (3) the setting up of participatory innovation sites in which citizens will be helped to turn their innovative prototypes into marketed products or services.

But who are these 'citizens' supposed to be, exactly? Throughout the program, citizens are conceived as the engine of regional (re)development through innovation. Apart from presenting them as inherently creative, the program in itself remains vague about the citizens that are supposed to participate in innovation-making. However, the Minister makes it clearer when linking his policies to entrepreneurship:

> The observation I made is that we say that entrepreneurship is not strong enough in our region. What is the cause of this? Globally, we are all with our past as if we were born with the memory of our predecessors (...) And so my goal was to support entrepreneurship, and entrepreneurship is to undertake one's life, it is not necessarily to create one's company, it is really a state of mind. And the desire was to say: "how do we generate this creativity and how do we break the traditional codes that say there is no future in Wallonia?" (Personal interview, December 2018)

Seen in this light, *Creative Wallonia* therefore also appears as an anthropological project. Indeed, it is a policy promoting a culture of entrepreneurial citizenship, which, as described by Irani (2019), "promises that citizens can construct markets, produce value, and do nation building all at the same time" (p. 2). As the quote expresses, the support of entrepreneurship is directly linked to the future of Wallonia: creative and innovative entrepreneurs are conceived as instrumental for the economic development and, therefore, for the future of Wallonia as a polity. At this point, it has to be noted that the Minister adopts a rather open perspective on what an entrepreneur is, locating it beyond the realm of economic entrepreneurship. In the next section, however, I show that the way *Creative Wallonia* was implemented in practice tended to narrow down this conception and to actually focus on entrepreneurs as creators of companies.

To better understand how participatory innovation policies developed in practice, the analysis now turns to the first series of participatory innovation sites that were set up in Wallonia: Creative Hubs. Creative Hubs are particularly interesting because they were conceived by Walloon public authorities as the central component of the innovation ecosystem that must be developed in the region. To link them back to the creative economy jargon, they were deemed crucial to make the *Middleground* come into being in order to ensure transfers of ideas between the *Underground* and the *Upperground*.

Enacting participatory innovation through 'Creative Hubs'

The call for projects to fund Creative Hubs was released by the Walloon administration in 2014. In the call, Creative Hubs are defined as "organizational platforms centered on the transformation of the traditional economy to a creative one through the

empowerment of actors by fostering open innovation, transdisciplinary hybridization, and collaborative intelligence". To make sense of this official definition, a policy officer in charge of coordinating the actions of all Creative Hubs at the regional level groups them under the label of "third place of innovation"[7]. This policy officer insists on the synergies that these places allow creating, notably by using creativity tools:

> They are places of unlikely encounters, places where you bring together people who would not have met if they had stayed in their usual working environment. And that are stimulated by all the tools of creativity, where you can find *hackathons,* creative workshops, pecha-kucha, in fact all things like that that allow you to share and be stimulated in a creative way in these third places. (Personal interview, April 2017)

Through this quote, creative hubs appear as spaces that are supposed to act as 'catalysts', as also expressed in the same interview: spaces where an ecosystem of different institutions, methods, and publics are animated to give birth to and foster innovative projects. In line with regional policies, the publics that are supposed to get involved and participate to innovation-making in these spaces are *a priori* more than loosely defined: they are considered as being "people", which basically applies to any citizen. Defined in these so open terms, participatory innovation can be presented as being the business of everyone in Wallonia. However, when analyzing how the actors that organize the activities of these sites conceive what the sites are supposed to be, what activities they are supposed to develop, and what publics they are supposed to involve, things get more complex.

To further explore the different conceptions that infuse Creative Hubs, I will zoom in into one specific Hub: the TRAKK, in the city of Namur. TRAKK was one of the first Hubs to be created in Wallonia. It was set up through a partnership between three entities: (1) the University of Namur, (2) the Economic Office of the Province of Namur (BEP) – a public organization that coaches projects with economic value to help them mature and get to the market –, and (3) KIKK – a non-profit association that aims at building bridges between arts, sciences, design, and new technologies. This partnership is organized through a division of labor: the University of Namur is in charge of studying and providing creative methods to the site; the BEP is in charge of coaching potential entrepreneurs; and the KIKK is in charge of animating the fab lab: a space in the Hub, open to anyone, where individuals can experiment with quick prototyping machines. What is interesting to note here is that this division of labor, and the different activities that the partners are focusing on, are attached to different

[7] The term "third place" derives from a book entitled Celebrating the Third Place (Oldenburg, 2000), itself a follow-up to a book entitled The Great Good Place (Oldenburg, 1989). In these books, Ray Oldenburg, Professor Emeritus of Urban Sociology at Pensacola University in Florida, refers to social environments that are neither the home nor the workplace. These "third places" – of which Starbucks cafes are supposed to be the most illustrious representatives – are places for the social life of the community, where individuals can meet, gather and exchange informally.

visions of the Hub and the publics it is supposed to involve. This is especially the case between the BEP and the KIKK.

Within the BEP, the Creative Hub is coordinated by the Department of Economic Development. Within this department, the Hub has been conceived from the beginning as a tool for developing new methods for coaching companies and to incorporate them into the different services that the BEP offers as a business and innovation center. This focus on companies is detailed by the Department's Director:

> For us, the TRAKK is really a tool that allows us to either see how to initiate innovation processes in companies through creative processes, to see how these creative processes can generate ideas that will be developed in an innovation process; or to see how, when an innovation process is stuck or does not grow sufficiently, how to boost it with creative tools. (Personal interview, October 2018)

This conception contrasts with the one of the KIKK, which conceives the Hub as a way of democratizing access to emergent technologies to a large audience. For the members of the association, it is crucial not to focus solely on economic value production in order not to miss out the core of what this kind of spaces can offer. They insist on the fact that the TRAKK is above all a space of exchange between different kinds of people, a space that has an important social dimension in that it fosters social cohesion and people's well-being:

> To me, the value of third-places like the TRAKK is to allow for the social dimension, the encounters… If we want to build bridges between disciplines, between people… This is not possible unless we open the door to as many people as possible. If we are too restrictive, then we lose this unlikely encounters aspect and the opening up of the barriers of creation. (Personal interview, November 2018)

When specifying the publics that they see at the core of the activities of the TRAKK, members of the KIKK speak of them as 'makers': individuals who tinker with new digital technologies and who are mainly motivated by a desire to express their creativity, to see what they are able to create, *a priori* without any other goal. A public whose focus is therefore not to produce economic value, which is seen as problematic by the BEP:

> Our main concern it is how to position the Hub with regard to all this logic of makers, of tinkering… But that won't generate revenues that would allow us to ensure the financial sustainability of the Hub. Moreover, in terms of return on investment, it's public money that we are putting into this, and the makers… Well, we have to know to what extent they can generate value on the territory, because it is our objective to generate value, employment, added value. So should the Hub focus on makers or should it focus on start-ups that will generate returns, jobs, and economic growth? And so you understand that given the financial stakes, to us, the Hub must be a place of business. But how can you ensure a balance between the two? How do you make sure that the two coexist? I don't know… (Personal interview, October 2018)

As this quote suggests, the balance between the two conceptions of what the Hub is and what publics it is supposed to involve is hard to find. This balance appears even more complicated by another factor: the way Creative Hubs were funded in Wallonia. Indeed, in order to scale-up the enactment of *Creative Wallonia* and the spread of Creative Hubs across the region, the Government, operating with limited financial resources, decided to have them funded by the European Regional Development Fund (ERDF). As part of the call for projects, the cabinet of the Minister of Economy therefore specifically asked the different Hub projects to apply for the ERDF's 2014-2020 programming period.

Funding Creative Hubs through the European Regional Development Fund

The ERDF finances programs through collaborations between the European Commission and national and regional authorities in Member States of the European Union (EU). It specifically aims to strengthen economic, social and territorial cohesion in the EU by correcting perceived imbalances between its regions. To do so, investments focus on several key priority areas, defined by the European Commission. Within these areas, each region negotiates with the Commission the specific measures it wants to develop. While Walloon regional authorities were developing *Creative Wallonia* and promoting participatory innovation as a means to foster economic development through innovation, they also succeeded in making 'creativity' a key component of the 'innovation and research' area in the Walloon specific ERDF program. As the Minister tells, having Creative Hubs and other sites of participatory innovation funded by ERDF was instrumental for Wallonia to financially afford its ambitions:

> Well, I would say… the European funds were like a financial windfall in which Wallonia had to put only 50% of the money, and the European Commission would put 40%, so we used it as a leverage to set up our different initiatives. (Personal interview, December 2018)

In this way, participatory innovation was considered a key element in the economic development of a region considered in a situation of imbalance compared to more developed ones in the EU. Through their financing by the ERDF, creative hubs *de facto* became means for Wallonia to catch up with leading European economies, making it more difficult to ensure a proper balance with social cohesion objectives.

In practice, Creative Hubs were funded through the Action 2.3. of the 2014-2020 ERDF's program. The main objective of this action was to "increase the number of innovative products and services through the intensification of open innovation and research and development in companies". This action involved a single indicator to evaluate the initiatives developed in the funded sites: the number of companies that

benefit from the Hubs' services. This had important consequences on how these spaces could operate in practice, as a member of the public administration recalls:

> Indeed, the mode of financing greatly influences everything that happens afterwards. The most blatant example is the Hubs and the ERDF (…) In this case, yes, it really conditioned the rest, especially the indicator aspect, because with the ERDF we are now in a more technological innovation axis, with a focus on supporting more companies, on generating economic value… instead of the more social aspects. (Personal interview, November 2018)

As a result, the ERDF financing narrowed down the scope of Creative Hubs and turned them into elements of a chain of operators designed to enable the development of a given technological entrepreneurial project, as a policy officer describes:

> Let's say that I am a Creative Hub, I have a project holder that I feel is mature enough to go and create his business plan and be accompanied. Well, I pass the torch to an entity that do business accompaniment. And the other way around: an operator like that who sees a company that needs an ideation session or a co-creation session, well, he can ask for the services of a Hub for this type of approach. (Personal interview, October 2018)

If this vision of Creative Hubs is well aligned with the one of the BEP detailed previously, it is far less aligned with how the KIKK conceives the site and its publics. The focus on a single quantitative indicator merely concerning companies is criticized by the members of the association as constraining their activities and not reflecting what really matters in such a site, human stories:

> At the beginning, there was a will to go for the European Social Fund instead of the ERDF, precisely to have a more social dimension. But in my opinion, that would have created a mismatch with the BEP's vision who was to be a partner in this initiative. What I find difficult is the fit between the mode of funding of ERDF and its constraints, regarding all the plasticity, the flexibility that creativity demands. In the end we try to fit into the required boxes but it is very often artificial. Also, I think here, in a certain way, we would like to develop this or that action, but we have to think "what would it effectively bring us in terms of indicators?" To me, indicators do not mean a thing, they are just numbers. To me, a number does not represent anything, what matters is the stories that stand beyond numbers. When we listen to the stories, we see that this does not directly generate economic value. (…) I think that behind all this economic value thing, you find human beings, and human beings cannot be thought of in one single way. And so fostering only the economic aspect at the expense of the other, I do not see how it could work. (Personal interview, November 2018)

The funding of Creative Hubs through ERDF is illustrative of and reinforces the focus of participatory innovation sites in Wallonia on economic entrepreneurship, both in terms of activities and publics. Interestingly, this narrowing down of participatory innovation policies is highlighted and criticized by the Minister's former Chief of Staff who drafted the framework-program in the first place. At the time of our interview, in July 2017, he stated that, to him, the program no longer existed, at least not as he had

originally conceived it, precisely because in his view the entrepreneurship dimension was the only one left:

> To me, *Creative Wallonia* doesn't exist anymore. So there is a dimension that has survived and continues to develop, which is the *start-up* aspect, innovative companies, and the rest, unfortunately, it is more or less stifled (…) if you take up photography back in 2014, it was not just that, it was Creative Hubs where we wanted to ensure that the Marshall Plan actors, universities, companies, research centers, could get in touch with the local fabric, in each of the geographic Hubs, that these people had a Fab Lab at their disposal, that there were opportunities to experiment in the social economy, etc. All of this has been very much a dead letter, it's been hijacked. There was really a capture by the economic aspect. (Personal interview, July 2017)

As this last quote and the case of the TRAKK suggest, the economic focus on techno-entrepreneurship that gradually developed in and through participatory innovation policies led to frictions among actors whose conceptions of what 'opening' innovation means diverge. One reading of these frictions may lead to consider them as indicative of a failure of participatory innovation policies: by restricting activities to economic entrepreneurship, *Creative Wallonia* and associated Creative Hubs failed to deliver a widespread participation and a true opening of innovation-making. In this perspective, the added-value of analyzing these frictions would be to identify them in order to find ways of repairing and ensure a 'true' participatory innovation to develop. The approach I develop in this article leads to another take on these frictions. Indeed, by paying attention to how different actors hold different visions of the same policy and resulting activities, it shows that frictions are simply inevitable. The same policy will therefore be considered a failure and/or a success depending on which actor is talking. More than hints of failure or success, what these frictions are indicative of is "whose particular interests, values, and visions of a good, desirable society as well as political choices" become inscribed in innovation policy agendas, and what alternative visions are diminished (Haddad & Benner, 2021, p. 8). Ultimately, then, paying attention to frictions is a way of paying critical attention to the politics of innovation and the (re)production of larger governance regimes and relations of power in a given State through innovation policies.

DISCUSSION

In this discussion, I want to further consider two main points related to the politics of participatory innovation analyzed in this article. The first relates to the critical analysis that can be developed by unpacking the links between creativity, innovation, citizens and the State in Walloon policies. The second is related to the specificity of Wallonia as a particular context and how it can inform broader analyses of (participatory) innovation.

Unpacking the links between creativity, innovation, citizens and the State

The very notion of what 'creativity' is appears ambiguous in Walloon policies. Indeed, while I showed in the previous section that the Minister of Economy tends to present it as a way to go beyond a traditional focus on technological innovation, it appeared inscribed into *Creative Wallonia* as a means to both enrich and foster innovation in technological sectors deemed crucial for economic development – mainly information and communication technologies. As the program developed and innovation sites were set up, this focus on technological innovation was made stronger. Therefore, far from representing a radical shift from technological innovation to an alternative 'X-innovation' (Gaglio *et al.*, 2019), creativity and participatory innovation in Walloon regional policies appear as a way to do more technological innovation by other means.

In fact, participatory innovation is conceived and promoted by public authorities as necessary in a world where these authorities are confronted with different constraints. On the one hand, techno-scientific uncertainty is increasing, public participation has become part of the public agenda, and modes of innovation have evolved so that innovation is no longer perceived as the work of a single isolated actor (Callon *et al.*, 2009). On the other hand, in the post-economic crisis context of 2008, public authorities must tirelessly propose effective responses to problems such as unemployment or declining competitiveness (Joly *et al.*, 2010). Governing through participatory innovation is therefore a way of developing industrial and innovation policies that take these constraints into account. Seen in this light, participatory innovation appears as a means of fostering territorial development through innovation, while delegating to citizens the delicate task of co-creating tomorrow's innovations.

Scrutinizing the relationship between creativity, innovation, and citizens is therefore key here. In a sense, when they promote participatory innovation, Walloon public authorities re-create a vision of innovation as a linear process: when involved, creative citizens will generate new ideas that – once appropriately nurtured and valorized through entrepreneurial projects – will generate innovative products and services. In this linear process, the role of the State is to help creative ideas emerge

and develop by cultivating the entrepreneurial attitude of citizens and developing participatory innovation sites within 'innovative ecosystems' to bridge the gap between ideas and market applications.

Scrutinizing this reconstructed linear process of innovation leads to unpack who is considered a relevant contributor to innovation-making in Wallonia, and how the participation of this relevant public is configured. In terms of which publics are to be involved in innovation-making, the Walloon instrumental vision of participatory innovation indeed rests on the assumption that "everyone is creative", which also lies at the core of co-creation approaches (Sanders & Stappers, 2008). As it is used in official documents and discourses, the term "creativity" seems to merely describe one's capacity to have new ideas. So openly conceived, it is of course a powerful instrument of mobilization: everyone can indeed have new ideas, so any citizen can be part of Wallonia's future. However, I showed that the "Creative" Wallonia that is expected to develop is not just a society where new ideas pop up. It is a society in which new ideas are turned into innovative products and services, with entrepreneurship as the preferred way to valorize these innovations. Therefore, the State does not really let to citizens the task of *freely* co-creating tomorrow's innovations. As the implementation of participatory innovation policies in practice shows, the role of the State *de facto* goes beyond merely "helping" creative ideas to be turned into innovative products and services. Most notably, I showed that the way it funds (or make other entities fund) participatory innovation sites plays a major role in shaping the direction of participatory innovation practices: by shaping the expected outcomes of participatory innovation, as well as the nature of the publics that are to be involved in such practices.

Overall, participatory innovation policies in Wallonia therefore reveal a reshaping of the "biopolitical relationship" (Pfotenhauer & Juhl, 2017, p. 82; see also Jasanoff, 2011) between citizens and the State, in which the latter exerts its power in conducting the conduct of the former (Foucault, 1982) as to generate innovative citizens. Putting the State at the forefront of analyses of participatory innovation therefore allows for critically scrutinizing the democratic ordering that is shaped by participatory innovation policies as instruments of government.

In this respect, Walloon policies tend to speak of citizens, users, consumers and entrepreneurs as a global set of publics to be involved in innovation. However, conceiving participating publics in terms of users, consumers, and entrepreneurs reflects a profoundly individualistic view of citizenship (Barber, 1998). The potential of democratizing innovation governance through participatory policies therefore has to be critically scrutinized. Participatory innovation as promoted and enacted through *Creative Wallonia* presents what Swyngedouw (2005) coined the "Janus Face" of

participatory policies: it did enabled new ways for citizens to participate in a therefore somehow democratized production of innovation. However, it also developed with an economic focus on techno-entrepreneurship that values individuation and self-realization through success on the market rather than a more profound and collective empowerment of civil society.

This is also directly rooted in the reconceptualization of the valued citizen as a creative one. As critically analyzed by Peck (2010), the "creative class" (Florida, 2002), so much sought-after by public authorities, appears as "an atomized subject, with a preference for intense but shallow and evasive relationships, taking place mainly in the sphere of consumption" (p. 198). The "creative class" thus has little capacity for collective meaning. Moreover, as Peck (2010) notes, assuming the existence of a "creative class" is tantamount to assuming the existence of a "non-creative" population, which would be asked to passively observe and wait for the creative class to generate a new socio-economic order on its own and for itself. This inequality between creative and non-creative people is under-problematized in the institutionalization of participatory innovation. Yet, it is crucial to analyze it critically in order not to simply increase social and economic inequality. Peck perfectly sums up the expectations of the creative class and the potential danger of this vision:

> So while everyone is creative, some are obviously more creative than others, and there are still some who "just don't get it". In other words, the creative class generates growth, the others live off the loot. (...) The problem is that the creative class, which has become a particularly restless factor of production, motivated by extrinsic rewards and the pursuit of happiness, is apparently constituted in like-minded enclaves, without concern for the broader social consequences, perhaps even without concern for society at large. (Peck, 2010, p. 210-212)

The risk is then great, through these public policies, of seeing the (re)creation of an urban elite, presiding through its inclusion in processes of participatory innovation in the definition of a certain common good, but nonetheless unable to think beyond the interests of the sum of the individuals that make it up. The promotion and implementation of participatory innovation in territories for the purpose of regional (re)development therefore runs the risk of increasing inequalities between the citizens who populate them, as well as drastically reducing the possible openness of scientific and technological choices.

Following the context-sensitive approach developed in this paper, this critical analysis is intrinsically linked to a particular territory. In the second part of this discussion, I reflect on what potentially makes this territory both singular and comparable to other ones.

A research agenda for context-sensitive analysis of innovation in the periphery

As show in the empirical section, to understand why participatory innovation gained traction and got integrated in Wallonia's policies, one has to take into account the specificity of Wallonia as a polity. It appears that Wallonia has, from the very beginning of its existence, made innovation a key component of a political project of identity-building through economic (re)development. Developing this project was crucial for Wallonia as polity that considers itself as lagging behind in the global economic competition between territories. This was felt ever more pressing by regional authorities in the aftermath of the 2008 economic crisis, when the global economy appeared ever more uncertain, made of rapid and unpredictable changes.

In this specific context, Walloon authorities searched for innovation models that would allow them to go beyond existing policies in order to mobilize new resources for generating more innovation in the territory. The resulting new policy was heavily influenced by different models: Montreal's creative cities, Silicon Valley's innovation ecosystems, or the MIT-based living labs.

The observation that (innovation) policy models travel and are adapted in different contexts has been made in both STS (Pfotenhauer & Jasanoff, 2017) and political economy (Peck & Theodore, 2015) literatures and through a variety of different contexts. What appears more specific to the Walloon case is the felt need, in policy makers' minds, to find new so-perceived best practices to tackle a situation perceived as critical. In this sense, the analysis developed here is at least partially one of policymakers that sought to mimic foreign models perceived as already working elsewhere as ready-made solutions, a tendency that is common to many peripheral countries and regions (Brandão & Bagattolli, 2017; Haddad & Benner, 2021; Kuhlmann & Matamoros, 2017). In this perspective, focusing on Wallonia contributes to advance an innovation agenda that suggests investigating "innovation in the periphery" as opposed to successful core regions (Eder, 2019).

However, more than merely mimicking foreign models, Walloon authorities translated these models and, by doing so, adapted them to the local specificity of Wallonia. In order to advance this agenda of studying innovation in the periphery, I therefore argue that analyses need to look both at what models are mimicked and why, as well as at how these models get transformed during the mimicking process. In line with what Irwin *et al.* (2021) suggest, the context-sensitive approach followed in this article therefore allows for developing a focus on both isomorphism and difference in innovation policies. In this process of adaptation of foreign models of participatory innovation, I showed that a key element to consider is the specific funding instrument that was used by Walloon authorities. As described in the empirical section, Wallonia decided to have its policy partially funded by ERDF, a fund

that it could benefit from as a region whose GDP per capita is lower than the EU average. This move allowed Walloon authorities to set up participatory innovation spaces – thereby allowing these spaces to exist in the first place and get seven years of funding – as much as it considerably constrained the activities of these spaces. In fact, while allowing Wallonia to develop local initiatives, the ERDF acted as a vector of "coercive isomorphism" (Irwin *et al.*, 2021, p. 2): it forced local initiatives to fit into global – European – standards focused on entrepreneurial firms and opportunities rather than on the involvement of widespread participation of Walloon citizens. In this case then, the peripheral nature of Wallonia influenced both its search for foreign models and the way these models were adapted to their host context.

As argued throughout this article, the policies, visions, and actors analyzed should be interpreted in light of the particular context in which they unfold. Nevertheless, the 'lagging' nature of Wallonia is both what makes it specific and comparable to other regions. In this sense, it opens fruitful inroads into context-sensitive analyses comparing case studies across regions, a task that was out of my scope here.

CONCLUSION

Through this paper, I intended to shed light on why and how participatory innovation became fashionable for a whole polity as to get incorporated into regional economic and innovation policies. By analyzing participatory innovation as conceived, promoted, and enacted in Wallonia, I showed that the involvement of a variety of publics in innovation-making gained traction among policy-makers as a way to boost innovation in the territory, which was conceived as urging for the economic (re)development of Wallonia. As argued, putting the (regional) State at the forefront of the analysis allows for critically scrutinizing the ways in which participatory innovation serves other purposes than the sole opening up of perspectives in innovation-making. This critical scrutiny helps highlighting a particular politics of participatory innovation, as conflicting visions enter in friction and some gain more traction that other. In this perspective, I analyzed the institutionalization and development of participatory innovation as reconfiguring the relationships between the State and citizens in a certain way. Participatory innovation appears as a mode of government through which Walloon authorities seek to cultivate creative and innovation citizens for the sake of a creative and innovation Region. As showed, this mode of government tends to focus on economic techno-entrepreneurship as the form of citizenship most valued for the development of the territory. Far from representing a radical shift from technological innovation, then participatory innovation in Walloon regional policies appear as a way

to do more technological innovation by other means. Ultimately, as discussed, the specific case of Wallonia calls for further analyses of the way participatory innovation develops in peripheral regions.

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The Politics of User-Driven Innovation: On innovative users, do-able needs, and frugal robots[1]

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ABSTRACT

Users play an increasingly important role in European innovation policy. They are commonly seen as drivers of and active co-creators within innovation processes. However, user-driven innovation remains infused with a number of assumptions about users, technology, and "successful" innovation, which (partly) undermine a more democratic, open approach to innovation. In this contribution, I investigate the interplay between broader policy assumptions in the European discourse on user-driven innovation and its practical performance within an innovation project centring on healthcare robotics. Here, I argue that the politics of user-driven innovation harbours particular assumptions that, in effect, restrict the agency of users while also engendering conflict and contradictory outcomes. Hence, user-driven innovation is not simply about users driving innovation but rather about interfacing users and their concerns with (robotics) developers and their technology. For this, I propose an analytics of interfacing, which draws together literatures on the performative dynamics of participatory processes and more recent work on the political economy of participation. Here, I contend that it is not enough to investigate the construction and performance of publics; rather, it is additionally necessary to follow the manifold practices by which those publics are rendered available for certain technological solutions – and vice versa. Such an analytical approach opens up a fruitful avenue to critically enquire into the politics of participation – sitting in between innovation policy and practice.

Keywords: User-Driven Innovation; Participation; Healthcare Robotics; Pre-Commercial Procurement; Interfacing.

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INTRODUCTION

Users are playing an increasingly important role in European innovation policy. While public deliberation on science and technology has been a concern since the beginning of the 21st century, recent initiatives have put emphasis on the role of users (and citizens) as *producers* of innovation (Macq *et al.*, 2020). Users have been invoked as a source of creativity – both because they can supply developers with novel problems and test potential solutions to those problems (Engels *et al.*, 2019). In this context, they have been acknowledged as drivers of socio-technical change (Hippel, 2005; Ritzer & Jurgenson, 2010) and thus identified as important actors in the co-creation of innovation (Debackere *et al.,* 2014; Ramaswamy & Ozcan, 2014). Most notably, their involvement has been heralded as a way to align what technological innovations can offer and what society supposedly needs in political and societal terms (Boon & Edler, 2018). It is part and parcel of a wider regime that assumes a general alignment between the promises of nascent technological fields and application domains (Lipp, 2019; Pfotenhauer & Jasanoff, 2017; Godin & Vinck, 2017). The central argument of this paper is that user-driven innovation, as it is conceived and practiced in European innovation policy, is not simply about users driving innovation. Rather, I suggest that user-driven innovation denotes a specific form of governance, which materialises in both policy and in concrete innovation practices, and that aims to interface users and a particular version of user-driven innovation.

Such a perspective does not take for granted the alignment of users and innovation – of what users want and what technology has on offer – but rather enquires into how these elements become interfaced within contexts of user-driven innovation. This enquiry is guided by two connected questions: What does the policy discourse on user-driven innovation assume about users, innovation, and technology? How do these assumptions impact and materialise in innovation practices "on the ground"? With this research interest in mind, I will report on a study of healthcare robotics within a pre-commercial procurement project that sought to enrol public institutions as end-users of robotics for automating a geriatric assessment procedure. Here, I will show that the politics of user-driven innovation harbours particular assumptions about users, technology, and "successful" innovation, which, in effect, restrict users' agency but also engender conflict and contradictory outcomes. As a way of understanding this ambivalence between participatory policy and practice, I propose an *analytics of interfacing*. With this, I describe particular practices that aim to render users and innovation available for one another. Such a perspective asks how different and often disparate elements – like users, their needs, and technological solutions – are gradually produced and re-worked in order to "fit" together. Hence, 'interfacing' does not so much refer to the interaction between users and designers

but rather to installing certain corridors of interaction within which participants can negotiate problems, needs, and solutions. I will show that the outcomes of user-driven innovation processes are the product of gradual re-workings through such interfacing practices.

In the following, I will first introduce my conceptual framework of an analytics of interfacing, which I have developed from literatures that have investigated the performative dynamics of participatory processes on the one hand and more recent work on the political economy of participation on the other. Next, I will give an overview of the European field of user-driven innovation. I argue that this field has been stabilised at the interface of policy and academia harbouring three core assumptions, which configure the way how users are enrolled in user-driven innovation practices. Furthermore, I will introduce the empirical case, the "Public end-user Driven Technological Innovation" (PDTI) instrument, and its connection to the field of public-driven innovation. Here, I focus on a particular project that seeks to automate a geriatric assessment procedure in a Catalonian hospital. Using my analytical framework, I then identify three contradictory products of the PDTI process that show its indebtedness to the above-described political assumptions while also shedding light on how those assumptions were moulded and resisted in practice. Finally, I will summarise my findings and outline some implications for the study of user-driven innovation.

PARTICIPATION AS INTERFACING USERS AND TECHNOLOGY

For decades now, scholars in Science & Technology Studies (STS) have investigated the role of users in shaping technological change and producing innovations (Kline & Pinch, 1996; Bijker *et al.*, 2012[1987]). This has given rise to an extensive body of literature focusing on the relationship between users and technology in terms of mutual "co-construction" (Oudshoorn & Pinch, 2005). This includes both the ways in which designers and their technologies prescribe certain ways in which users can interact with the latter *and* how users continuously re-interpret as well as displace such scripts in use (Akrich, 1992). This early literature on users has been central to research on the performativity and governance of participation. Studies in this vein ask how participatory practices configure and thus construct the manifold publics they seek to address (Irwin, 2001; Wynne, 2006). Hence, users or citizens are not a pre-existing category external to participatory endeavours but are rather products of the "technologies of democracy" (Laurent, 2011) that seek to engage them. Such a perspective aims to deconstruct "residual realist' understandings of participation, democracy, and the public" (Chilvers & Kearnes, 2020, p. 349) by, for example, insisting

on a multiplicity of publics (Felt & Fochler, 2010), on the role of materiality (Marres, 2012) or on the performative nature of publics (Michael, 2009).

Many STS scholars who have researched participation in this vein have called for more reflexivity and inclusivity *vis-à-vis* common assumptions and configurations in participatory processes, since they often undermine the initial intentions (Vertesi *et al.,* 2017; Irwin, 2006). Partly as a result of this, topics like responsible research and innovation (Stilgoe *et al.,* 2013) and public engagement (Felt & Wynne, 2007) have now become commonplace in the European governance of innovation. This is particularly visible in the context of healthcare robotics and ageing. An increasing body of literature specifically focuses on the position of older users and health professionals in technology design. Such approaches problematise the passive user script in robotics (Neven, 2011) by claiming that (older) users' innovation activities should be recognised (Peine *et al.,* 2014; Östlund, 2010; Bergschöld *et al.,* 2020; Peine *et al.,* 2017). Such attempts are confronted with imaginaries of care in robotics, which still largely ignore the realities of care work (Maibaum *et al.,* 2021; Vallès-Peris & Domènech, 2020; Lipp, 2019).

However, despite these engagements with participatory practices, STS research has hitherto mostly excluded the policy dimension of participation. There is still a lack of empirical analyses of how participatory processes are shaped by and re-constitute assumptions made within broader political discourses on participation (Felt & Fochler, 2010; Delvenne & Macq, 2020). This has recently sparked interest in the political economy of participation (Tyfield, 2012). Most importantly for the case of European innovation policy, Macq *et al.* (2020) have argued that, in recent decades, there has been a considerable shift from a deliberative towards a productive approach to participation. They identify three phases of policy about participation unfolding since the turn of the millennium: deliberation (2000-2010), innovation (2010-2014), and production (2014-today). Deliberative approaches configured citizens as participants in political decision-making processes who are nonetheless external to the matter at hand – e.g., to certain scientific research areas or technological fields. Likewise, despite the inclusive imperative such approaches embodied, they did not prove immune to a deficit model of participation (Irwin, 2006). During roughly the first half of the 2010s, innovation concerns played an increasingly important role in the European policy agenda. Here, participation was a means to align new scientific and technological advances with societal challenges and consumers' needs. The main role of consumers was to facilitate the design of marketable products, which would, in turn, help to stimulate European economies and strengthen international competitiveness. Finally, Macq and colleagues have noted a new phase starting around 2014, when participatory policies began to configure citizens, users, and consumers not as mere participants in public debates or innovation processes but as

their active drivers. Drawing on new concepts and ideals such as co-creation, citizen science, or user-driven innovation, European policies saw publics as legitimate producers of knowledge and innovation in their own right.

I add to this strand of literature by arguing that instruments of user-driven innovation not only construct different publics or forms of citizenship but, more specifically, operate by way of extensively *interfacing* users and their concerns on one hand, and developers and their technological designs on the other (Lipp, 2019, p. 65-81). By interfacing I describe particular practices that aim to install and prescribe certain corridors of interaction between different actors (Lipp, 2022). Such practices essentially re-work these actors' interests and intentions so as to render them into fitting components of an overarching project such as co-creating a healthcare robot. What such an analytics shares with the above-mentioned approaches is a constructivist interest in participation (Chilvers & Kearnes, 2020, p. 354), i.e., the contention that users and their concerns along with technological artefacts are constructed by the very practices and instruments that seek to engage (and interface) them. However, an analytics of interfacing more specifically focuses on the kinds of practices that bring these elements into relation, both at the level of political assumptions and innovation practices (Lipp & Maasen, 2022). It is important to note here that this analytics does not replace notions such as configuration (Woolgar, 1991), script (Akrich, 1992), or co-construction (Oudshoorn & Pinch, 2005) but builds on them. The notion of interfacing aims to pay attention to how the mode of co-construction of users and technology changes due to a shifting political landscape of "productive" participation.

I argue that it is not enough to simply focus on the construction of publics and issues, their inscription into participatory formats, and their performance. Rather, it is worthwhile to identify the ways in which users and technologies are gradually rendered available for one another through ever more elaborate, co-creative procedures of user-driven innovation. This makes it necessary to trace and amplify how users and technologies become continuously reconfigured throughout user-driven innovation processes – in relation to one another. At the same time, it prevents the analysis from putting too much emphasis on the design of participation as opposed to its enactment (for a critique of this, see Felt & Fochler, 2010, p. 220). The analysis also takes stock of the manifold frictions between what user-driven innovation ought to be (e.g., based on the assumptions of policy makers) and how it plays out in practice (Macq *et al.,* 2021). As I will show in the PDTI case, neither users' needs, their ideas about robotics, the technical requirements that are communicated to the robotics community, nor the robotics technology itself are fixed entities once they are constructed. By contrast, they are constantly moulded throughout the PDTI process, sometimes with surprising results. Hence, this perspective remains sensitive

to the dynamics and mutual adjustments that are enacted in user-driven innovation practices while still keeping in view the rationales at work in broader policy and academic discourses.

THE EUROPEAN FIELD OF USER-DRIVEN INNOVATION

I will hence turn to the specific discourse of interest here: user-driven innovation. This discourse, I argue, has stabilised at the interface of policy makers and academic scholars that have been concerned with 'opening up' innovation practices to users. Its analysis thus includes both policy papers by the European Commission as well as academic work that has informed these documents. Here, I will analyse three core assumptions that have accompanied this new interest in users. First, user-driven innovation assumes that *users as innovators* are interested in producing innovation and in taking risks in the process. Second, it presumes that successful innovation is about *matching* users' pre-existing needs with malleable technologies. Third, it champions *cutting edge technological innovation* as a panacea for those needs and connects them to broader societal challenges.

The first assumption is based on the premise that *users are inherently innovative*. This assumption is fuelled by academic literature on users, especially in marketing research and business management, that critically engages with traditional models of production and consumption (Hippel, 1986; Toffler, 1989). One of the main arguments here is that users do not just passively consume what industries offer to them but are active in adapting products to their needs, coming up with new application scenarios, or even creating entirely new products. This is thought to be enabled by the increased availability of information and communication technology (Hippel, 2005). Such academic accounts of innovative users have more recently been translated into a strategic imperative for policy makers and businesses to co-create innovation together with those innovative users (Debackere *et al.,* 2014; Ramaswamy & Ozcan, 2014). Here, the concept of "lead users" (Hippel, 1986) has been particularly influential. The notion that users innovate is understood as a resource that public institutions and businesses should tap into. This is especially clear in the context of innovative procurement and demand-oriented policy, where public end-users are expected to create new "lead markets" for nascent technology (Edler & Georghiou, 2007, p. 955). Following this assumption, the main challenge is to register demand and "align it with emerging innovative solutions in the context of societal challenges" (Boon & Edler, 2018, p. 436).

The second assumption is that successful innovation is about *matching users' pre-existing, yet unsatisfied needs*. This assumption likewise entails a critique of

traditional "closed" models of innovation (Chesbrough & Appleyard, 2007). Proponents of user-driven innovation note a mismatch between users' specific needs and companies that have an incentive to reduce development and manufacturing costs and thus prefer to manufacture standardised, "non-innovative" products. Here, the promise of user-driven innovation is that it will meet unsatisfied needs by interconnecting those disparate actors, users, companies, technologies, and the market, within increasingly heterogeneous institutional arrangements – e.g., "networked, multi-collaborative innovation ecosystems" (Debackere *et al.,* 2014, p. 5). The invocation of users and their unfulfilled needs, which exist "out there", serves to legitimise various participatory processes in which users should supply knowledge about their needs to companies and public institutions in order to enable the latter to cater to those needs. Such "realist" assumptions about the unsatisfied user (Chilvers & Kearnes, 2020) pervade much of the user-driven innovation literature, especially business-related works on co-creation and open innovation (for instance, see Prahalad & Ramaswamy, 2004, p. 5). This defines "unsuccessful" innovation as insufficient information about those needs. It renders users largely apolitical in that it assumes that users just want their needs to be satisfied by marketable and otherwise politically contested products. In this sense, user-driven innovation also remains indebted to dyadic assumptions concerning malleable "technology" on the one hand and "markets" waiting to be exploited on the other hand (for a critique of this, see Pfotenhauer & Juhl, 2017, p. 74-75).

This leads me to the final and third assumption that has consistently shaped much of user-driven innovation discourses. It holds that, no matter the problem, *cutting edge technological innovation* is indeed best suited to fulfilling users' needs (Wesseling & Edquist, 2018, p. 494, Pfotenhauer & Jasanoff, 2017). Healthcare robotics and the grand challenge of an ageing society make for an illustrating case of this. Ageing is commonly framed as having potentially negative consequences for economic productivity and the stability of European healthcare systems (European Commission, 2010a). It is estimated that by 2050 almost 30% of the European population will be 65 or older (European Union, 2020). Spain, where this paper's case study was conducted, is no exception here. According to the United Nations, in the next 50 years, the Spanish population will decrease by nearly 10 million people while a third of that population will be 65 years or older (United Nations, 2019). At the same time, the topic of an ageing society features heavily within European innovation policy, namely as a backdrop for justifying increasing investment in high-tech technological innovation (European Commission 2010b, p. 2). Here, robotics has been firmly established as a potential technological solution to demographic ageing, at least on the discursive level (Lipp, 2019). Robots have been positioned here as a "universal tool" (Bischof, 2017, p. 162-163) that can be translated to almost any area of elderly

care and assisted living. There have been attempts to present robots as both an assistive consumer technology in the home and a medical technology that is used to support caregivers in institutional care settings (Partnership for Robotics in Europe, 2013). In this context, ageing has become an opportunity for technological development and business exploitation as well as a legitimising background story to showcase how benevolent and desirable robotics technology is. The concern of an ageing society has been connected to the imperative to innovate and thus transformed into an opportunity to foster economic growth. This interconnection between robotics and care is built on an "opportunist register of innovation and ageing politics" (Lipp, 2019, p. 63) that has rendered (robotic) innovation a societal imperative (Godin, 2015) and demographic ageing a techno-scientific problem (Peine & Neven, 2019).

THE "PUBLIC END-USER DRIVEN TECHNOLOGICAL INNOVATION" INSTRUMENT: CASE STUDY & METHODS

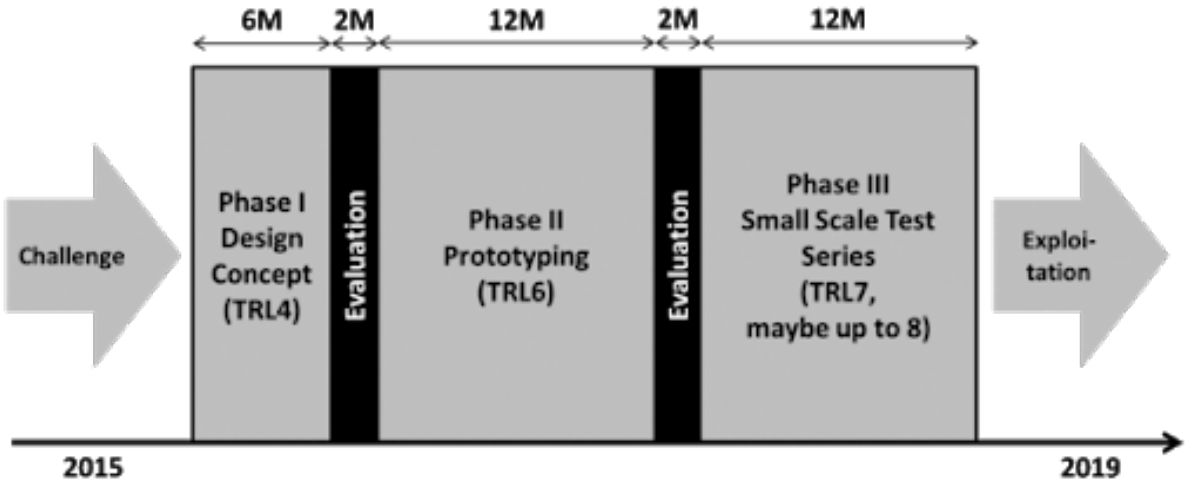
This set of assumptions has given rise to new participatory instruments and innovation initiatives. In the domain of robotics, the Public end-user Driven Technological Innovation (PDTI) instrument has been developed to facilitate user-driven innovation and to use it for promoting robotics in the public sector. In the following, I will introduce this case of user-driven innovation and show how, by design, it reproduces those assumptions of user-driven innovation.

The case examined in this article, the PDTI, is a particular funding scheme developed by the "European Coordination Hub for Open Robotics Development" (ECHORD) for the purpose of facilitating user-driven innovation in the domain of (healthcare) robotics. ECHORD was a European project funded under the Seventh Framework Programme and ran from 2013 to 2018. The ECHORD consortium coordinated the PDTI instrument and provided funds based on a cascaded funding scheme. It was led by European universities (e.g., Technical University of Munich) and robotics companies (e.g., Blue Ocean Robotics). Its mission was to bring robot technology "from lab to market" (ECHORD, 2018a). This mission connects ECHORD to the wider context of European innovation policy and, in particular, to the assumption that cutting edge innovation such as robotics provides solutions for tackling societal challenges. Robotics is seen as a contribution to alleviating the "(h)ealthcare burden of (the) elder population" (ECHORD, 2015b, p. 5).

At the same time, there is still a lack of uptake of robotics, especially in the healthcare sector (Maibaum *et al.,* 2021). That is why ECHORD offers a range of instruments specifically developed to facilitate interaction between users and developers to co-create robot technology "for real-use cases" (ECHORD, 2018a).

Among them is the PDTI instrument, which addresses public institutions and their members as end-users of robotics. This makes the PDTI an especially interesting case with regard to user-driven innovation policy, because it simultaneously highlights the public sector as funder (European Commission) and as beneficiary (the public end-user). It thus allows me to conceive of public authorities not just as actors who make publics (Felt & Fochler, 2010) but as publics themselves. The PDTI targets public bodies in a pre-commercial procurement process in which technical consortia develop prototypical robotics solutions tailored to their particular requirements. The pre-commercial nature of the process was chosen in order to lower the entry barrier for public bodies, which are perceived as rather risk averse (Interview ECHORD-1). The aim is to recruit these institutions as first users of robotics technology. This echoes the call in academic and policy literature on public procurement to view the public sector as an important driver of innovation (Edler & Georghiou, 2007; European Commission, 2007). Hence, the PDTI is based on the assumption that public end-user should be innovative effectively helping a nascent technology such as robotics to gain traction in new markets.

Figure 1: The PDTI process



Source: ECHORD, 2018b.

The PDTI process stipulates a particular procedure (Puig-Pey *et al.*, 2017), which operates as follows (see figure 1): the ECHORD consortium chose a particular domain, in this case healthcare, and called for proposals from public bodies to define a challenge that could be solved by a robotics application. During this "phase 0", an expert board evaluated all submissions and then selected one. In the present case, it chose the proposal by a Catalonian hospital to automate the so-called

"Comprehensive Geriatric Assessment" (CGA), a routine set of tests conducted by a geriatrician and other health professionals to assess an older person's health state. This general proposal was then translated into an open call that consortia from the robotics community (both industry and academia) could respond to by proposing robotics solutions. In a peer-reviewed evaluation process, the ECHORD consortium then selected three consortia to enter the first phase on designing a concept. After six months, these design concepts were evaluated (among others by the public end-user). From then on, two remaining consortia were expected to develop (phase II) and test (phase III) a robotics prototype to automate the CGA. The involved public body did not pay for the development directly; the costs (e.g., consumables, working hours) were reimbursed by ECHORD via a cascaded funding theme. However, the hope was that at least one of the solutions would convince the institution to invest in further development measures afterwards and to make the innovation market-ready.

My case study relies mostly on six interviews (see table 1), which I conducted with members of one of the two remaining consortia (CLARC), the Catalonian hospital, the "Agency for Health Quality and Assessment of Catalonia" (AQuAS), and the members of the ECHORD consortium. I recruited my interviewees via the ECHORD consortium, to which I had field access through affiliation (at the time of the case study I was affiliated with the Technical University of Munich). Through my first two contacts (ECHORD-1 and ECHORD-2) I could establish contact to the rest of my interlocutors. I conducted some of these interviews (ECHORD-1, ECHORD-2) in German and translated them into English. The rest of the interviews were conducted in English. In the interviews, I enquired about the PDTI process, i.e., the activities of the project as well as the particular role of each interviewee in that process. I especially focused on changes in the course of action as well as in the designs throughout the whole process. Additionally, I drew on a number of documents produced in the course of the PDTI process and beyond. For example, I obtained the original proposal by the geriatric physician (geriatrician's initial proposal), which led to the PDTI call on healthcare. I also analysed the two versions of the PDTI's challenge brief (ECHORD 2015a & 2015b). Most of these documents are publicly available and are publications of ECHORD, e.g., the project's website (ECHORD, 2018a and 2018b), or the research consortium's knowledge collection (CLARC, 2016). Finally, the analysis draws on field observations made during a series of tests in October 2018 in the Catalonian hospital. I triangulated these materials through a coding software. The coding was continuously informed by further data collection throughout the whole timeframe of the case study.

Table 1: List of interviews

Interview code	Role of interviewee	Organization / project	Date of interview
ECHORD-1	Project manager	Technical University of Munich	9 June 2016
ECHORD-2	Public relations	Technical University of Munich	9 June 2016
Doctor	Geriatric doctor	Catalonian hospital	8 November 2017
Roboticist	Roboticist	Malaga University	28 June 2016
AQuAS-1	Official	AQuAS agency	12 February 2018
AQuAS-2	Official	AQuAS agency	8 February 2018

Source: elaborated by the author (Lipp, 2022).

THE CASE OF THE PDTI: INTERFACING USERS AND INNOVATION

In the following, I will illustrate how the PDTI interfaces users and robotics. My analysis is organised according to three products of such interfacing practices: *innovative users*, *doable needs*, and *frugal robots*. These products correspond to different stages in the PDTI process. The first section refers to the preparation of the PDTI process, i.e., contacting public end-users and them submitting the initial proposals. The second section describes the creation of the "challenge for healthcare" based on those initial proposals, which were translated into technical requirements for robotics consortia. The third section draws on the design and testing of robot prototypes by consortia together with the end-user.

Innovative users: how the PDTI elicits demand for healthcare robotics

ECHORD has committed to the mission of bringing robots "from lab to market" (ECHORD, 2018a). The overall assumption in this discourse is that, due to demographic change, there *is* a self-evident demand for robotics in the healthcare sector. The PDTI is thus a way to stage this alignment by showcasing the supposed usefulness of robots to the European Commission funding the whole operation. Furthermore, in opting for a pre-commercial procurement scheme, the PDTI expects users to have an innovation mentality, i.e., to seek out prospective solutions that are not yet available on the market. However, these assumptions turned out to be problematic in the case of the

PDTI. Public authorities contacted by ECHORD coordinators were not aware of robotics and lacked the technical expertise to participate in a project such as the PDTI. Coordinators thus had to put extensive effort in seeking out and "interesting" end-users in robotics' ostensible benefits (Akrich *et al.*, 2002). The PDTI could thus not rely on a pre-existing demand for robotics but had to *elicit* demand by interfacing users with the promise of robotics innovation in the first place. This required the end-user to assume the role of the *innovative user* who supplies application scenarios that could be addressed by a prospective robotics prototype.

During the preparation for the PDTI process, ECHORD officials had a hard time acquiring public end-users who were interested in robotics or the PDTI process respectively.

> Well, the first thing that was necessary was that we have explained to public institutions …, what is robotics and what benefit can they generate via robotics. Well, we had a relatively long forerun, where we have started completely from scratch to contact public institutions, which were nowhere present and which we had to identify in a painstaking effort. It was like 'cold calling', you know? Making phone calls, well, cold calling in principle. So, and then to explain to people, what is robotics, what do we want to achieve with this call and so on and so forth. (Interview ECHORD-1)

Faced with such difficulties, ECHORD coordinators were forced to actively seek out and convince public bodies to participate in the PDTI process. To their surprise, they found it hard to get a hold of those authorities. It proved particularly difficult to find people within public institutions who were open to robotics innovation and who would assume responsibility for a pre-commercial procurement process like the PDTI. ECHORD interviewees described this as an extremely laborious task. It proved insufficient to rely on established channels of social media or public relations. Cold calling and "a lot of very expensive communication" (*ibid.*) was required. This shows that users are not simply "there" but that laborious efforts were needed to render them favourable to ECHORD's undertaking.

However, the PDTI is not only about selling robotics. It also requires the end-user to adopt an innovation mentality to robotics and the procurement process. In order to participate in the PDTI, end-users have to embrace robotics as a *prospective* opportunity but also assume risks in the case that it does not materialise. Here, too, users did not conform to this ideal initially but needed to learn how to perform being *innovative* users (Michael, 2009).

> In other words, you need an entirely different approach. You do not procure 'best value for money', but you take part in generating a product, which optimally satisfies your needs. That is a considerable mind shift, which is especially absent in public procurement in Germany. (…) And another problem is that we punish failure in Germany. (…) If you buy 'best value for money', the risk of failure is low. If you invest into innovative procurement, then the risk of failure is relatively high. (Interview ECHORD-1)

Hence, the PDTI invokes a specific representation of what users *ought* to do and be like. In addition to the common criteria of "best value for money", the public body should invest in robotics innovation not only to satisfy its needs specifically but also to become a lead user in the robotisation of CGA procedures at large. In the procurement literature, this is usually described as the public sector acting as a "lead market" (Edler & Georghiou, 2007, p. 955), where individual end-users (i.e., public institutions) trigger demand in a whole sector and thus create a new market for a given product or technology. For this, the hospital in question invested its employees' working hours, provided expertise ("demand knowledge"), and made available its facilities for piloting the robot prototypes. Any associated costs (e.g., consumables or working hours) were reimbursed through ECHORD. This was to compensate for the "relatively high" risk of failure (Interview ECHORD-1), i.e., of not producing a reliable product that fulfilled the users' requirements.

Furthermore, preparing end-users for the PDTI process required "a strong expertise in ICT [Information and Communication Technology]" (Interview AQuAS-1). Before submitting their challenge, the eventual public end-user that was picked for the healthcare challenge, was supported by another actor, the "Agency for Health Quality and Assessment of Catalonia" (AQuAS). This public body had longstanding expertise in conducting innovative ICT procurement in the region of Catalonia. Its technical expertise was necessary since the PDTI required end-users to identify other "current technologies that solve the described challenge or parts of it" (geriatrician's initial proposal, p. 1). Here, AQuAS identified potential competitors in this market and showed to ECHORD coordinators that there really was demand for a robotics product and thus high chances of bringing it to market. Once again, the PDTI could not rely on users to simply be innovative. Rather, it required a number of activities and additional actors that *rendered* users compatible with the rationale of the PDTI process. Hence, innovative users were the *product* of the PDTI and not a pre-condition for it.

Doable needs: how geriatric care is adapted to what robots can(not) do

Figure 2: The creation of the "Challenge for Healthcare"

Source: ECHORD 2016, p. 4.

The PDTI promised to ensure that robot technology would be tailored to "the requirements of the target group, technically and price-wise" (ECHORD, 2018b). In the previous section, I have already shown that public bodies did not have those requirements *a priori* but needed to be convinced by way of manifold networking and marketing techniques. However, this does not mean that, once proposals were submitted, these were simply adopted as blueprints for the development of robotics solutions. Instead, the submitted proposals were only the starting point for creating the so-called "Challenge for Healthcare" (see figure 2), which was then put out to tender. At the heart of selecting such a challenge lay the need to interface what users would want a robot to do and what it can actually do. As a result, the PDTI reconfigured end-users' initial proposals and produced *doable needs*[2], which, on the one hand, satisfied some sort of "need" on the part of users but, on the other hand, posed a doable technical challenge for roboticists.

[2] This notion of do-ability is inspired by Fujimura's ethnographic study of how scientists in cancer research construct do-able problems by articulating alignments between different levels of work organisation (see Fujimura, 1987). I will take do-ability as the result of extensive interfacing work not just by scientists but rather by a range of different actor groups (engineers, users, coordinators etc.).

The creation of the challenge took place, in close communication with end-users, during the "phase 0" (Puig-Pey *et al.,* 2017, p. 164-165). ECHORD coordinators sought to collect demand knowledge from end-users, i.e., to find out what they would expect robots to do in their respective domain. However, they were confronted with what they viewed as unrealistic images of what robots could do, which were "super strongly shaped by everything that is science fiction" (Interview ECHORD-2). Hence, public end-users *did* know about robotics but they supposedly had a "wrong" image of it that had to be corrected by what is "reflected in reality" (*ibid*.). For example, an interviewee referred to a meeting that he had with representatives from the hospital submitting the CGA as a challenge. Healthcare personnel had suggested that the robot could "do something like drawing blood" (*ibid*.). This, according to the interviewee, is miles apart from what robots actually are, which resembles more an "iPad on wheels" (*ibid*.).

Nascent fields of science and technology often depend on constructing promissory discourses around, for instance, prospective benefits of their technology (van Lente, 1993; Brown & Michael, 2003). Robotics is an especially illustrative case in this respect, since it heavily draws inspiration from science fiction (Bischof 2017). In turn, when confronted with such expectations *in situ* – for instance, from funders or test users – scientists engaged in activities of both lowering such expectations (Gardner *et al.,* 2015) as well as staging what a given technology might do when it is fully realised (Lipp, 2019, p. 146-163; Möllers, 2016). In the particular case of the PDTI's phase 0, ECHORD coordinators interfaced the seemingly "two completely different worlds" between users and robotics (Interview ECHORD-2), i.e., they produced a challenge that sufficiently promised usefulness to users and remained within a corridor of do-ability within "5-10 years" (Geriatrician's initial proposal, p. 1). For this, the ECHORD consortium organised a series of workshops and information days that aimed to align what might be beneficial for a particular user in healthcare and what might be doable with robotics.

After this initial selection process, the winning challenge, i.e., the CGA procedure, had to be translated into a so-called challenge brief, i.e., a document that specified to the robotics community the technical requirements of an eventual robotics solution. It hence required another "translation transfer from what they [the hospital] want and what that means in the language of roboticists" (Interview ECHORD-1). This process required "a lot of work" in various meetings in both Barcelona and Munich involving the public body, AQuAS, and a board of robotics experts commissioned by ECHORD (Interview AQuAS-1). This led to the release of two consecutive challenge briefs, since the first one did not yield proposals "with enough quality" (Interview AQuAS-1). I will come back to this statement about quality in the next section. For now, it is important to note that the drafting of these challenge briefs

did not leave the functional requirements of the hospital untouched but instead significantly changed or simplified the CGA procedure. By contrast, studying the two versions of the challenge brief shows that interfacing "what users need" into "what robotics can do for users" requires the former to be adapted to the latter.

For instance, performing the CGA takes about 40 to 60 minutes. This is an extremely challenging task for robotics. In fact, during the small-scale field tests that took place later on in the PDTI, one of the roboticists told me that performing the CGA for about twenty minutes was already a great achievement by the standards of robotics research. Furthermore, the challenge brief made some suggestions on how to adapt the CGA to what robots can do in order to circumvent some of the CGA's complexities. For instance, the challenge brief proposed "to change the questions in closed ones with pre-defined answers" (ECHORD, 2015a, p. 1). This alternative was "useful" (*ibid*.) since it reduced the complexity of the problem at hand, which in any event posed a great challenge.

Hence, it shows how interfacing robotics and the CGA did not leave "the requirements of the target group" (ECHORD, 2018b) untouched but rather prompted their intentional simplification in order to adapt them to what robots can do (see also Lipp 2022). Such workarounds can pertain to simply shortening the length of tests. Moreover, they can also entail altering the modality of the CGA. Changing questionnaires from open to closed does away with patients' ability to respond outside of pre-defined answers or to ask questions themselves. It shows how the elements that the PDTI purports to satisfy, like users' requirements, are actually the product of a long chain of interfacing activities that can profoundly change what it set out to do. In the end, phase 0 was not only about creating a "Challenge for healthcare" but also a do-able, decidedly technical challenge for robotics.

Frugal robots: how users disrupt robotics innovation

The PDTI promised close interaction between "technology developers and the public authorities […] during the conception and development of the solution" (ECHORD, 2018b). While the previous sections covered the interfacing practices involved in the acquisition of end-users and the conception of a "challenge for healthcare", I will now illustrate how a particular end-user within the hospital, a geriatrician, impacted the technical outcome of the PDTI. Here, the PDTI stipulated different instances in which the robotics consortia (initially three, then two) would interact with the public end-user, for instance, by receiving feedback and demonstrating prototypes in the hospital's facilities. One of the key design criteria defined in the challenge brief was the robot's mobility. This was envisaged as offering additional functionality (e.g., escorting an older person to the assessment room) and was thought to provide a more sophisticated technical challenge. However, throughout the design iterations and

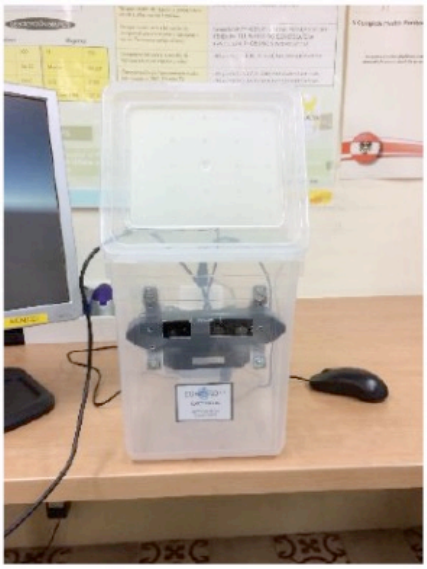
feedback loops, it became clear that such a solution would be too expensive for the end-user (the hospital) and not reliable enough to actually perform the CGA. In response to that, CLARC's competitor consortium ignored the requirement and instead went on to develop what one could term a *frugal robot* simply consisting of a "camera in a box" and a tablet. By frugal I refer to a design strategy that seeks to reduce the technical complexity of a given technology in order to provide a more cost-effective and reliable solution to a given problem (Radjou *et al.,* 2012). This design choice was preferred by the doctor but controversial within ECHORD, since it disrupted one key assumption of the PDTI: that the solution to public end-users' problems would have to be robotic.

Users' idea of innovativeness clashed with what the PDTI process had defined as an innovative solution. As mentioned above, the "challenge for healthcare" required robotics consortia to go beyond the state of the art. Crucial for this was the technical requirement of mobility. The robotics solution, as originally envisaged, should be able to autonomously navigate the hospital premises and "to maintain sufficient visibility for the video and audio recording of patients during the tests" (ECHORD, 2015b, p. 13). Interestingly, this criterion was only added to the second version of the challenge brief. While the first version states that "[t]here is no need to have mobile platforms" (ECHORD, 2015a, p. 3), the second lists mobility as a technical requirement (ECHORD, 2015b, p. 13). Mobility was seen as a defining criterion that stood for innovativeness and, as one of the roboticists at CLARC puts it, "the major difference between the robot and the PC" (Interview CLARC). Hence, the PDTI embodied a specific idea of innovation that favoured technological complexity over applicability.

As indicated above, the public end-user had a different perspective on what constituted a good solution. The geriatrician and AQuAS were looking for "[s]ome technologies… [that] helps to mechanise a process" (Interview AQuAS-1). This meant that the public end-user "thought in a technological solution for [the] CGA process, not specifically a robotic device" (Email geriatrician). Most importantly, the solution was envisaged to save time for doctors and leave more time for other activities. They were not looking for a solution with sophisticated assistive or interactive abilities: "We don't want to create some kind of machine to help the elderly person to do the assessment but we wanted a system that was connected and recorded information from one time to the next" (Interview AQuAS-1). Hence, the solution did not need to be a mobile robot with advanced interactive capabilities. There was one important reason for this insistence on simplicity and technological openness: the affordability of the solution. On the one hand, robotics as understood by the PDTI is a very hardware intensive and thus expensive technology to develop (see, for instance, CLARC's design, figure 3). On the other hand, the healthcare sector is a particularly price-sensitive area, which sees itself under increasing "cost pressure" (Interview AQuAS-1)

due to demographic change and ongoing austerity measures (Stuckler *et al.*, 2017). Thus, the PDTI produced the contradictory challenge of developing an affordable robot. The second consortium "met" this challenge by simply ignoring the criterion of mobility and focusing mostly on a software solution, the "camera in a box" (see figure 4).

Figure 3 & 4: the CLARC design (left) & "the camera in a box" (right)



In the end, the frugal design, the camera in a box, represented a much better fit between what robot developers had on offer and what a geriatric doctor might be able to use in practice. I specifically say "a geriatric doctor", since this fit was largely impacted by the doctor's perspective on the CGA. It leads us back to the particular vision of the CGA that the doctor sketched out in the initial proposal. The idea was "to mechanise" (Interview AQuAS-1) the CGA. This configured the assessment procedure as a process of "just 'doing tests'" (challenge proposal). Hence, automating the CGA promised to relieve the doctor of the burden due to the CGA's "repetitive/mechanistic and tiring nature" (email geriatrician). This distinction between tedious and valuable aspects of (care) work is a common thread in automation narratives (Rhee, 2018; Lipp, 2019, p. 107-109; Vallès-Peris & Domènech, 2020). It essentially establishes hierarchies between different forms of labour and assumes that individual parts of it can be extracted and taken over by specialised machinery. However, during the tests towards the end of the project, it became clear that the assessment was really a highly complex process that posed great challenges both for robots (which have difficulties operating autonomously for longer than twenty minutes) and for older users, who struggled to perform the test on their own or with the robot.

This points to a central contradiction of the PDTI process. By championing cutting edge robotics technology, it undermines its very purpose, i.e., showcasing robotics to users and the Commission as a practical solution to real-world problems. The eventual disregard of the frugal design embodies both failure and success of user-driven innovation as it is conceived and practiced within the PDTI. While it shows how a single end-user can have considerable impact on core assumptions and outcomes of a user-driven innovation processes, it also illustrates how the PDTI's core idea about cutting edge robotics innovation persisted in the end. Moreover, it shows how user-driven innovation also begs the question of who is identified as the "right" user in such a process. In the case of the PDTI, the geriatric doctor had a significant say in the direction of the design process while older people and other health professionals were marginalised at best.

CONCLUSION: THE GOVERNMENT OF USERS AND ITS CRITIQUE

The case of the PDTI illustrates how assumptions made in the discourse of user-driven innovation both shaped innovation practice but were also warped or displaced in that very practice. Here, my analysis identifies three concrete (contradictory) products: *innovative users*, *doable needs*, and *frugal robots*. An analytics of interfacing shows how these products come about through concrete practices that aim to interconnect users and their concerns with developers and "their" technologies. Moreover, it illustrates the link between broader assumptions in European user-driven innovation policy and concrete projects such as the PDTI.

First, user-driven innovation presumes users to be innovative. This not only pertains to active participation in innovation processes but also includes that these users have a demand for especially technological innovation. They are assumed to know about its benefits and to take associated risks regarding uncertain innovation outcomes. However, the PDTI case shows that these assumptions were in no way in place but needed to be laboriously elicited by way of marketing and networking techniques. In doing so, PDTI coordinators did not just have to convince users of the benefits that robotics might have in their professional domain. They also had to make them assume a particular role, the *innovative user*. Users were asked to adopt the mindset of innovators that developed stakes in the innovation process by investing time and money in robotics development.

Second, user-driven innovation imagines the innovation process as a matching process, where pre-existing yet unsatisfied "needs" by users are connected to malleable technology. The promise of innovation is then to meet those unsatisfied needs by merely connecting a range of disparate actors, users, companies,

technologies, and the market, in coordinated innovation activities. However, the case of the PDTI shows that the requirements for a robotics solution were not simply set by users but had to be adapted to what robotics actually can(not) do. This involved a balancing act on the part of the PDTI coordinators to, on the one hand, disappoint users' expectations *vis-à-vis* care robots and, on the other hand, motivate them to supply new applications scenarios that required robotics developers to go beyond the state of the art. Thus, the interfacing of users' needs and what robotics can offer occurred within a corridor of do-ability or, put differently, *do-able needs* that somewhat satisfy both sides.

Third, public end-user innovation champions cutting edge technological innovation as a panacea to a range of societal challenges. Demographic change is a particularly illustrative example, where various information and communication technologies have been inscribed in the quest to tackle healthcare challenges associated with an ageing society. In the case of the PDTI, robotics is promoted as a means to automate a geriatric assessment procedure thus disburdening care personnel. However, the solution that eventually seemed to solve this problem was not robotic. Instead, the end-user preferred a frugal design dubbed a "camera in a box", since it was more affordable and reliable compared to a mobile robot design. Hence, such a *frugal robot* challenged the idea that public end-users in the healthcare sector were best served by cutting edge robotics innovation that required roboticists to go beyond the state of the art.

What does this mean for reflecting critically on the PDTI in particular and on the politics of user-driven innovation in general? First, an analytics of interfacing can convincingly show the interrelation between broader political rationales and innovation practices *in vivo*. The PDTI is a paradigmatic case for how the central tenets of user-driven innovation can become warped or displaced by practices and rationales of (robotics) innovation. As a result, an analysis focusing on the manifold interfacing practices "on the ground" can show how user-driven innovation has all kinds of often contradictory effects. The PDTI illustrates how users become interfaced within the context of broader imperatives of innovation policy, i.e., being motivated to engage with a technology they would otherwise not have considered or needed or being confronted with additional responsibilities such as investing in (robotics) innovation. Moreover, users' concerns were consistently adapted to the political fabric of the PDTI in particular and user-driven innovation policy in general. In this context, the assumption of robotics as a solution to demographic change led those concerns to be adapted to robotics and not the other way around. The PDTI also shows how users take a different position than in traditional, linear innovation models. Here, the elevated position of the geriatrician illustrates that users indeed acquired some agency to impact the innovation outcome. This can be seen in the frugal robot design

that was pursued by one of the consortia in response to the geriatrician's feedback and contrary to the initial design criteria defined by the PDTI coordinators. However, this "frugal" fit between the user and the developers also turned out to be partial and limited, since it represented only the doctors view on the geriatric assessment procedure and thus excluded or at least marginalised other users, such as older people or other health professionals. Hence, a critique of user-driven innovation must include the question of who comes to be interfaced as the "right" user in such processes. From the perspective of an analytics of interfacing this question will have to be answered by looking at the interrelation of broader rationales and concrete decisions taken on the ground. In the case of the PDTI, the elevated position of the doctor resulted from a 'political' fit, where the doctor's desire to reduce his "mechanical" workload of testing coincided with the economic imperative of reducing costs in the healthcare sector in the face of demographic ageing. Thus, a critique of user-driven innovation must concentrate on the question: driven by *whom* and "at what cost"? (Foucault, 1997, p. 29)

A critique of the PDTI in particular and thus of user-driven innovation more generally can hence be guided by at least two sets of questions: what kinds of *subjectivities* and expectations do user-driven innovation instruments such as the PDTI invoke about users' positions? The PDTI case shows that such expectations of users are connected to wider assumptions about users' innovativeness, which, as my analysis shows, denotes a product of user-driven innovation rather than its pre-requisite. Beyond this, the presumption of innovative users also raises the question of the desirability of such an "ideal" for users. Should users' interests really be aligned with a political regime that is predicated on the assumption that the best means for tackling societal challenges is high-tech innovation? In the case at hand, ECHORD preferred a solution that was largely useless to the end-user, simply because it advanced robotics research and was appealing by virtue of fitting into a wider rationale of European innovation policy. Furthermore, my analysis of interfacing in the PDTI case shows the *reciprocal* ways in which users' needs and technology become mutually adapted to one another. Here, the question is who is (dis)counted as the user? Whose needs are invoked in user-driven innovation processes and whose needs become marginalised in the process? I have shown that the PDTI was predicated on the idea of finding a do-able but challenging problem for the robotics community to demonstrate the desirability of robotics in the public sector. This attempt was based on a rather partial idea of how geriatric assessments operate, represented by one singular doctor in a Catalonian hospital.

An important lever for critique in this context is to follow this ambivalence of interfacing users and technologies in the course of innovation practices while at the same time attending to their configuration through broader political rationales. This

middle position focuses on practices of interfacing as the paramount vehicle for critical enquiry. Such critique consists in investigating and questioning the ostensibly self-evident rationales that inform assumptions about the compatibility of users and innovation. User-driven innovation is thus not simply about users driving innovation but about interfacing users with a particular rationality of innovation politics. Hence, critique can be defined as the persistent quest to unravel the (political) assumptions on which such endeavours of interfacing rely, as well as the impositions with which they confront the actors that are involved in innovation practices "on the ground" (see also, Lipp, & Maasen 2022).

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The Configuration of Older Users as Drivers of Innovation in the Design of Digital Technologies

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ABSTRACT

This paper develops hypotheses on the discovery of "users" in publicly funded development of digital technologies for people in old age, on the motivations behind, and on consequences for the products and people in old age. We reconstruct the involvement of users in two funding programmes, one on the European level and one on a national level (Germany). Based on this, we discuss resulting consequences by describing how older people are configured as users in technology development focusing on the concept of user-centred design (UCD) and what this configuration bears for the technologies developed as well as for the users. We describe that participation of older people in technology development projects is a complex task that is not beyond controversy within social science research on user participation. Finally, we briefly argue in favour of alternative technology development strategies and funding practices.

Keywords: Innovation Age; Digitization; Participation; Funding Policies; User-Centred Design (UCD); Solution-Centered Design.

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INTRODUCTION

In the contexts of digitization, older people are often considered late adopters. Supposedly, they are particularly excluded from the digitization process (Ehlers *et al.*, 2021). However, the last decade saw the development of various digital products and digitally supported services specifically designed for older people, including several smart home devices and active/assisted living (AAL) technologies. The development of these products was frequently supported by public funding programs, on national as well as supranational levels (Meyer *et al.*, 2011). This process integrated older people into technological development and design through different approaches and their participation has frequently become mandatory for receiving funding. Despite this funding policy and the application of various design approaches for the participation of older people in technology development, we argue that their integration might be misleading. The article describes these developments, critically discusses the form of participation of older people as users in technology innovation and asks for opportunities to reconfigure this role and for alternative technology development strategies.

The paper combines results from a systematic literature review (Merkel & Kucharski, 2019), a document analysis of European and national funding programs in the context of active/ambient assisted living, and integrates our observations as researchers who have been active in the field for several years. Furthermore, we confront the common practice to adopt "user-centred" (Norman & Draper, 1986), participatory and co-creative strategies of applied sciences into technology development processes with knowledge from social science research methods. We will mainly focus on the concept of user-centred design (UCD) as we argue that UCD and related concepts follow comparable strategies and methods and thus bear similar challenges that need to be considered. However, in this paper, we do not refer to UCD in all contexts, but specifically focus UCD in the field of ageing and technology development.

INVOLVEMENT OF OLDER USERS IN (DIGITAL) TECHNOLOGY DEVELOPMENT

Research on user involvement in the field of old age and digital technologies has continuously gained relevance as multiple scholars, mainly from the fields of gerontology, psychology, and sociology but also science and technology studies (STS) are critically engaged in the field (see, for instance Künemund & Tanschus, 2013; Endter, 2016; Peine & Neven, 2019; Wanka & Gallistl, 2021). Both the motivations for user involvement and the common practices have been analyzed in two recently

published reviews on user involvement in the field of ageing and (digital) technology (Merkel and Kucharski, 2019; Fischer *et al.*, 2020).

Merkel and Kucharski (2019) find that one of the main reasons for the involvement of older users is the association of user involvement with better outcomes in the sense that older persons are more likely to adopt and use technologies. However, even though this assumption is expressed in several studies, empirical evidence is scarce (Fischer *et al.*, 2020). Other arguments for user involvements are described by Beimborn *et al.* (2016) and cover ethical reasons, namely empowerment and democratisation (Beimborn *et al.*, 2016). Users should be "consulted about research that is conducted on them" (Walker, 2007; Beimborn *et al.*, 2016, p. 324) and have a right to influence the research processes actively. Furthermore, the participation of older people should help to counter negative age-related stereotypes and ageism (Peine *et al.*, 2014; Beimborn *et al.*, 2016; Endter, 2018; Wanka & Gallistl, 2018). Fischer *et al.* (2020) argue that mainly three motivators can be used to summarize purposes for user involvement: (1) soft motivators, such as learning about older people's lives or getting feedback on prototypes, (2) material motivators, such as achieving a better quality of design, and (3) normative motivators, such as empowering the users. Those motivators form the starting point of an analytical framework on user involvement of older users proposed by the authors. This model covers the purpose, nature, and consequences of involving older users. With respect to the consequences, the authors find that three aspects are relevant here: (1) learning, (2) adjusted design, and (3) an increased sense of participation (Fischer *et al.,* 2020). *Learning* encompasses a mutual process, as older persons learn about design and development processes and the technicians/designers about the life worlds of older persons, which might help to counter negative age stereotypes (Fischer *et al.*, 2020). Technology design can be *adjusted* because of user involvement and, consequently, might result in a better design quality. An *increased sense of participation* manifests, for instance, in positive feelings of older persons on participating and having a voice in the research and design process (Fischer *et al.*, 2020).

Various methods are used in the design process of a technical artefact to test the prototype and ensure that the requirements placed on it are met. Therein, UCD has become the key design approach. It aims at achieving a high degree of fit between the needs and requirements of the later users and the technical artefact by involving persons who represent the target group as good as possible.

UCD goes back to the psychologist Donald A. Norman, who in his work at the University of California San Diego dealt with design principles for user interfaces in the late 1980s. He first presented his concept together with Stephen W. Draper in the

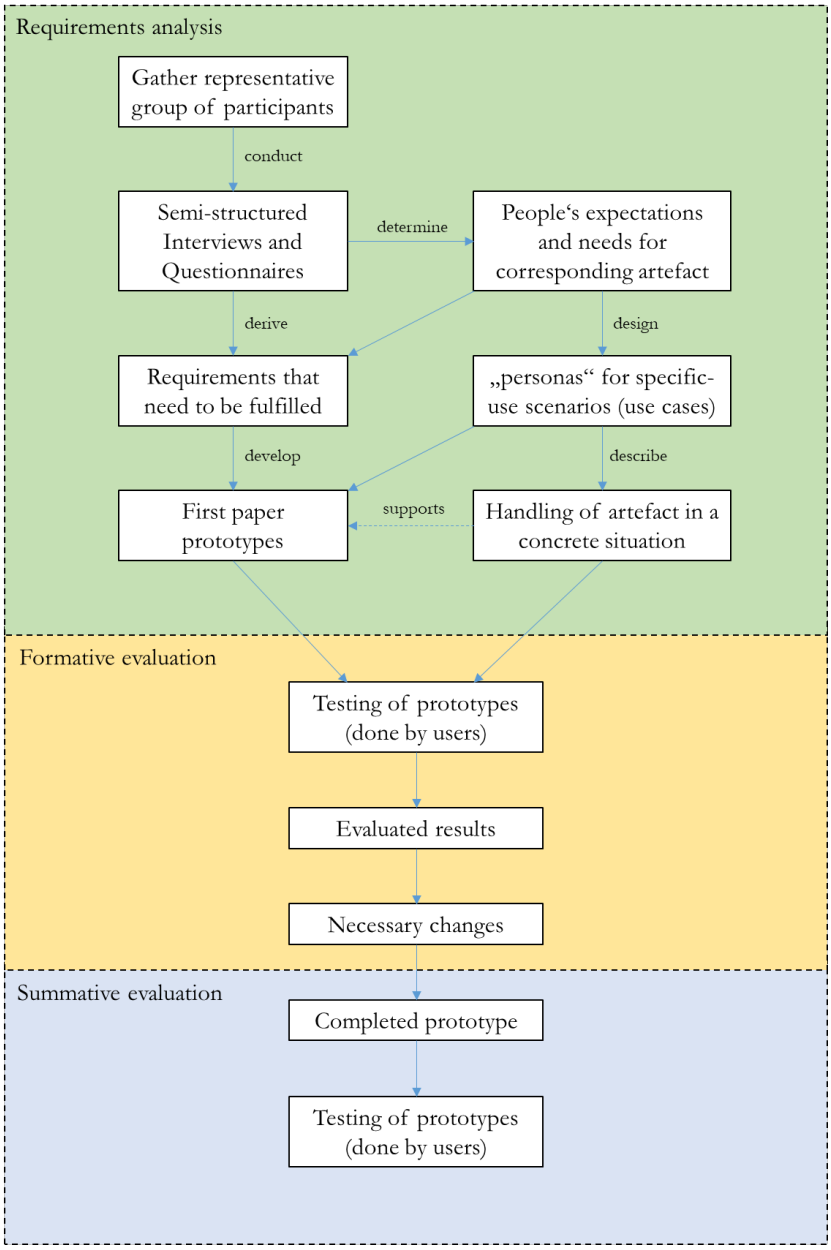
book "User-Centred System Design: New Perspectives on Human-Computer Interaction" (Norman & Draper, 1986). It is followed by "The Psychology of Everyday Things" (Norman, 1988), in which Norman further elaborates his approach regarding basic design principles.

Although it is explicitly stated that products should be designed with and for older users, it remains unclear how this should be practically achieved. Idealized, the design process of a technical artefact consists of various phases and methods that serve to test the prototype to see whether the requirements placed on it are met. The focus is on the usability and functionality of the artefact. UCD has established itself as a central design approach. It aims to achieve a high degree of fit between the needs and requirements of future users and the technical artefact by involving people who represent the target group as well as possible. According to Norman's claim, the consideration of future users takes place at various points in the development process. In the first phase, the requirements analysis, people are asked about their expectations and needs for the corresponding artefact by means of qualitative, semi-structured interviews and questionnaires. From the results of the survey, requirements are derived which the later device or system must fulfil. To bundle these and illustrate them vividly, so-called personas can be designed on empirical data, which are embedded in specific use scenarios (use cases) in which their handling of the artefact at disposal is described in more detail in view of a concrete situation. At the same time, first paper prototypes can be developed based on the requirements and evaluated by the test users.

After the context of use has been ascertained and the requirements for the technical artefact have been derived and defined, the second phase of the design process follows, in which the future product is conceptualized and designed. Here, the users have the task of testing the prototype designs in the form of paper prototypes or mock-ups (formative evaluation).

While the results of the formative evaluation flow into the further development process, the summative evaluation – and thus the third phase – is about testing the completed prototype. Similar to the second phase, the participants perform a series of tasks with the prototype that are typical for later use. The aim is that the test persons complete the tasks with as few errors as possible – without difficulties or interruptions – in as short a time as possible and are satisfied with their own performance as well as with the operation of the device. In contrast to the formative evaluation, the results of the summative evaluation do not flow into the development process, as this is already considered completed. Rather, the summative evaluation serves to check whether the product meets the goals and expectations of the users. Figure 1 illustrates the three phases of a typical and idealized development process.

Figure 1: Development process based on Norman (1986)



Source: Source: Own representation based on Norman/Draper (1986) and Norman (1988).

In recent years UCD has become an umbrella term for a broad set of methods and agendas linked to the participation of users in different fields of innovation (Mackay *et al.* 2000; Karlsson *et al.*, 2012; Marcus, 2015). In addition to the more narrowly defined UCD approach, there are several approaches that address a broader group of users, such as human-centred design, design for all, or universal design. What they

have in common is the goal of making human-technology interface accessible for all users, regardless of prior knowledge and experience, age, and gender. However, UCD seems to be the dominant concept and especially in European and national funding programs on assistive technologies for older people – like for example AAL – it has become one of the main approaches to enable older people to participate in the design process (Merkel & Kucharski, 2019; Fischer *et al.*, 2020). In these contexts, UCD goes beyond Norman's classical conception by shifting the focus towards user driven technology development. Here, the participation of older people in the design process pursues different objectives. First, UCD – as it is for example mandatory in the German funding program on AAL – is a reaction to the lack of market success of the developed technologies (Greenhalgh *et al.*, 2016; Fachinger, 2018). To overcome the missing market penetration UCD should guarantee that needs and requirements of older users are met, and the products' acceptance increases (Compagna, 2012; Endter, 2021).

In contrast to this political agenda, the practical implementation of UCD reveals that these objectives cannot be achieved easily. Rather, it becomes clear how tricky the application of UCD is. Nevertheless, it plays a central role in publicly funded technology development in the field of ageing and technology.[1]

INVOLVEMENT OF OLDER USERS IN THE PERSPECTIVE OF PUBLIC FUNDING PROGRAMS

Vines *et al.* (2015) see funding bodies and governmental agencies as central actors influencing "what is researched, how it is researched, and what problems [research] seeks to address" (2015, p. 3). Drawing on that argument, we investigate public funding programs in Germany and the European Union to analyze how user involvement is framed and what exactly is understood by the term in practice. For Germany, we will concentrate on recent programs launched by the German Ministry for Research and Education (BMBF) and give a general overview based on our observations. On the European level, we will look specifically at the Active/Ambient Living Joint Programme (AAL-JP). Here, we obtained all official call texts as well as supplementary documents from the official website[2] starting with the first call in 2008. The call texts were then screened for information on user involvement (e.g., suggested methods, definitions of users).

[1] Another discourse relevant here surely is on knowledge production (e.g., Gibbons et al., 1994), however, a critical discussion of this concept of transdisciplinary research is beyond the scope of this paper.

[2] http://www.aal-europe.eu/stay-up-to-date/calls.

In Germany, the everyday life of older people has been identified as a suitable field of application for AAL and smart home technologies. However, it is not innovation and digitization that are brought to the fore within the funding policy activities, but the (statistical) factuality of an ageing population and the associated problems and challenges (BMBF, 2008). In the calls of the Federal Ministry of Education and Research's funding program, for example, a picture of demographic change is drawn up as a fundamental social change and challenge that requires political control and action. It is emphasized that demographic developments will lead to massive burdens on the social systems. At the same time, it is emphasized that the (future) need of older people for (outpatient) care and nursing can be met by adding technical assistance services. For this reason, the development of technical assistance systems is advantageous both for older people, as they can age in place, and for society, as they reduce the need for person-centered care and nursing associated with demographic change, as well as their costs, and at the same time strengthen Germany as an innovation and business location (BMI, 2012; BMBF, 2011).

UCD plays a central role within the German funding of "Altersgerechte Assistenzsysteme" [assisted living technologies] and thus in the political agenda to respond to demographic changes through technical innovations. Since 2011, projects funded within this funding line have had to work in a user-centred manner. This follows the recommendation of the AAL Expert Council, which the BMBF convened in 2009. In its recommendations ("Loccumer Memorandum"), the expert committee advocates the inclusion of potential users. It states:

> The success of technical assistance systems depends heavily on whether the needs, wishes and requirements of potential users are taken into account and incorporated into the development of technologies and services at an early stage. The participation of users is helpful for the preparation of requirements analyses, for testing and evaluating product concepts, for assessing operating concepts or for designing products, packaging, and operating instructions. (AAL-Expertenrat des BMBF, 2010, p. 4, translated by the authors)

Following the *Loccumer Memorandum*, the BMBF obliges the funded projects to implement UCD and to consider ethical, legal, and social issues. Accordingly, the Federal Government's research agenda for demographic change, published in 2011, states that:

> The focus of funding is not on individual technological results, but on the implementation of innovative solutions that also encompass social, ethical, legal, and other societal aspects and are mostly driven by user needs. The aim is to explore fundamental issues of social participation of older people and to develop innovative solutions, including new products and services for long and healthy aging. (BMBF, 2011b, p. 18, translated by the authors)

The mandatory recommendation of a specific design approach subsequently has a decisive influence on the projects and their working methods. Thus, a broad portfolio of methodological instruments for the implementation of the political requirement and an equally varied practice of UCD developed, oscillating between classic evaluation studies and market analyses on the one hand and participatory approaches on the other. Moreover, in most cases, software developers and engineers are assisted by social scientists who are responsible for the implementation of user participation.

The AAL-JP was initiated in 2008 by 20 European countries as well as Israel, Norway, and Switzerland (Decision No 742/2008/EC), based on the European Commission's action plan "Ageing Well in the Information Society" formulated in 2007 (Chicot *et al.*, 2018). The central aim of the action plan was to focus the development activities of information and communication technologies (ICT) on the demographic change. The rationale was that ICT can help to cope with the ageing of European societies and may result in a "triple-win": Improving health for Europe's citizens, supporting the sustainability and efficiency of the health and social care systems, and the expansion to new markets (European Parliament and of the Council, 2008). Since then, calls are published on a yearly basis and with differing foci in the field of age and technologies. To apply for the very first call published in 2008 "ICT based solutions for Prevention and Management of Chronic Conditions of Elderly People" (AAL-JP, 2008) a necessary condition was the integration of at least one end user partner organization in the consortium. According to the call text, the term "end user" is defined as either primary end users – those individuals who will be using the products or services –, secondary end users – persons or organizations in direct contact with primary users –, or tertiary end users such as organizations and institutions that are in indirect contact with the products and services such as insurance companies (Ambient Assisted Living (AAL) Joint Programme, 2008). The second call was published in 2009 and focused on the "advancement of social interaction of elderly people" (Ambient Assisted Living (AAL) Joint Programme, 2009). The call text was introduced with a statement that the AAL-JP aims for products and services "addressing identified wishes and needs of the end users" (Ambient Assisted Living (AAL) Joint Programme, 2009, p. 3). Furthermore, it encourages a direct involvement of end users and sees end user involvement as an "essential component of activities from the outset and throughout the life of the project." (Ambient Assisted Living (AAL) Joint Programme, 2009, p. 8). This is explained in more detail in a section on requirements that proposals need to meet:

> Applying technologies to fulfil the needs of elderly persons and their partners, family or friends, requires specific attention to user acceptance, user interface and usability design in order to meet the expectations, cognitive capabilities and eSkills of the end-users (whether primary or secondary end users). Importantly development and use of new ICT should not lead to exclusion and widening of the digital divide. To fulfil these requirements, involvement of end users during the

> whole process is essential. The solutions should be validated in 'real end user' situations for a well-defined user case study. (Ambient Assisted Living (AAL) Joint Programme 2009, p. 12).

With the 2010 call on independence and participation in the "self-serve society" (Ambient Assisted Living (AAL) Joint Programme 2010) end user involvement was regulated within the annex of the call, which described it as "mandatory and essential" for the first time (*ibid.*, p. 21). In addition, a framework for "end user involvement" was provided. It explained how an innovation culture should be realized where "the design of new solutions is done with and for the older persons" (*ibid.*). The framework focused on the innovation process and broke it down into three parts, (1) the exploratory and creative phases, (2) the development phases, and (3) business model development (*ibid.*). The framework remained unchanged until today – except that in later versions, the words "with" and "for" were not underscored anymore and that since 2014, with the call "Living actively and independently at home", a link was added to the framework's description pointing to several documents on user integrations (Nedopil *et al.*, 2013a, 2013b; Youse GmbH, 2013). These documents aim to explain potential benefits of user involvement, as well as to introduce and present methods and techniques for application in projects funded within the AAL-JP. Here, it is argued that focusing on the users – the report draws mainly on the concept of UCD – might result in "superior products that are often more successful" (Nedopil *et al.*, 2013b, p. 13). As the most important aspect, the authors see that "user integration […] allows a user-friendly product to be created." (*ibid.*). According to the authors, a user-friendly product or service is hence more successful, more likely to be accepted by the users, and, in turn, might save the developers money as mistakes during the development process are avoided. The report distinguishes four iterative phases of user involvement: (1) understanding the user, (2) conceptualization, (3) testing, and (4) business model development. Like the initial framework on user involvement defined in the call text, integration of users particularly in the first phase is understood as observing or asking them (without further methodological elaboration). During the second phase, more details on the role of users are given. Here, users are seen as "experts of their daily routines" (*ibid.*, p. 16). It is argued that listening to them – and not researchers and technicians – could prevent a "frustrating product experience" (*ibid.*). The report suggests working with lead users, characterized as having a "strong drive to improve their current situation and often already having ideas for solving a particular need" (*ibid.*). During the testing phase, "users can help innovators detect real errors" (*ibid.*, p. 17).

CRITICAL DISCUSSION OF USER-CENTRED DESIGN IN TECHNOLOGY DEVELOPMENT PROCESSES

When comparing the reasons for including older users in (digital) technology development mentioned in the literature with call texts and additional material of the funding programs, it seems that the central aim for user involvement is what Fischer *et al.* (2020) call material motivators. Consequently, the intended outcome of user involvement is mainly adjusted design leading to better market success. However, from a social science research methods perspective, many shortcomings, blind spots, and misunderstandings must be mentioned. Firstly, requirements analyses require some sort of theoretical or empirical representativity of study participants. In a quantitative paradigm this could be achieved by a random sample from population registers, making sure that not only individuals with, for example, strong interest in technology or better education take part in this requirement analysis, but most frequent patterns of competencies, life situations etc. are captured in the sample. In a qualitative paradigm, theoretical sampling might be an option, making sure that as many different life worlds and perspectives are covered as necessary for the theoretical problem which is being reconstructed from some first cases. Both strategies are – to our knowledge – rarely used. Self-selection or convenience sampling clearly dominate. Hence, results of the requirement analyses are biased in unknown ways already at the sampling stage (e.g., Grates *et al.*, 2018). Secondly, in a quantitative paradigm we would expect – for example – theories and hypotheses guiding the development (or at least selection) of valid and reliable measurement instruments and research designs. In a qualitative paradigm, we may favor the recording of social practices as they occur in everyday life to identify patterns that individuals involved are not necessarily aware of. What we usually observe in technology development for older adults, however, are rather naïve assumptions on user as experts that can be asked for their expertise using guideline questionnaires or *ad hoc* focus group discussions, instead of theoretical or empirical representativity (Beimborn *et al.*, 2016; Wanka/Gallistl, 2020). From our point of view, the assumption that users are "experts" is misleading. E.g., physicians, psychologists, sociologists, judges, and social workers will not simply rely on the diagnoses and solutions provided by those concerned, but use information provided as data to be carefully analyzed (while considering, for example, other data and sources of information, different methods and measurements, and of course theoretical knowledge about the phenomenon at hand). By contrast, in most UCD contexts requirements will extracted from what the sampled individuals have perceived, or suspect to be the problem, what might significantly differ from a professional assessment. For example, it has been shown that older individuals have developed coping strategies so that problems professionals might identify by observing the case are not mentioned in an interview

setting because the individual workaround exists: the problem is not cognitively present, although existent (Pelizäus-Hoffmeister, 2013). And as we know from the example of hearing aid usage, existing problems may be played down, withheld, or even completely denied, especially when stigmatization as "old" is feared (e.g., Vestergaard & Andersen-Ranberg, 2013). To summarize our criticism: Starting from individual "users" is an unprofessional and probably misleading strategy.

The shortcomings of convenience sampling and research methods are not limited to the requirement analyses. We also see these in formative and summative evaluations of the products. Nevertheless, exactly these procedures are frequently recommended, for example by Nedopil *et al.* (2013b) who recommend convenience sampling (e.g, "personal contacts might come in handy", 26) and generally data collection methods scratching the surface (e.g., "Self-Documentation" or "Walt Disney Method"). Data analysis and interpretation are widely regarded unnecessary. In our view, a funding program suggesting such a methodological repertoire (or even makes them mandatory), tends to mislead innovation processes. These procedures do not satisfy scientific criteria, neither quantitative nor qualitative, but what is more important: they also do not allow for generalizations of requirements or technological solutions.

Similar problems frequently arise where scenarios, personae, and use cases are the starting points for technology development. Starting from these – as alternatives for requirement analysis with user involvement –, again requires theoretical or empirical representativity of scenarios, personae, and use cases. It is our impression that frequently stereotypes of old age are merged to sketch these scenarios, typically addressing negative aspects of aging.[3] Hence, these negative aspects of aging are inscribed into the products developed, what might further contribute to the weak marketability. We rarely find any projects that aim at positive aspects, for example, self-fulfillment, wisdom, or enhancement of capabilities, except in some medical and rehabilitation settings of research. It is – at least implicitly – assumed that senior citizens are a homogeneous group, impaired and in need of help, living alone etc., not a heterogeneous group with certain abilities that can be trained, supported, or improved.

Other important aspects to consider in this context are generational and social change. Older people today – both in cases of scenarios and user involvement – might be very different from older people tomorrow, for example in terms of education, health, experience with technology, and lifestyle (DiDuca *et al.*, 2006). And these individuals as well as their environments change over time. For example, we have

[3] Cf. Künemund & Tanschus (2013); Endter (2021). Of course there are some approaches that draw on a more complex methodological design (see e.g., Waycott *et al.*, 2012; Vines *et al.*, 2015), these still seem to be the exception rather than the norm.

found that the acceptance of fall detection technologies increases with age, namely when falls become a prominent concern (Künemund & Tanschus, 2014). Patterns of sociodemographic characteristics, experience with technology and technology acceptance are not stable but differ between cohorts, change over time, and of course change with the availability of specific technologies.

Furthermore, within the framework of various ethnographic observations, it has been shown that the involvement of the users in the development of the technology should not disturb the overall process (Endter, 2021). Thus, it is already clear at the beginning of the participation how it should proceed and what results should emerge. Participation should take place, but it must not interfere, this is how the observation could be reduced to a formula. Thus, the users only appear when it makes sense and is helpful for the course of the project. It is also evident that both the decision at *which* point in time of the design process participation takes place, as well as *how* it takes place and *who* is involved, are an expression of a specific power relationship in which older people are involved, but do not participate (Endter, 2016; Endter, 2020).

While the political guidelines clearly advocate the implementation of UCD, professionals in the field criticize that this can often not be realized, or only to a limited extent. A usability consultant, for example, speaks of a "farce" (field note, 11.03.2014, Endter, 2021). A social scientist involved in the implementation wonders: "You have to ask yourself why you are actually doing all this. I always find the comparison to others quite good: I do crap, but the others do much bigger crap." (*ibid.*). Such statements reflect the ambivalence associated with the participation of older people: on the one hand, there is the requirement of the funding agency to involve older people so that the technologies are developed more in line with their needs, thus increasing their willingness to use them and improving the chances of the technologies being disseminated on the market. On the other hand, it shows how complex and time-consuming the integration of older people in technology development projects is and how there is still a lack of suitable formats, methods, and the necessary experience on the part of the project actors to make this process successful. At the same time, the limitations of user participation become visible: who, how, by whom and for what is involved is not decided by the older test users.

Against this background, it becomes clear that user participation is less a manifestation of the participation process of older people than of the powerful practices of establishing controllable users.[4] Neven (2010; 2015) asks why more and more older people should be involved in technology development and suggests that the outcomes of participation should be scientifically evaluated rather than continuing

[4] In a similar vein, Künemund and Tanschus (2013) have suspected that some scenarios might be constructed to demonstrate the abilities of the technology.

current practice, which has also been stressed by Merkel and Kucharski, who argue that not only the outcomes but also the process of user involvement should be evaluated (Merkel & Kucharski, 2019). Wanka and Gallistl (2020) also demand a revision of the funding programs which envision other participation formats of older people.

TIPPING POINTS OF USER INVOLVEMENT

It becomes clear that the participation of older people in technology development projects is a complex task that is not beyond controversy within social science research on user participation. Still, user involvement and associated concepts such as participatory design, or co-creation are considered "*sine qua none* in gerontechnology design" (Peine & Neven, 2019, p. 16). On the one hand, the view that older persons should be integrated into the design and development process of digital technologies has become more and more popular and, as shown, has also been acknowledged by policymakers responsible for public funding strategies. Beimborn *et al.* specifically refer to funding agencies and, more explicitly, to the AAL-JP when they state that "older people are increasingly involved in development processes, for instance in the evaluation of products, in selected decision or via empirical surveys on users' preferences" (2016, p. 323).

On the other hand, several aspects have been criticised in this regard, covering the intentions of user involvement as well as the realization. In view of the intentions, we showed that multiple aspects might influence the decision on integrating users. With respect to public funding programs, however, the main considerations seem to be in view of acceptance and, consequently, profitable products. Beimborn *et al.* (*ibid.*) point out that one of the major desired outcomes are devices better adjusted to the users which will be more successful on the market. Other motivators, such as empowering the users by giving them a voice during the innovation process seem to play a minor role. This might be an explanation to the "interventionist logic" (Peine & Neven, 2019) of technology in the field of ageing. Here, ageing is seen as a problem or challenge that can be overcome by the means of technology. Furthermore, it is criticised that in the context of technology development, older people are mostly imagined as a group of people who are distant from technology (Peine *et al.*, 2017), whereby this view is often accompanied by a paternalistic approach to older people (Wanka & Gallistl, 2021). Mackay *et al.* conclude that the practice of user participation has little in common with the humanistic, democratic, and utopian ideal of participatory design; rather, users are considered "a 'good thing'" (2000, p. 738) because their participation would lead to an improvement of the technical artefact. Hagen *et al.* (2018) speak of an acceptance bias of user-centred approaches that aim

to achieve acceptance through the means of participation – a bias that also often affects the role of non-technical researchers in technology development projects (Endter, 2015; Lassen *et al.*, 2015; Beimborn *et al.,* 2016). Peine and Neven (2019) identify a development within gerontechnology research projects that would promote the use of participatory methods but view them exclusively as a method for eliciting user needs for design and development (Peine *et al.*, 2014). Compagna comes to a similar conclusion stating that the integration of users is "a necessary condition for success" (2018, p. 177) but emphasizes that this does not necessarily mean that user involvement is successful. The use of participatory methods in the context of age and technology would promote specific problems – such as paternalistic access or the exclusion of older people who are difficult to reach – which are given far too little consideration in the current discussion of methods (*ibid.*). It seems that older persons are reduced to a rather passive than active role during the development process. Despite being seen experts of their life world, their role during the development process seems to be as supporters of researchers and technicians. A circumstance that is exacerbated by the lack of professionalization and institutionalization of participatory methods in the context of age and technology (Merkel & Kucharski, 2019; Endter, 2016). In this context, the involvement of older people is a thoroughly critical and challenging situation for the projects. This is especially true in the phase of the summative user tests, since at this point the development process of the prototype is largely completed.

This set of conditions leads the projects into an ambivalent situation: they must (1) involve people who represent the target group as accurately as possible and (2) ensure a stable, permanent participation of these people over a longer period and multiple tests, whereby the tests may be physically demanding, emotionally stressful and/or cognitively challenging for the test persons. At the same time, the project members must ensure that (3) the participation of the test persons does not jeopardize the success of the project. Even if the design of the artefact has been completed, the attestation of a lack of age-appropriate design and usability can become a problem for the project, as it firstly calls into question a successful introduction on the market, secondly casts doubt on the external presentation of the artefact as age-appropriate and thirdly impairs the proof of success vis-à-vis the funding body.

As an alternative, we would like to point to problem-centred, or even better: solution-centred design (Künemund, 2018; Künemund & Fachinger, 2018). The idea is to not start with a user, not even from a user perspective, but with a problem that needs to be solved, for example falls or cognitive decline. A multidisciplinary (in our case: gerontological) evaluation of a problem should review and discuss the literature and evidence first, or perform detailed qualitative research, if such evidence should be non-existent. At target here are causes of the problem. In the example of falls,

geriatrics, psychology, sociology, and social work will most probably mention very different causes like heart insufficiency or medication (e.g., Benzodiazepine), cognitive decline (e.g., declining ability to focus two or more issues at the same time, like remembering what one is looking for and watching the step), lack of social support (e.g., necessity to perform exhausting tasks), or inadequate housing conditions (e.g., slipping carpets). Given such an evaluation of potential causes, it should be discussed which of these causes can be addressed with technology in order to identify a starting point for technology development. As a second step, prior to starting any technology development or involving any user, potential solutions targeting these causes should be discussed with regard to potential consequences and side effects by means of thought experiments. For example, if the problem identified is cognitive decline, and the potential solution are reminder devices (e.g., pillboxes with reminder functionality), psychologists will (hopefully) intervene by pointing out that cognitive decline is slowed down by training prospective memory tasks, not by avoiding them, and that the potential solution might accelerate cognitive decline. We regard these two steps as starting technology development from gerontology and its interdisciplinary knowledge on aging instead from user stories or personas based on prejudices, negative images of aging, small and biased samples of potential users, or static representations from survey research. Users later will have to be involved in the evaluation of the technology developed (formative and summative evaluation in figure 1), but we should start from an evaluation of a theoretical problem (reconstructed from detailed qualitative research, when interdisciplinary scientific knowledge is non-existent) instead from anecdotical evidence. This implies multidisciplinary teams and research prior to any technology development, and of course prior to any user participation (which should match the necessary methodological standards, of course). Additionally, the funding programs should be adjusted to this problem-solving oriented approach, for example by providing starting grants to strengthen research on causes of problems to be solved instead of funding technology development starting from "users".

CONCLUSION

In this article, we argued against a naïve integration of older people in technology development processes, as it does not achieve goals like empowerment of the users or individual self-determination in old age systematically and might be misleading in terms of marketability products as well as problem solving. Current practices of user integration, and possibly the idea of UCD or participatory design itself are insufficient, as are co-creative settings. The main reason for our judgement is the missing scientific evaluation of a problem that needs to be solved, including causes and consequences.

Furthermore, forms of participation which may disturb, delay, or even terminate the innovation process, are overlooked, older users that are less educated or facing cognitive or physical limitations, are mostly not involved, and – finally – a scientifically based evaluation seems to be an exception, not the rule. Main problems here are convenience sampling, and *ad hoc* research methods, which most frequently do not satisfy methodological standards of sociology and gerontology. Moreover, we argue that funding programs enable and possibly encourage researchers to apply such misleading strategies: Although they encourage researchers and developers to apply UCD and similar concepts, they do not provide any specific recommendations. However, even if they do so, as is the case with the AAL-JP, the methods suggested focus on market success rather than user needs in terms of the problems to be solved.

We propose to focus more on the starting points of research and design projects: Understanding and evaluating problems. While users can play a role here, we underline that they do not have to – and user involvement could even be counterproductive. Instead, it should become standard to include methodological skilled gerontologists or social scientists with a focus on old age and aging. And a proper interdisciplinary analysis of a problem to solve should become a prerequisite for any application for funding. To be clear, that is no argument against participatory research and design, which can and should be applied in later stages of the research and development processes. Hence, alternative funding measures are needed, if the aims of the funding were self-determination in old age, independent living, and empowerment of people in old age.

While our paper argues based on observations made in the field of gerontechnology, our conclusion cannot be transferred the UCD in general. Still, we think that some of the arguments can also be considered in the overall discussions on UCD, which is also expressed by other researchers (Vines *et al.*, 2015).

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Users and non-users in engineering and feminist participatory research on sustainable aviation[1]

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ABSTRACT

Within engineering, economics, and the natural sciences, sustainable aviation is often configured as an ecological and economic problem, which can be solved through technological innovation. In contrast to this, we set up a research project centering on social innovation, named *Human demands of sustainable aviation*. In the project, we combined theories from Feminist Science and Technology Studies (FSTS) with methods from Participatory Design (PD) and practice-based Ontological Design (OD). In this paper, we use our project as a case study to analyze and discuss how users and non-users are configured within different disciplinary contexts. The findings illustrate that conceptualizations and categorizations of users and non-users are not stable. They denote highly situated phenomena that emerge out of different research approaches and understandings of innovation. Power structures that are entangled with the positions researchers take, including specific theories, methods, and (implicit) values, pervade these contexts and understandings. With this in mind, we advocate for power-critical reflections on the performative effects of knowledge making as processes of world making and for inter- and transdisciplinary research to do justice to the different life worlds we inhabit. We further argue that innovation should be based on collectively negotiated visions of how we want to live in the future, instead of predictions that project our current realities into the *status quo* of tomorrow.

Keywords: Feminist Science and Technology Studies; Ontological Design; Participatory Design; Social Innovation; Feminist Innovation Studies; Sustainable. aviation.

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INTRODUCTION

In the face of the global climate crisis and local environmental pollution around airports, including high levels of aircraft noise, aviation researchers strive to make aviation more sustainable. This objective requires more than the improvement or modification of existing technologies. Technological innovation alone will not suffice to eliminate the negative impacts of aviation on the environment in the near future (Åkerman, 2005; Fluglesvedt *et al.*, 2008; Heuwieser, 2017; Lee *et al.*, 2009, 2021; Okonkwo & Smith, 2016; Rothengatter, 2010). Political and social engagement is needed to establish sustainable mobility concepts that take account of people's variable relations with aviation worldwide.

Statistical research provides the following insights: in 2018, only around 11% of the global population travelled by air. Air travelers were mostly high-income people living in North America, Europe, and the Asian-Pacific Region (Gössling & Humpe, 2020). Even in highly industrialized countries, such as the USA, Great Britain, or Germany, over half of the population does not fly (Gössling & Humpe, 2020). Only 1% of the global population, namely frequent flyers, are the cause for more than 50% of emissions from passenger air travel (*ibid.*). At the same time, non-users of aircraft who live in the southern hemisphere are the ones most severely affected by the negative impacts of aviation as a catalyst for the climate crisis (Alston, 2013; Denton, 2002; Gössling & Humpe, 2020; Israel & Sachs, 2013). Despite these insights, many projects from engineering, the natural sciences, and economics focus on technological solutions tailored for sustaining conventional air travel in a more environmentally-friendly way, instead of exploring new holistic concepts for future mobility, which would consider differences in people's living conditions and mobility needs.

We, two feminist researchers at a technical university in Germany, launched a project that provided an alternative approach to making air travel more sustainable. Our project was part of an engineering research cluster[2], which focuses on sustainable and energy-efficient aviation. The objective of our project was to introduce the demands of users and non-users, whose needs are frequently marginalized in projects targeting technological innovation, into the cluster's research. As a complement to our colleagues' quantitative, economically – and technologically-oriented projects –, we applied a qualitative, feminist, participatory research approach to directly integrate and qualitatively investigate passengers and people living near airports regarding their demands for and future visions of sustainable mobility. In this paper, we use our project as a case study to analyze and discuss our findings concerning the performative effects of different disciplinary fields, theories, and approaches on the

[2] For more information about the research cluster, see: https://www.tu-braunschweig.de/se2a.

configuration of passengers and those living near airports, who represent users and non-users of aviation. Our aim with this paper is to draw attention to the performative power of different research approaches in order to inspire critical reflections on users and non-users as situated and contextual process categories. We then evaluate those categories with regard to their effects on enabling more socially and ecologically sustainable mobility futures.

To begin with, we introduce our project and its institutional framing. Then, we present the results of a literature review and our ethnographic inquiry. The latter was conducted to illustrate the conceptualizations of human demands that emerged when we studied the projects of the research cluster our project was embedded in. Following that, we describe how the concept of human demands transforms when it is grounded in Feminist Science and Technology Studies (FSTS), and Ontological and Participatory Design. This comparison was crucial for our project, because it guided the setup of our participatory research approach. In section three, we discuss the performative effects of our own theoretical and methodological framework as well as the contextual circumstances of our research (for example, the outbreak of the COVID-19 pandemic) on the (re)configuration (Suchman, 2007, 2009) of human mobility demands. We then show how concepts such as users and non-users evolved as situational process categories through the interaction between us as researchers and the participants of the workshops we conducted. After discussing the influence of our own situatedness as researchers on the results, we finally argue for future-oriented inter- and transdisciplinary innovation processes. From our feminist and power-critical point of view, these approaches should allow for collectively created socio-technical visions that take the perspectives of overlooked social groups, specifically non-users, into account, instead of taking past or current usage patterns as unquestioned starting points.

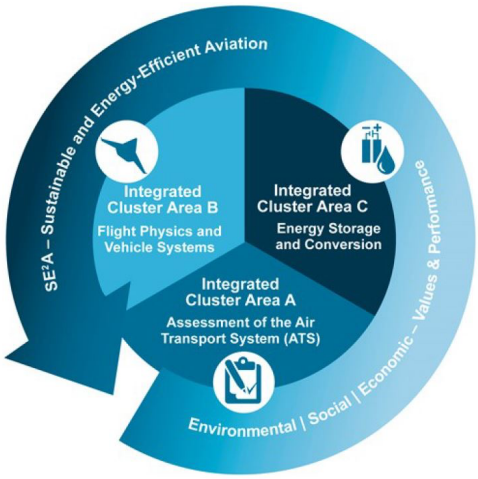
COMPARING CONFIGURATIONS OF HUMAN DEMANDS IN ENGINEERING AND FEMINIST PARTICIPATORY RESEARCH

By comparing research from engineering, economics, and the natural sciences with our own feminist participatory approach, we show in the following paragraphs how these approaches influence whose demands and interests are considered when it comes to sustainable aviation. From this, we derive conclusions on the varying relevance of the concepts of users and non-users to different notions of innovation.

Conducting feminist participatory research within an engineering research cluster

From October 2019 to April 2021, we conducted a project titled *Human demands of sustainable aviation.* The project was part of an ongoing seven-year interdisciplinary research cluster, funded by the German Research Foundation (DFG).

Fig.1: Organizational structure of the SE²A cluster



Source: Hurtig Design/TU Braunschweig/SE²A.

The cluster, which involves different research institutions from Lower Saxony, Germany, conducts research within three areas of, as its name indicates, "Sustainable and Energy-Efficient Aviation" (SE²A) (Fig. 1). Researchers in the cluster mainly come from engineering, economics, and the natural sciences. In contrast to more technically- and economically-driven engineering research on sustainable aviation, our project centered on social innovation. Our research was guided by theories from FSTS, which explicitly draw attention to marginalized or overlooked perspectives and social groups in technological research and development processes. This theoretical background led to the objective to investigate the demands of passengers and residents living in the vicinity of airports, which, from our point of view, were not appropriately considered within the cluster's research projects. We implemented the project using methods from Ontological and Participatory Design. The following questions structured our research: "How is sustainability defined within the cluster's engineering projects and to what extent are human demands considered within these projects? What (in contrast to the cluster's assumptions) does sustainability mean to passengers and airport residents? What is the role of gender and other aspects of diversity? How do these aspects affect living conditions, and, in consequence, mobility demands as well as exposure to noise emissions?"

Our research process consisted of two main phases:

Phase 1: Literature review and ethnographic inquiry into aviation researchers' ways of thinking and working: In order to understand aviation researchers' notions of

sustainability and which human demands were addressed within their projects, we first conducted an extended review of existing literature on the social and environmental impacts of aviation. The literature review supported us in formulating questions for the ethnographic inquiry. During ethnographic fieldwork, we accompanied some of our colleagues within the cluster to their daily working contexts, conducting participant observation and contextual interviews to gain insights into their research methods and objectives.

Phase 2: Participatory workshops with passengers and people living near airports: For the second phase of the project, we invited participants of diverse ages, genders, living conditions, and relations with and attitudes towards aviation to workshops on sustainable mobility. Within the workshops, we used storytelling and scenario-building methods to inspire the participants to exchange stories about their mobility needs and demands as a basis for the joint development of future mobility scenarios. Originally, the workshops had been planned as face-to-face-events but, due to the COVID-19 pandemic, were reconceived as virtual.

Human demands in engineering research, economics, and the natural sciences

The results of our literature review and our ethnographic inquiry demonstrate that, from an engineering point of view, sustainable aviation is mainly configured as an economic and ecological problem that needs to be solved through technological means. Recent studies show that, over the past decades, air traffic has increased considerably (Lee *et al.*, 2021). Despite a temporary decline due to the COVID-19 pandemic, researchers expect passenger demands and international air traffic to continue to rise in the future (Gössling & Humpe, 2020). At the same time, the climate crisis creates the need to drastically reduce greenhouse gas emissions released by aircraft (Kantenbacher *et al.,* 2018; Terrenoire *et al.,* 2019; Olivier *et al.*, 2020). In addition, local noise emissions at airports impact both humans and animals (WHO, 2018) creating further environmental issues.

In order to deal with those challenges, some research initiatives aim to improve the efficiency of existing technologies, such as the traditional turbofan aircraft, while others target different technological configurations, for example, blended wing bodies (Åkerman, 2005; Okonkwo & Smith, 2016). Moreover, research is investigating solutions for alternative drives, such as electric or hydrogen-based propulsion systems to substitute kerosene as jet fuel (Åkerman, 2005; Lee *et al.*, 2021). Since the 1960s, the efficiency of passenger aircraft transport has increased considerably by approximately the eightfold (Lee *et al.* 2021). Still, fleet turnover is a slow process and technological improvements lag behind the rapid growth of the aviation sector (Whitelegg, 2000; Lee *et al.*, 2021; Walker & Cook, 2009). Moreover, aviation companies, the main stakeholder of aviation research, demand economic feasibility

as well as safety of the technologies researchers and developers envision (Åkerman, 2005; Müller *et al.*, 2018). This is why new aircraft configurations cannot be introduced into the market immediately. Therefore, political actions, like kerosene taxation and fundamental changes in the transport system, are regarded as necessary to mitigate the impacts of air traffic on the environment in the near future (Åkerman, 2005; Fluglesvedt *et al.*, 2008; Lee *et al.*, 2021). Aviation researchers, thus, must serve demands that cannot be easily combined: They have to provide economically feasible and safe technological applications that are affordable for aviation companies, while simultaneously emitting considerably less noise and greenhouse gasses.

The *Flightpath 2050* vision paper issued by the European Commission (2011) serves as a frame of reference for evaluating logistical and technological modifications and innovations in aviation research. The paper's specific objectives are a 75% reduction in CO_2, 90% in NOx and 65% in noise emissions. Economic growth, wealth, and the creation of new jobs are listed as further goals. Technological research and innovation to achieve these goals are named as the "key to maintaining Europe's capacities and competitiveness" (European Commission, 2011) in the aviation sector. With a view to the *Flightpath 2050* objectives, it is remarkable that most CO_2 emissions from international air travel are not covered by political efforts to slow down climate change, such as the *Paris Agreement* of 2015, and that the aviation industry is heavily subsidized by governments (Fichert, 2020; Gössling *et al.*, 2017; Lee *et al.*, 2021). This shows there exist clear political hierarchies between different human demands in relation to aviation. Economic interests and the interests of passengers as aircraft users are considered more important than the interests of human and non-human sufferers from environmental pollution caused by aviation.

For the cluster's research projects, the *Flightpath 2050* vision paper serves as an orientation for long-term research objectives. The researchers we observed and interviewed carry out simulations and create optimization models to assess technological possibilities for making air traffic more sustainable. In addition, production process optimizations and air transport systems logistics are researched from an economic perspective. Research is based on quantitative data sets, largely obtained from international databases. Confirming the literature findings, the researchers we interviewed also mentioned passenger safety as an important research constraint. In our observations, critical reflection on the fact that aircraft passengers only make up a small part of the global population (Gössling & Humpe, 2020) does not take place within the cluster's research projects. Generally speaking, social concerns were only considered in the field of social life cycle assessment, for example to avoid the use of resources using child labor. These insights demonstrate that in the projects we studied, sustainable aviation was predominantly framed as an ecological and economic problem. Innovation was defined in terms of technology

improvement and development, in contrast to social transformation towards more sustainable ways of living, based, for example, on reduced aircraft use.

In the literature, as well as in the projects we studied, human demands play a role in the form of a predicted increase in passenger numbers in the future, which serves as a motivation to make air travel more energy-efficient and ecologically and economically sustainable. Passengers emerge as flight service customers and, therefore, as a quantifiable and relevant economic factor. Technological innovation is considered the main solution to meeting their demands in an environmentally-friendly manner, while also ensuring their safety. In addition, ensuring the continued employment of people in the aviation sector is a further human demand that motivates research on sustainable aviation. Due to the environmental impacts of aviation, those demands need to be met within a framework of political measures, such as the goals set in the *Flightpath 2050* vision paper. Research projects predominantly rely on quantitative data and methods for computational simulation and optimization to enable technological innovation to achieve these goals in the aviation sector. Accordingly, human demands of sustainable aviation are treated in quantitative or statistical terms and are detached from the settings and situations they are embedded in and from which they arise. Due to this approach, human (mobility) demands emerge as decontextualized factors. Within the projects we studied, neither the concept of users nor that of non-users is explicitly reflected upon. Instead, the certain groups of individuals, such as (future) passengers or airport residents, are treated as having the same demands and interests. Consequently, users and non-users are considered in research on sustainable aviation, but without investigating the reasons and motivations that make them users or non-users. In our work, political frameworks and industrial institutions appeared to restrict such a deeper reflection, as the objective of maintaining air travel is prioritized before the goal of making mobility in general more environmentally friendly, not to mention socially just. When aviation research is cut off from specific situational and local contexts, everyone is assumed to be equally affected by the negative as well as positive impacts of the technology, and differences are obscured. Consequently, certain perspectives become marginalized or even invisible in research and development efforts.

Changing perspective: Human demands under the lens of FSTS, OD and PD

In contrast to the projects we studied, we aimed to qualitatively investigate what humans need from sustainable aviation. We focused on passenger and residents living in the vicinity of airports and asked about their needs and desires concerning future mobility. We configured human demands as a set of real people's heterogeneous interests, emerging from dimensions of diversity that include gender, life circumstances, mobility habits, and personal attitudes, all of which need to be

captured in qualitative terms. The focus on passengers and local residents resulted from our objective to close the knowledge gaps in the engineering cluster. As a complement to the investigated projects, we aimed to provide contextualized insights that reveal reasons for the use or non-use of certain means of transportation, including aircraft. For this purpose, we combined of FSTS theories with approaches and methods from Ontological and Participatory Design research. Built on values of social justice and democracy, these theories and approaches share a power-critical view that explicitly focuses on exclusions in knowledge and technology production processes. The field of FSTS provides analytical lenses to reveal power imbalances and raise awareness of the perspectives and interests of affected, but often overlooked and marginalized, social groups in technology and knowledge production. As power-critical methodological complements, Ontological Design (OD) and Participatory Design (PD) offer concrete methods and tools for overcoming these inequalities in favor of more democratic, socially and ecologically fair realities.

Ontological Design is based on a critical stance towards dominating capitalist, patriarchal societies, mostly located in the global North. It lays responsibility at designers' feet for their role in this power game, which follows an exploitative and consumerist agenda (Escobar 2018; Law 2015). Such an approach can be considered responsible for current social and ecological crises that severely affect life worlds in southern regions of the globe. Inspired by queer-feminist, decolonial, and indigenous thinking, OD aims to sensitize researchers and designers to marginalized realities and argues for collaborative, local approaches to knowledge and technology development to overcome Western or Eurocentric perspectives and destructive practices. Christian Nold (2018) turns the philosophy of Ontological Design into a practice-based model that uses Participatory Design as a methodical approach to directly integrate disadvantaged or excluded user groups as equal participants in concrete research and development processes (Björgvisson *et al.*, 2010; Robertson & Simonsen, 2013).

Inspired by Nold's model, we conducted participatory workshops to give affected people a direct opportunity to speak for themselves, reflect their mobility preferences and habits, and create their visions for mobility futures. Combining FSTS, OD, and PD can be understood as a way of doing feminist innovation research that can be described as collective accomplishments from the margins (Griffin, 2021; Pecis & Berglund, 2021; Styhre, 2013). Such approaches consciously consider affected social groups, often configured as non-knowers or neglected as non-users. By pointing out the marginalization of certain perspectives in knowledge and technology production, feminist research strives to overcome power structures and inequalities that risk being reproduced in scientific "facts" and technological artifacts (Akrich, 1992; Berg, 1999; Cockburn & Ormrod, 1993; Ehrnberger *et al.*, 2012; Ford & Wajcman, 2017; Hofman,

1999; Suchman, 2007; Wajcman, 1991, 2000, 2010). Based on the insights we gained from the cluster's projects on sustainable aviation, we can validate with empirical observations of FSTS and feminist-inspired critical innovation studies (Benschop & Husu, 2021; Pecis, 2016) that reveal the ways in which research and innovation are strongly associated with technology, men, and masculinity. In this sense, feminist-inspired innovation research promises to provide practices of alternative knowledge- and world-making. These practices approach research activities and development efforts through the lens of social justice and democracy instead of economic productivity and efficiency, and integrate overlooked knowers and users as main change drivers.

In our project, the combination of FSTS with Ontological and Participatory Design guided our reflections on who should be part of research and development activities for sustainable mobility. In political papers or statistics, like the ones we identified as orientation points for the research cluster, human demands appear as decontextualized numbers. Meanwhile, PD and OD turn human demands into the situational, local, and varying interests of both users and non-users. In this sense, our theoretical and methodological approach had a performative effect on our research process and its results. This empirically underpins Karen Barad's argument (2003, 2007) that the outcomes of research processes, as well as the actors involved, emerge within concrete *intra-actions*, which shape and are shaped by power structures, gender relations, and social values. Such perspectives, theories, and approaches helped us to open the 'black box' of human demands for our own project. By, for example, consciously considering and directly inviting both aviation advocates and opponents to our workshops, we hoped to inspire wide-ranging debates or to stimulate what Chantal Mouffe (2000, 2010) calls 'agonistic struggles' on how we want to live in the future and which role aviation should play in future mobility. In Mouffe's perspective, these struggles are a core element of a vivid democracy. Finally, the emergence of human demands within our workshops revealed that users and non-users of flight services have different drives, needs and demands regarding future mobility. Our research results, as we show in the next chapter, are closely related to the situated conditions of our project, including our research interests, the theoretical and methodological approach we followed, as well as the disciplinary and institutional context we were embedded in, with its underlying values.

EMERGING SOCIAL ACTORS IN FEMINIST PARTICIPATORY RESEARCH

In our project, the user and non-user demands considered resulted from our previously described approach to sustainable aviation, which was influenced by our

own being and knowing as feminist researchers within the cluster. In the following, we focus on the second phase of our research: our participatory workshops. We also reflect on the methods we used to design, organize and conduct our workshops regarding the emergence of specific users and non-users of aviation and their visions for the future of mobility.

Participant recruitment and research design

In the course of our project, we conducted three online participatory workshops. The first workshop was part of the conference *Zukunft für alle*[3] (engl. *Future for all*). Originally planned to take place face-to-face, the conference turned virtual due to the COVID-19 pandemic restrictions. The conference aimed to develop ecologically, socially, and economically sustainable future visions for the year 2048 for almost all areas of life, such as education, (care) work, agriculture, housing, migration, mobility, environmental protection, digitalization, the finance system, and global commerce. We considered this an appropriate context for encountering aircraft users and non-users who were interested in the relation between sustainability and mobility. At the conference, we connected with members of *Stay grounded*, a global network of more than 170 organizations, among them local airport opposition and climate justice groups[4], who supported us in the recruitment of further participants after the end of the conference. In accordance with Donna Haraway's concept of 'situated knowledges' (1988), this example demonstrates research as a highly situative and performative practice, in contrast to claims of science as a production site of neutral and objective knowledge. Our project evolved in intra-action with the places and situational circumstances we were embedded in and the personal connections we established. The COVID-19 pandemic in particular had a considerable influence on the ways we organized, designed, and conducted our research.

In order to attract participants for our following two workshops, we designed a digital postcard (Fig. 2). The image side displayed pictures with provocative captions, hinting at topics related to sustainable mobility and the COVID-19 pandemic to arouse the curiosity of potential participants. On the back side of the postcard, we presented a short invitation text, including information about our research project and expressing our wish to attract participants with diverse mobility demands and varying attitudes towards aviation. We distributed our invitation to flight enthusiasts, including our colleagues, using the cluster's and our institution's e-mail lists, to environmental activist groups, to citizens' initiatives against air traffic and aircraft noise, and finally

[3] More information on the conference, which took place online from the 25.-28.08.2020, can be obtained on the following website: https://zukunftfueralle.jetzt/.

[4] More information on the network "Stay grounded" can be found here: https://stay-grounded.org/.

to family members, friends, and acquaintances who live near airports (as we do), using instant messengers or social networking sites.

Fig. 2: Postcard for workshop participant recruitment

Source: Technical University of Braunschweig.

Planning and carrying out participant recruitment led us back to Pinch and Bijker's influential approach (1984): the *social construction of technology* (SCOT). The authors elaborate on the role of 'relevant social groups' who share the same notion or a common understanding of a problem that is attached to or supposed to be solved by a certain artifact. Relevant social groups strongly influence an artifact's problem definition, purpose of use, and final design. These groups can comprise producers (e.g. engineers or designers), advocates (e.g. policymakers or lobbyists), users, and bystanders (e.g. neighbors, family members, friends, etc.) as differentiated by Lee Humphreys (2005). Depending on the contexts where research and development processes take place, certain groups are considered relevant and participate in design decisions, while others are neglected or overlooked. The latter groups are not explicitly considered in SCOT, as described in Oudshoorn and Pinch's critique (2003). In accordance with feminist research and innovation approaches, the authors show how users and non-users matter, especially when it comes to gaining insights about the reasons for an artifact's use and non-use.

Guided by this double focus on relevant social groups, on the one hand, and users and non-users, on the other, we considered the interests and demands of users (such as passengers) and those of non-users (such as annoyed residents living near airports) equally relevant in order to complement and contextualize the quantitative data on which the engineering approaches to sustainable aviation were based. We applied Oudshoorn's and Pinch's analytical concept in combination with an

emancipatory mission to make aviation research more socially fair and democratic. To create new and alternative ideas for current and future mobility, we saw participatory workshops as suitable research interventions and "politics by other means" (Harding, 2016, 10) for empowering diverse people to articulate their mobility needs and interests themselves. In the end, we as researchers defined the focus of inquiry, which theories and approaches were applied, which users and non-users were relevant, and, finally, which findings became part of the cluster's knowledge base. These decisions and corresponding actions demonstrate our power position as researchers and the performative effects of our own situatednesss in bringing certain human demands into being. Users and non-users, we conclude, are never just there; they emerge in intra-action and in relation to local and situational circumstances. Moreover, "user" and "non-user" are no stable categories. They are heterogeneous, permeable, and changing according to people's social or professional positions and the transformation of their life circumstances over time, as we will demonstrate in the next section.

The COVID-19 pandemic was another situational aspect that influenced our research approach and the insights we gained. Initially, we considered mobility restrictions and social distancing obstacles that forced us to set up the participatory workshops online[5], instead of conducting them face-to-face. However, in the end, the situation opened up new possibilities for our research in two respects:

- It offered us the opportunity to gather participants from different regions of Germany, overcoming the usual barriers of cost and time imposed by travel.
- We took the pandemic as a real-world experiment and turned the collective experience of (im)mobility into the basis of our participatory research phase.

During the workshops, which we conducted in the summer and autumn of 2020, we asked our participants to imagine themselves back to the beginning of the pandemic in spring and reflect on the disruption of taken-for-granted mobility habits in relation to their (tacit) mobility needs and demands as well as their understanding of sustainability. Based on this, we invited them to create future mobility scenarios. We used storytelling and scenario building as techniques to provoke collective reflections and discussions on the participants' experiences and visions about how we want to travel and live in the future.[6]

[5] To retain some aspects of the workshop experience we used the conference platform BigBlueButton and the digital whiteboard Miro.

[6] The participants' quotes used to illustrate our findings in the following paragraphs were originally in German. For consistency in language and easier comprehension, we translated them here into English.

Reflecting on our overall research process, the design of our workshops was as situated an approach as the process of participant recruitment. The specific time and place in which they took place impacted the socio-material dimension of our workshops, such as the tools we used to enable an online format, or the knowledge the workshops brought into being.

(Re-)configurations of users and non-users in participatory intra-actions

A total of 17 people, aged from 20 to 54 years, participated in our workshops. In order to get a first impression of our participants' occupations, life circumstances, interests, attitudes, and experiences, we handed out questionnaires some days prior to the workshops. These questionnaires contained open and closed questions covering the aspects named above. In the questionnaires, 11 people referred to themselves by names we interpreted as masculine and six described themselves with names with female connotations. All our participants were either academics or had studied at the university level. All of them lived in larger German cities (Berlin, Braunschweig, Dresden, Essen, Jena, Köln, Leipzig), most of them in a flat. The majority of our participants lived with other people, either with a partner, family, or flatmates. In order to get an overview of the participants' attitudes towards aviation, they were asked to assign themselves to one or more of the following categories: 'frequent flyer', 'aviation enthusiast', 'environmental activist', 'person opposed to flying', 'resident of the vicinity of an airport', 'person affected by aircraft noise' and 'other'. Five participants considered themselves aviation enthusiasts, another five environmental activists, three frequent flyers, and one opposed flying. Seven participants stated that they lived close to an airport. Of these seven, four indicated that they were annoyed by aircraft noise. Four participants described themselves as a combination of aviation enthusiasts, frequent flyers and environmental activists. Of these four, three were aviation engineers.

Most participants use the bicycle as the primary means of transportation in their daily lives, in addition to using public transport or walking. For longer distances, most participants use the train. The choice of these means of transportation, as the workshop revealed, is prompted mainly by environmental consciousness. Additionally, we assumed that since all participants live in larger cities, they have access to bicycle lanes and a well-developed public transport system. The four participants who fly frequently do this for professional reasons. Two of them also use aircraft to visit family members who live abroad. Four participants like to travel by bike during their holidays. Another four own a car, which they use for family vacations and transporting larger items for professional reasons. In two cases, the car was shared with adult members of the family or household. One participant, who used to predominantly travel by public transport and train, reported renting a car more often since the infection rates

of COVID-19 started increasing to reduce the risk of infection. The latter case shows that use and non-use are categories that shift with time. Situational circumstances have a performative effect on who is a user and who is a non-user of a certain technology. The COVID-19 pandemic made us realize this radically once more.

Without us having asked them to do so, our participants explicitly reflected upon how their mobility preferences and behaviours had changed over the course of their lives. Even though all participants had flown at least once during their lifetime, more than half described themselves as trying to avoid flying. One participant, aged 42, explicitly stated: "In the future, I would like to use the plane only in absolutely exceptional cases." Five formerly-frequent flyers had turned into people who avoid flying because of an increasing environmental consciousness. A further reason for travel reduction was parenthood. A male participant, father, and amateur pilot who tries to avoid flying said: "My family and I have so far completely avoided air travel, both for ecological and economic reasons, although, as a hobby pilot, I am an enthusiastic user of small, economical aircraft". The participants who were parents in particular referred to a generational responsibility, which they mentioned as an additional reason for avoiding travelling by air. Another male participant reported his personal mobility turnaround eight years ago. As a software developer dealing with smart meters[7], he reflected ever more on energy consumption and sustainability and eventually decided for a fundamental change. He transformed from a frequent flyer and car driver into a rail traveller and cyclist. Formerly, he visited the USA three times a year and frequently travelled to Spain, Latin America, and Asia. He now explores Europe by train. Use and non-use, we concluded from this, are categories that, in the case of our participants, had changed over their life span and were influenced by personal living circumstances and the attitudes developing in relation to these circumstances.

The younger workshop participants avoided travelling by air mainly for environmental reasons. A female student reported that she liked to travel by train but was sometimes overwhelmed by the cheap flight prices between European cities. Due to her increasing involvement in the *Fridays for Future* movement, she booked a train ticket for her last trip to London. One student, who had written his master's thesis on sustainable mobility and formerly travelled to Asia and South America, now prefers destinations in Germany and Europe. A further student participant rejects short trips and legitimizes travelling by air to distant places if he can extend a trip to several months.

[7] Smart meters record the energy consumption of e.g., water, electricity, gas and send it periodically to the respective energy suppliers.

Three out of the four participants who were engineers or engineering researchers were also hobby pilots, flying small planes for leisure. During the workshop discussions, it emerged that the aviation researchers suffered from an inner conflict: they were enthusiastic about flying but, at the same time, conscious of the environmental impacts of aviation. One researcher, who also worked as a business consultant, expressed this explicitly:

> (…) by using the current technology, I have got an environmentally harmful hobby – piloting small aircraft and getting to know other cultures. Also due to my profession, business consultant, I travelled by air twice a week before the pandemic started. As I do not want to give up this lifestyle and these hobbies, already during my studies, I began to stand up for new, more environmentally friendly air traffic.

This contradiction was a career choice motivation for many of the participating aviation engineers. One doctoral researcher, whose family lives abroad, expressed his personal motivation as follows: "Immigrants need aviation" – a requirement that results from a globalized world based on the migration of people and the global transportation of goods.

Our workshop participants were highly homogeneous in their attitudes towards aviation, although these attitudes derived from different reasons and life circumstances. They also assigned similar meanings to the concept of sustainability. The participants mainly defined sustainability in ecological terms. Some also mentioned social aspects, like fair working conditions, as a part of the concept. All our participants possessed a critical consciousness of their mobility habits, including flying. Most participants connected their definition of sustainability with the wish to reduce greenhouse gas emissions. According to them, this aspect strongly influenced their mobility behaviours, as described above. Most said that if alternative means of transport to aviation, such as trains, were affordable and comfortably connected across national borders, they would prefer to use those for holiday or business trips, instead of flying. In addition, most participants emphasized that they enjoyed train rides and liked to use trains as a mobile office. For us, this revealed air travel to be a means to necessary ends. It is currently needed for fast travel between different locations, while other means of transportation, such as trains, were associated with a different set of benefits. Accordingly, in most future mobility scenarios the participants developed, public transportation, including e-mobility (in the best case as a free public service), the expansion of bicycle lanes, and railroad networks, including long-distance ones, played central roles. In these future visions, airplanes were depicted as an exception. Some participants even described them as technologies that, in the future, would only be allowed for family visits and humanitarian purposes, such as supply flights for medical care. Most participants

agreed that, in view of their pandemic experiences, short trips by conventional planes, especially for business purposes, will be harder to legitimize in the future.

These insights show that it is problematic to consider current usage patterns the basis for future technology development. Instead, it seems advisable to take into account how people imagine themselves as users or non-users in the future. Acknowledging that use is not stable and might change in the future, alongside other circumstances such as working life, or as an effect of external events or crises, is highly relevant. The mobility scenarios developed showed very clearly that mobility habits, needs, and demands are inseparable from the ways we work and live. In addition, mobility demands are always related to questions of time and financial concerns. One group of participants developed the vision of a post-growth society that offered a completely new idea of how we will live, work, and travel in the future. Due to drastically reduced and flexible working hours, including the possibility of working from home and virtual collaboration between international enterprises and partners, it was envisioned that there would be more time for local engagement in the neighbourhood and slow travelling. Within this scenario, travelling was considered a pleasure in itself, including the appreciation and awareness of distance and different locations. Another scenario involved the possibility of rapid connections between countries and cities through hyperloops[8]. Thus, slow as well as fast travellers were considered. In general, the scenarios included new usage patterns that provided alternatives to the statistical data on increasing flight passenger demands, which we had identified as a phenomenon the aviation research of the cluster was trying to address without questioning it.

DISCUSSION: DOES FEMINIST PARTICIPATORY RESEARCH HAVE THE POWER TO PROVOKE SOCIALLY JUST INNOVATION?

All our workshop participants, whether they were aircraft users or not, can be described as critical urban consumers, highly conscious of ecological sustainability. However, this description is unstable. We observed that some participants assigned themselves labels that seemed mutually incompatible to us, such as 'flight enthusiast' and 'environmental activist'. Some participants switched between perspectives depending on the context and position; professional or private. Others changed their self-labels according to changes in their attitudes or conditions over the course of

[8] Hyperloops are ground-travelling systems in which passengers travel within a hovering cabin integrated into a vacuum tube. The maximum speed that can be reached with this means of transportation is estimated to be around 1220 km/h. So far, this futuristic transportation concept has not been put into practice. For further information, see, for example: https://www.discovermagazine.com/technology/what-is-hyperloop-and-when-will-it-be-ready [21.02.2022].

their lives. We noticed even our own roles as researchers and workshop organizers changing within the workshops. We sometimes joined the discussions like participants, talking about our own experiences and opinions towards aviation. This dissolved the boundaries and related power structures between researchers and participants. Despite that, we as researchers remained in a superior position. We determined the focus and the questions discussed and our moderation steered the workshop discussions into specific directions. Consequently, our presence had performative effects concerning the knowledge that came into being and the users and non-users that emerged within the workshops. Our feminist research project on sustainable aviation using power critical, democratic approaches, such as OD and PD, was not, therefore, automatically more socially just than technologically-driven innovation processes like the ones we encountered within our colleagues' projects in the research cluster. Feminist participatory research can bring alternative knowledges and worlds into being, but only if the researchers reflect on their powerful positions and the categories they apply, and use their positions actively and consciously to empower marginalized social groups. Our own results demonstrate that we were not successful in this respect.

In analyzing the workshops and reflecting on our research approach, we became aware of the fact that our invitation had reached a very homogeneous group in their education, social class, and living conditions: white, mostly male academics with a respectable income living in larger German cities. Due to their similar life circumstances and social and educational backgrounds, they shared similar (im)mobility experiences, similar attitudes towards sustainability, and had similar experiences in relation to the COVID-19 pandemic. For example, all of our participants were able to work from home. This made us realize that with this particular group of participants we had attracted people whose life circumstances, experiences, and attitudes largely mirrored our own positions and life contexts. Even though we had tried to critically and consciously use our positions of power as researchers to invite people with different educational, social, and economic backgrounds, we lacked non-academic or rural contacts. We were, thus, unable to fully put the feminist mission of empowering marginalized users and non-users into practice. Our own situatedness, our own being, knowing, and the relations that structure our lives affected which users and non-users emerged from our project and whose knowledge was finally transferred back into the research cluster.

Taking the critique of Ontological Design, its anti-western, anti-capitalist stance seriously and referring to the feminist critique of innovation as a technology-driven, male-dominated concept, we would have been required to integrate non-users from other regions of the world into our research design. For example, women from the southern hemisphere, who have been severely impacted by a climate crisis

(Israel & Sachs 2013) to a large degree driven by our transportation system, including air travel, should have a say in innovation for more sustainable mobility. Although the digital format of our workshops would potentially have allowed for international cooperation, we focused on the demands and interests of users and non-users from our own geographic location. The reasons for this were not only our own positions as researchers living in Germany, but also structural constraints, such as the limited duration of the project (one and a half years) and the single PhD position it included. Besides, the digital global society produces its own structures of power and oppression that determine socio-technical participation through the possession of and access to digital communication and information devices as well as hardware infrastructures (Chen & Wellman, 2004; Cruz-Jesus *et al.*, 2018; Huffman, 2018). Only the users of digital technologies and infrastructures have the opportunity to participate in research projects like ours. Different configurations of users and non-users seem to be interwoven and contained within one another. In our case, the users of digital conference tools were also (former) users of aircraft. The reasons for this are their geographic location, socio-economic backgrounds, and levels of education. Including non-users of aviation from other parts of the world into our project would have required a completely different recruitment strategy and research design. The acquisition of participants, thus, was grounded in the theoretical and methodological concerns of the chosen research approach as well as on our local and institutional embeddedness and our professional and personal networks, which partly worked against each other. All these situative aspects ultimately limit a democratic and socially fair research process that would have allowed for joint knowledge-making and world-making with heterogeneous affected users and non-users from around the worlds.

CONCLUSION AND OUTLOOK

Human mobility demands are taken into account in both research approaches we discussed in this paper. But when taking a closer look at what "human demands" mean, different configurations of users and non-users come into being. We showed how these configurations are intertwined with disciplinary conventions, the theories and methods applied, researchers' perspectives and values, as well as situational circumstances and institutional contexts, not to mention funding policies and programs. In the research cluster we studied, human demands are considered in abstract, decontextualized categories, involving statistics and quantifiable metrics. Current usage patterns and the assumed increase of (passenger) air travel in the future are taken as the unquestioned basis for research. The predicted demand for air travel legitimizes research into technological and economic innovation with the goal

of maintaining, if not fostering, the economic growth of the aviation sector. In this context, passengers as (future) users, who only represent a small share of the global population, hold considerably more powerful positions. The research cluster we studied mainly serves their interests. Even though these users do not speak for themselves, their interests are 'heard', although the underlying personal motivations that guide them are not.

Our feminist participatory research approach brought different users and non-users into being and revealed reasons for the use or non-use of aircraft. Despite the environmental consciousness of our participants, our findings show that the use or non-use of a means of transportation is often not a matter of choice. On the contrary, mobility preferences and requirements result from socio-technical conditions that shape certain ways of life. In the case of our project, and this holds true for our participants as well as ourselves, the way we live, work, and travel are expressions of a certain lifestyle practised by people sharing a comparatively high socio-economic and educational status, living in urban areas in one of the most prosperous countries of the Western industrialized world. In comparison, the majority of the world's population are non-users of aircraft or even suffer from aviation's negative impacts on the environment and health.

Our insights demonstrate that the acknowledgement of the dynamic and relational emergence of different users and non-users in reference to disciplinary contexts and situated conditions is highly relevant to implicit local and global power structures and the inequalities they produce. Categories like human demands, users, or non-users are not neutral descriptive labels. They are political, because they mirror and reinforce positions and hierarchies of power that provide advantages to certain realities and social groups, while suppressing and marginalizing others. From a feminist and power-critical point of view, non-users and their personal attitudes and life circumstances play a crucial role in enacting more socially just life worlds, as we argue here.

Feminist innovation research is a collective knowledge- and world-making process that explicitly focuses on the margins. By integrating the perspectives of vulnerable social groups that, in other approaches, are configured as (irrelevant) non-knowers and non-users, feminist innovation research questions and changes power structures, hierarchies, dominant lifestyles, and narratives. It expands the notion of innovation itself, from simply a technological solution to, in line with the Scandinavian Participatory Design tradition, something that involves new social relations. We argue accordingly for research and innovation on sustainable mobility as open inter- and transdisciplinary processes that involve researchers, developers from different disciplines, politicians, and affected non-academic social groups, if necessary, from

different regions of the world. In addition, conducting responsible innovation research for more socially just worlds involves questioning the *status quo* in favour of the desired. Futures are neither predetermined, nor do they represent projections or extrapolations of current developments. Futures are made. Instead of basing research projects on usage patterns projected from past or current realities, we argue for innovation processes that reverse the order of questioning, asking first: How do we want to live in the future? And then: Which role should technology play? No matter how idealistic our sketch of a feminist research and innovation concept sounds, facing the current social and ecological crises, we think that rethinking innovation cannot be idealistic and ambitious enough.

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The Constitution of Boundaries How the Embeddedness of Organizational Users Structures the Transfer of their Knowledge[1]

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ABSTRACT

Private and organizational users are widely treated as equal in the literature on the integration of users in innovation projects. Based on a practice-theoretical perspective, we argue in this paper that this equation is inconsistent and inadequate. While users are conceptualized as competent and embedded when it comes to the genesis of their user knowledge, both factors are ignored when their involvement in the innovation process is considered. Drawing on empirical findings on interorganizational knowledge transfer, we show that the social, formal, and material embeddedness of organizational users crucially structures their integration. By elaborating the role of different structural dimensions in detail, we highlight the distinctive features of organizational users. In doing so, we further develop a heuristic that enables a detailed and adequate analysis of their integration.

Keywords: Organizational Users; Innovation, Boundaries; Knowledge Transfer; Social Context; Materiality.

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INTRODUCTION

The central idea of Open Innovation (OI) is that the deeper and earlier involvement of users in the innovation process can bring fresh creative impetus and a keen focus on user needs (Bogers *et al.*, 2010; Bogers *et al.*, 2017; von Hippel, 1986). Thereby, it is recognized that user knowledge is highly context-specific and implicit. Accordingly, with regard to their usage practices, users are conceived as structurally embedded, knowledgeable actors. In contrast, when it comes to the transfer of user knowledge, they are conceived as structurally unbound and obedient knowledge carriers (Bogers *et al.*, 2010; Schweisfurth, 2017).

We criticize this representation of users as being theoretically inconsistent and pro-innovation biased. Critical innovation studies have pointed out that research on innovation is often affected by a *pro-innovation bias* (Rogers, 2003, p. 92). Affected by this bias, the manageability of innovation processes by innovating companies is often overestimated, while resistance and opposition by affected and involved actors is underestimated (Godin & Vinck, 2017; Gold, 1969). In light of this bias, we challenge the assumption that knowledgeable acting users are ever willing to provide their knowledge to innovating firms. Further, Bogers *et al.* (2010, p. 866) have pointed out that OI research lacks a foundation in social theory and thus often draws on inconsistent assumptions. In line with practice-theoretical assumptions (Giddens, 1979), OI research emphasizes that user knowledge is practical and context-specific, making it valuable but difficult to transfer (Bogers *et al.*, 2010; von Hippel, 1994). With regard to their usage practices, users are accordingly conceived as structurally embedded, knowledgeable actors. In contrast, when it comes to the transfer of user knowledge, they are treated as structurally unbound and obedient knowledge carriers (Bogers *et al.*, 2010; Schweisfurth, 2017).

The theoretically inconsistent conception of users facilitates the pro-innovation biased depiction of user knowledge integration. This is especially true for organizational users. Since many products and services address organizational users, both private and organizational users have been considered in the OI literature from the very beginning (Bogers *et al.*, 2010; Bogers *et al.*, 2017). Because organizational user knowledge is typically distributed among several actors, it is considered to have a higher degree of complexity, which further complicates knowledge transfer. Thus, the involvement of organizational users is often realized in the form of long-term-interorganizational innovation projects. Apart from that, however, private and organizational users are thought of in strong analogy in the OI literature and are often not distinguished from each other at all (Bogers *et al.*, 2010; Brem *et al.*, 2018; Schweisfurth, 2017). By ignoring their structural embeddedness and its practical

significance, it is assumed that private and organizational users equally integrate into innovation processes.

Practice-theoretical research on interorganizational collaborations already suggests that the structural embedding of organizational users is highly relevant for the transfer of their (user) knowledge (Berends & Sydow, 2019; Windeler, 2001). Interorganizational collaborations are comparable to the involvement of organizational users in innovation projects, because here as well, autonomous organizations cooperate and share knowledge within the framework of temporary projects. Thereby, the core of our practice-theoretical approach is the *duality of structure and action* (Giddens, 1984, p. 14). This idea emphasizes that structures such as hierarchical relations or the formal organization of projects are produced by the practices of competent actors. At the same time, actors are bound to given structures that enable and constrain practices. Structures in the sense of rules and resources are therefore both the product and the precondition of practice (Giddens, 1984, p. 19).

In contrast to previous conceptions of user integration, which distinguished organizational and private users at best on the basis of the complexity of their knowledge, we thus emphasize the specific structural embedding of these actors. We argue that different dimensions of these structures in their practical interplay have a structuring effect on knowledge transfer processes and thus practically constitute boundaries between organizations insofar as they hinder or promote the transfer of user knowledge (Leonardi *et al.*, 2019; Levina & Vaast, 2005).

The paper makes the case for the significance of the structural embedding of organizational users. To this end, we proceed as follows. First, we will revisit in more detail how the transfer of organizational user knowledge is conceptualized in the OI-literature. Subsequently, we will reformulate the transfer of organizational user knowledge in terms of practice theory. To this end, we will first discuss the practice of knowledge transfer and its general preconditions. In the main part, we will then draw on rich findings from research on interorganizational knowledge transfer (Milagres & Burcharth, 2019; Nakauchi *et al.*, 2017) in order to demonstrate the relevance of different dimensions of organizational structures for the practical transfer of organizational user knowledge. Hence, we substantiate the basic argument in a nuanced way and furthermore develop a model that explicates diverse forms of structural embedding and its interactive effect in the transfer of organizational user knowledge. In doing so, we identify a multitude of causes for why organizational users limit their engagement in open innovation processes. We thus critically expose a blind spot in the OI literature, in which users are typically assumed to be highly motivated to participate in innovation processes (Bogers *et al.*, 2010; Godin & Vinck, 2017).

THE TRANSFER OF (ORGANIZATIONAL) USER KNOWLEDGE

In the literature on user knowledge transfer, three concepts are key to explaining the transfer process (West & Bogers, 2014). First, it is pointed out that user knowledge is *sticky* in the sense that it is mostly implicit and context-bound knowledge of action (Bhagat *et al.*, 2002; von Hippel, 1994; Inkpen, 2008). Users are thus unable to easily communicate the knowledge. Rather, greater effort is required to make the knowledge explicit for transfer. The literature recognizes that organizational user knowledge is particularly sticky because user practices in organizations are usually distributed among multiple individuals and are embedded in complex processes (West & Bogers, 2014). Secondly, the concept of *Absorptive Capacity* emphasizes that the knowledge held by the innovating organization and its organization are crucial for its ability to absorb new knowledge from the outside (Cohen & Levinthal, 1990; Zahra & George, 2002). Thirdly, the *Not-Invented-Here Syndrome* points out that the culture of the focal organization can be such that knowledge from outside is generally underestimated and rather rejected (Bogers *et al.*, 2017; Katz & Allen, 1982).

The concept of stickiness emphasizes that users' knowledge is highly situational and implicit. This assumption is in line with practice-theoretical conceptions of actors. In tension with this theory are the remaining two concepts. They suggest that innovating organizations, if they have the appropriate capabilities, can absorb the knowledge of (passive) users. Thus, while users' knowledge is conceptualized as the product of situated everyday practices, knowledge transfer itself is not considered as a situated practice. Thus, the structural embeddedness of the actors and differences between organizational and private users in this respect are neglected when considering the transfer of user knowledge.

In contrast, from a practice-theoretical perspective, we assume that the structural embedding of the actors of the user organizations fundamentally structures the practice of knowledge transfer. Especially in the case of organizational users, the structural embedding of the actors seems significant. While private users can be widely integrated into the structures of the focal organization for knowledge transfer, organizational users are embedded in their own social, formal and material organizational structures (Carlile, 2002; Milagres & Burcharth, 2019). Depending on how compatible these structures of the heterogeneous organizations, especially SME, are with each other, conflicts can arise that can significantly impede the transfer of user knowledge. This is especially true because the transfer processes are particularly lengthy due to the high stickiness and require fine-scale coordination between the organizations. The structural embedding of organizational users is therefore of particular importance here.

At the center of our practice-theoretically informed reflections is the question of how the various organizational structures in practical interaction constitute more or less permeable boundaries between organizations (Leonardi *et al.*, 2019; Levina & Vaast, 2005). In order to understand the constitution of these boundaries from the interrelation of organizational structures, it is crucial to look at how these relations are practically created (Carlile, 2002). In the following, we will therefore specify the constitutive knowledge transfer practices in more detail drawing on findings from knowledge transfer research, and then ask how the interrelationship of organizational structures the constitution of boundaries between organizations. Hard boundaries hinder the involvement of organizational users in innovation processes. Contrary to the uncritical depiction of user integration practices, we thus elaborate various reasons why users are unwilling or unable to engage in innovation processes.

THE PRACTICE OF KNOWLEDGE TRANSFER

Boundaries between organizations are constituted by practices of sharing knowledge (Carlile, 2002; Leonardi *et al.*, 2019; Levina & Vaast, 2005). In order to understand the impact of organizational structures, we will discuss below requirements for the conduct of such practices. Although we subsequently refer to findings from innovation and knowledge transfer research, we do not assume that knowledge transfer and innovation are generally desirable and that boundaries between organizations are a problem in this respect. Rather, we are interested in describing the boundary defined constellations and their consequences without evaluating what would be desirable (Godin & Vinck, 2017).

Both innovating and using organizations can in principle be quite different types of organizations. However, the findings we refer to in the following mostly concern companies. In conclusion, we will discuss whether our argumentation can also be applied to other types of organizations. We will illustrate the requirements for the transfer of organizational user knowledge with an alienated example, which we will briefly introduce below.

Example: DigiWelder

The machine tool manufacturing company "Rabe" is striving to digitize its product portfolio in order to improve the performance of the machines, increase demand and thus ensure the long-term success of the company through innovation. After a number of failed innovation projects, the company management has become convinced that the potential users of their machines have to be involved at an early stage in order to align the development to their needs from the beginning and continuously. The aim

of the "DigiWelder" project is to develop a digital-technical support system for the loading of a welding machine and the manual alignment of the workpiece in production. This is intended to relieve the workers during work activities around and at the welding machine as well as to enable a higher precision of the alignment of the workpieces. "Rabe" has succeeded in acquiring three customer companies, which use Rabe-equipment in various fields of application, for the project. In addition to the prospect of machines improved to meet their own needs, a crucial factor in their willingness to participate was the fact that they managed to win government funding to compensate for the personnel costs. The collaboration project is scheduled to run for three years. Central to the collaboration are the moderated workshops hosted by "Rabe" and the three application companies. The main aim of these workshops is to tap into the distributed and highly implicit knowledge of the users. At the same time, "Rabe" representatives are eager to share their perspectives and needs in order to give users a sense of what information they need from them. Because of the distributed nature of user knowledge, experts from different areas of the organizations are brought in as needed, in addition to a core project team composed of representatives from the four organizations.

In the knowledge transfer literature, in particular three requirements are described as central to the transfer of tacit and complex knowledge. These are (1) belief in the value of the knowledge, (2) trust in the transfer partner, and (3) adequate channels and opportunities for transfer (Hansen *et al.*, 2005; Milagres & Burcharth, 2019). In the following, we will elaborate on the three prerequisites and illustrate them using the "DigiWelder" example.

Organizational user knowledge is complex and implicit to a greater extent. As a result, the recipients of the knowledge can only predict to a limited extent what exactly they will learn from the users and how the knowledge they have learned will be of benefit to them. The high transfer costs are thus incurred in uncertainty about the return. The crucial factor in determining whether the willingness to make a corresponding commitment arises and is maintained therefore depends on the attribution of value (Borgatti & Cross, 2003; Inkpen & Tsang, 2005).

In the "DigiWelder" project, for example, it would be conceivable that, despite the fact that management has expressed its appreciation for user knowledge, the technically skilled developers regard practitioners and their knowledge as less valuable because of their appearance and analytical skills and therefore make less of an effort to understand them. Conversely, machine operators take for granted to a large extent how to lift and rotate workpieces and fit them into the machine for further operations. Since they are not aware of the value of their practical knowledge of

everyday operations for the development process, they do not share it. We argue that value attribution and consequently engagement in the knowledge transfer process between organizational developer and organizational user is also influenced by structural differences between the organizations involved.

In contrast to the sender-receiver dichotomy, complex knowledge transfers are interactive processes in which both sides make themselves vulnerable to some extent. Two forms of vulnerability are addressed in the literature. First, people who open up make themselves vulnerable. When transferring everyday knowledge that is applied pre-reflexively, a particular challenge in the transfer of knowledge is to find out what is not self-evident to others. Such knowledge gaps, especially when it comes to expert knowledge, can be legitimate in principle. At the same time, gaps in knowledge can cause offence and loss of reputation, because they can also be interpreted as inadequacies. Furthermore, in this scanning interaction process, unquestioned assumptions are usually expressed, which upon closer examination, prove to be questionable or wrong. Here, again, there is the risk of offending and losing reputation. Users in the "DigiWelder" project, if they went deeper into their approach, would casually articulate their ideas about technical welding processes. However, they are not sure of the correctness of the underlying assumptions. Given the high level of expertise in this regard on the part of the Rabe developers, though, they might shy away from expressing themselves openly because the latter could recognize their lack of knowledge.

Second, once knowledge has been transferred, it cannot be withdrawn, so that control over the transferred knowledge is relinquished to a certain extent. It is then possible that organizational knowledge is not used in the interest of the respective organization or group of organizational members. For example, users in the "DigiWelder" project are asked to reveal the physical strain they feel when loading the system and aligning the workpiece. However, comments in this regard can also be interpreted as a user's lack of resilience. Furthermore, the application of the equipment should be considered in its embedding in the organizational processes of the application organization during the workshops. This requires the disclosure of competition-critical knowledge that could be used to the disadvantage of the user organization.

At the same time, openness is an important prerequisite for the successful transfer of organizational user knowledge. Because openness bears risks, it presupposes trust. Thus, for knowledge transfer to succeed, the actors involved must develop trust in each other (Hansen *et al.*, 2005; Inkpen & Tsang, 2005; Nilsson, 2019). We will argue that trust formation is influenced by structural differences between organizations and hence structures the transfer of organizational user knowledge.

After all, knowledge transfers do not succeed simply because actors are interested in knowledge and willing to open up. Rather, they must be carried out interactively. This requires appropriate communication channels and opportunities. Because of its special richness, face-to-face communication is considered to be extremely helpful for the transfer of tacit knowledge (Daft & Lengel, 1986; Nilsson & Mattes, 2015). In addition, however, it is argued that different forms of media-mediated communication also offer advantages for specific dimensions of knowledge transfer (Dennis *et al.*, 2008; Leonardi & Vaast, 2017). In the "DigiWelder" project, for example, the opportunities to meet in person at short notice are distributed differently due to spatial distances. Contact with the more distant application partners is more often realized via media. But even here, certain channel related inequalities are apparent, for example because individual user companies do not provide their employees with the required hardware (cameras for video telephony) or certain applications are not allowed to be used for security reasons (cloud services). We state that discontinuities between organizational structures may limit communication channels and opportunities and thereby influence the transfer of user knowledge.

We argue that trust building, value attribution, and channels and opportunities for communication enable the conduct of knowledge transfer practices. By influencing these requirements, organizational structures structure the conduct of knowledge transfer practices and thus the constitution of boundaries between organizations. Accordingly, the constitution of boundaries can be used to work out that and why users are unwilling or unable to engage in open innovation processes.

BOUNDARIES BETWEEN ORGANIZATIONS

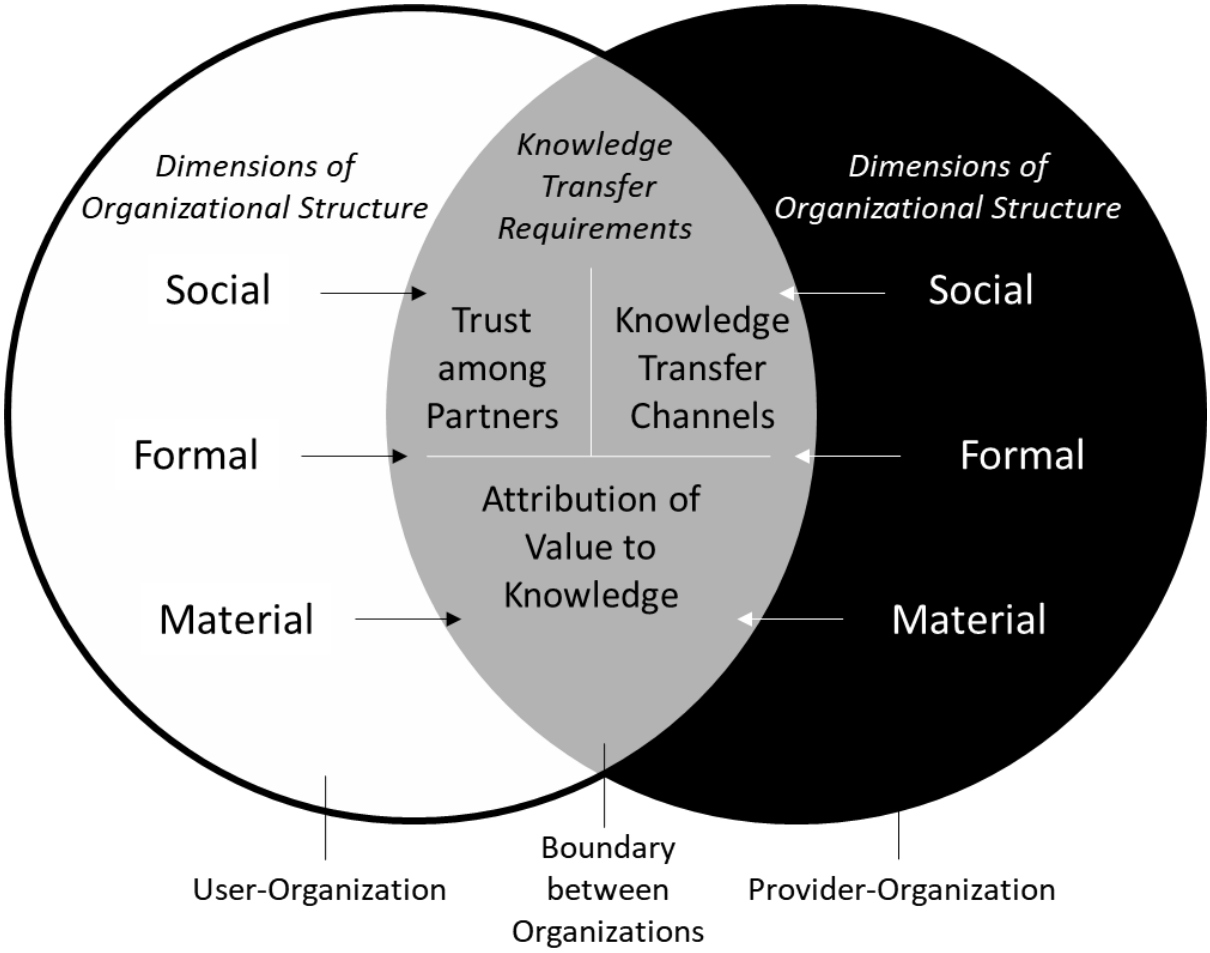
Below, we will draw on findings from research on interorganizational knowledge transfer and translate them in our practice-theoretical conception. We assume that organizational boundaries are defined by the structural embeddedness of the individuals involved in knowledge transfer and the practical meaning of this context (Lamont & Molnár, 2002; Leonardi *et al.*, 2019). Thus, we account for the fact that not all members of an organization are equivalently embedded in every dimension of the organizational structure, because organizations are not homogeneous entities in every respect.

If we consider the reputation of an organization or formal standards that equally affect all members of an organization, organizational boundaries can be determined rather independently of individuals. However, if we look at hierarchical and functional embeddedness, it seems less useful to look at the overall structure to understand how boundaries are defined. Instead, it is crucial to consider the specific embeddedness of the individuals involved. Only in consideration of the positions in

the organizational structures and the resulting relationship, the specific configuration of the boundary between the organizations becomes comprehensible, which can influence the transfer of organizational user knowledge. Thus, the relational understanding of boundaries between organizations means thinking about the social, formal, and material embeddedness of the actors involved in the transfer of user knowledge in order to better understand the transfer process. Drawing on this practice-theoretical understanding of organizational boundaries, we will subsequently highlight different dimensions of these organizational structures and show how they structure the transfer of organizational user knowledge and hence constitute corresponding boundaries. Thereby, we focus primarily on the constitution of hard boundaries. Hard boundaries make the interorganizational transfer of user knowledge more difficult and have been neglected in research on user integration.

With regard to the categorization of the context dimensions, we follow the outline of Pirkkalainen and Pawlowski (2014). Accordingly, we distinguish different social, formal, and material dimensions of boundaries between organizations. The clear distinction between dimensions that do not actually exist independently of one another, serves here solely as a heuristic device to enable a concise presentation of the various findings and to highlight the influence of organizational boundaries in the knowledge transfer process. In the following section, we will take a closer look at one dimension after the other along the heuristic and work out their significance for knowledge transfer. For this purpose, we will relate them to the three conditions mentioned for the success of knowledge transfer: (1) belief in the value of knowledge, (2) trust in the transfer partner, and (3) adequate channels and opportunities for conducting the transfer (see Figure 1).

Figure 1: The Entanglement of Organizational Structures Constitutes the Boundaries between Organizations

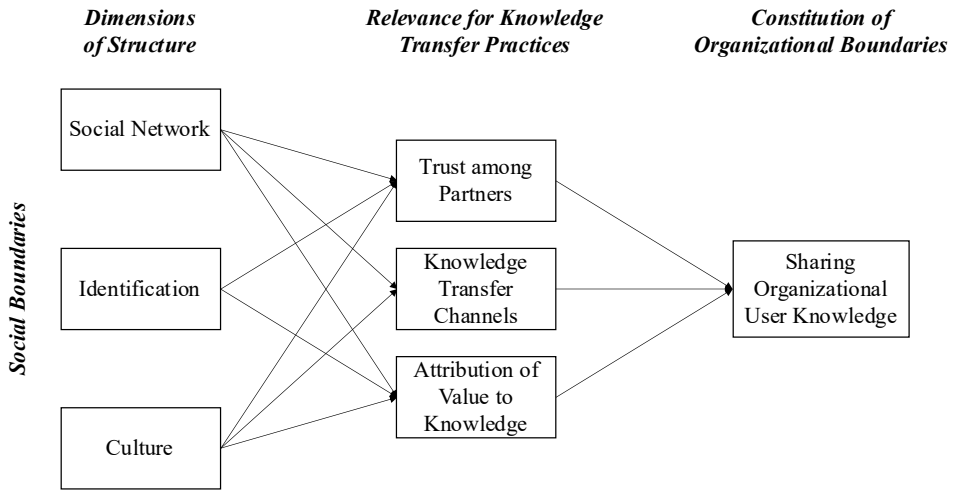


Source: elaborated by the authors (Roth & Diefenbach, 2022).

Social Boundaries between Organizations

Organizational research has shown that formal processes, insofar as they are carried out by interacting people, are permeated, and flanked by social processes. In organizations, therefore, social structures develop and shape their operations. In the following, we will argue that the embedding of individuals in organizational social structures can constitute social boundaries between organizations and thereby influence the transfer of organizational user knowledge. In doing so, we will elaborate on three aspects: Social Networks, Identification, and Culture (see Figure 2).

Figure 1: Social Boundaries between Organization influence the transfer of organizational user knowledge



Source: elaborated by the authors (Roth & Diefenbach, 2022).

Social Networks

Social networks are understood as the interweaving of personal relationships and have proven to be a particularly important social structure in organizations (Kilduff & Tsai, 2011; McEvily *et al.*, 2014). The configuration of the social networks of individual organizational members is especially effective as social capital. In the corresponding literature, three mechanisms are highlighted (Inkpen & Tsang, 2005; Lin, 2001). First, relationships can be understood as channels through which knowledge flows. A broad network that connects an actor with people from different areas of the organization enables the supply of correspondingly diverse information (Burt, 2004; Granovetter, 1973). In contrast, local networks that focus on people from a particular area are more likely to lead to redundant information and thus to a more limited supply of information (Roth, 2022). Second, social networks act as social capital because social relationships are associated with reciprocal obligations (Cook *et al.*, 2013; Cropanzano *et al.*, 2017). Through his relationships, an actor therefore has access to the resources of his partners to a certain extent. Third, positive social relationships have a reputation-enhancing effect because evaluating actors orient themselves to one another (Lin, 1999; Rivera *et al.*, 2010). Many positive relationships therefore prompt the attribution of trustworthiness and competence. This is especially true when there are indirect positive relationships between individuals. Because people value the

person who maintains a relationship with another person, the relationship is particularly beneficial to the person's reputation (Borgatti & Cross, 2003). In addition, third parties can actively share information about a person known to them that enables a particularly reliable (positive) image of that person to be formed (Burt & Knez, 1995; Granovetter, 1985; Uzzi, 1997).

Both the social networks of an actor within the organization and between the interorganizational transfer partners effect the transfer of organizational user knowledge (Drach-Zahavy, 2011; Seo, 2020; Tortoriello *et al.*, 2012). The networks within the organization are significant, primarily because the people in the project act as representatives of their organizations. How well they can inform about organizational processes and disseminate the information they receive within their own organization depends on their internal networks. In addition, internal networks define to some extent the influence they can exert in their own organization. This influence is significant for the transfer partner in that it can, for example, persuade colleagues to participate in a more detailed investigation. For the transfer partner, the influence based in the personal network is important because it makes it easier to mobilize resources that are significant for the application of the transferred user knowledge. Finally, trust in the goodwill and competence of transfer partners is also significant for internal knowledge transfer. Since an actor's reputation is enhanced by direct and indirect positive relationships, the internal organizational network also affects how well an organization's representative can transfer knowledge about or into his or her own organization as part of an interorganizational user knowledge transfer project. Accordingly, the internal networking of those responsible for transferring organizational user knowledge fundamentally affects whether knowledge transfer succeeds because it defines the organizational boundary. Whereas internally well-networked actors soften the boundaries and enable external parties to have wide-ranging access, poorly connected partners create a hard boundary.

In addition, the network-structural embedding of the transfer partners also affects the knowledge transfer between them in the transfer project (Seo, 2020; Tortoriello *et al.*, 2012). On the one hand, intra-organizational networks can have a reputation-building effect within the project, if they are indicated to the project partners. In addition, however, the joint network of transfer partners is also important. First of all, this concerns the direct relationships between transfer partners. Such build trust and act as transfer channels because specific communication practices are established and routinized in relationships (Borgatti & Cross, 2003; Hansen, 2002). In the same way, indirect relationships continue to have an effect, which can exist and become effective through other members of the interorganizational project-team, but also independently of this, by creating trust or suggesting competence (Burt & Knez, 1995; Drach-Zahavy, 2011; Granovetter, 1985). Knowledge transfers between partners

without strong or indirect relationships therefore require more coordination effort and are more likely to fail. The boundaries between organizations are thus also defined by the personal networks between them. The weaker and smaller the relationships between members of organizations, the more likely they are to create and reinforce boundaries between them, making the transfer of organizational user knowledge between organizations difficult. In contrast, network effects are not as relevant for the integration of individual private users.

Identification

Research on interorganizational projects shows that conflicts of role and interest can arise in such (Margolis, 2020; Nakauchi *et al.*, 2017). The reason for this is that the members of such projects usually take on roles in their own organization as well as in the interorganizational project-team that are associated with specific interests. Sometimes these interests are conflicting. In the case of "DigiWelder", this becomes apparent when the employees have to prioritize between the tasks in the project, e.g. participation and preparation for a workshop in the company "Rabe", and the work on company-specific projects in the respective company, as well as decide how much time and energy they should invest in each task. To the extent that interorganizational knowledge transfers are time-consuming, their success also depends on the extent to which a project partner prioritizes the corresponding task. Research shows that commitment also depends on how much a project partner identifies with the interorganizational knowledge transfer project (Brake *et al.*, 2020; Chen *et al.*, 2021; Drach-Zahavy, 2011). In addition to commitment, it is also important that the partners trust and open up to each other since a lack of openness leads to an incomplete transfer of information. Low identification with the interorganizational user knowledge transfer project thus means hard boundaries, while high identification establishes weak boundaries.

In research on the development of identification, four explanations are offered (Brake *et al.*, 2020; Drach-Zahavy, 2011; Margolis, 2020). First, identification with an interorganizational project-team depends on an actor's further activities. If he/she is also engaged in numerous other projects with other tasks, conflicts are more likely and the average identification with each individual team is lower. Second, identification is determined by the recognition of the project in the home organization. If recognition there is high, an employee can increase status and self-esteem in his or her own organization through his or her performance in the interorganizational project. If, on the other hand, recognition is low, a conflict arises in this respect and average identification is lower. Third, identification at the project-team level is favored by positive narratives concerning the collective. In particular, the definition of a common past and common goals, which are shared within the project-team and

substantiated by experience, are crucial here. Fourth, identification is constituted at the personal level. The greater the cumulative identification with individual team members, the stronger the identification with the project-team. Identification with other team members is developed interactively and categorically. Personal relationships are developed through interactions. The stronger the cohesion of the network of relationships in a team, the more likely actors are to identify with the project-team as a whole (Brake *et al.*, 2020; Drach-Zahavy, 2011). Categorization, on the other hand, describes the assignment of people to social groups on the basis of personal characteristics (Joshi & Roh, 2009). Identification between individuals is more likely the more significant the shared categories are in the categorization process and the greater the number of shared categories. In this context, home organizations can also play a role if the types of organizations are used as categories. Identification is then more likely, for example, if organizations operate in the same or comparable industries. Low identification with interorganizational project-teams can harden the boundaries between organizations, make the transfer of organizational user knowledge more difficult, and thus distinguishes organizational from individual private users.

Culture

To some extent, every organization has its own local culture, which is rooted in knowledge that is shared and taken for granted (Morrill, 2008). First, organizational culture results from the specific intersection of influences that converge in the organization. For example, specific organizations recruit employees primarily from specific regions and departments. Employees carry their cultural knowledge into the organization and thus shape the organization's culture. Furthermore, the culture of an organization is influenced by its members interacting with the members of certain other organizations and thus unquestioningly carrying knowledge into their own organization. The culture of the organization is thus shaped by the industry in which it is active, for example (DiMaggio & Powell, 1983). Second, cultures are (further) developed idiosyncratically in social collectives in which actors repeatedly interact with each other (Fine, 1979). As a result, organizational processes follow culture-specific logics that differ from one another to a greater or lesser extent. If they differ strongly, this complicates the transfer of organizational user knowledge in two respects. First, the transfer of organizational user knowledge requires the explication of tacit knowledge. Some of this tacit knowledge is also cultural knowledge. For example, it is reported that organization-specific styles exist in the development of equipment, which determine, for example, which materials are used or which target dimensions (safety, durability, etc.) are given particularly high priority. These culture-specific styles can strongly influence the use of a product and are thus part of user knowledge. The more similar organizational cultures are, the larger the shared

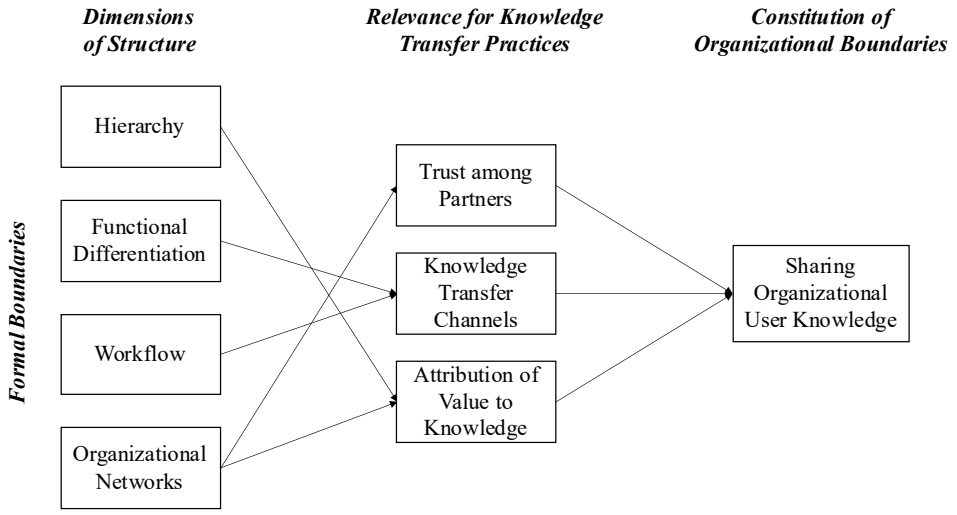
knowledge base and the smaller the proportion of tacit knowledge that must be made explicit and transferred in order to achieve the transfer goal. Differences between organizational cultures can therefore make transfer more difficult because the user knowledge is more distant and the required transfer effort is therefore greater (Bhagat *et al.*, 2002; Milagres & Burcharth, 2019; Seus, 2020, p. 11). Second, culture-specific tacit knowledge may not only affect the use of the focused product, but also cooperation in the interorganizational project. Such organization-specific idiosyncrasies can, for example, concern technical language or the definition and weighting of punctuality. Cultural differences can cause difficulties and conflicts here because they cause misunderstandings and disappointed expectations (Inkpen & Tsang, 2007; Milagres & Burcharth, 2019; Nakauchi *et al.*, 2017). The relations of organizational cultures can affect all three knowledge transfer conditions. The extent to which cultures ground shared language and communicative practices, in a sense, influences the channel of communication. In addition, cultural differences can give rise to mistrust because, for example, the way one prepares knowledge or dresses is culturally associated with social status and respectability. Differences between organizational cultures in this respect can accordingly lead to partners appearing less competent and respectable, and their knowledge being valued less highly. Cultural differences between organizations can thus constitute hard boundaries between organizations and make the transfer of organizational user knowledge more difficult.

Formal Boundaries between Organizations

Formal boundaries between organizations are defined by the relationship between the embedding in formal structures of the individuals involved in knowledge transfer. On the one hand, this refers to the embedding in one's own organization, whereby the formal structures here can be homogeneous or heterogeneous. They can be homogeneous, for example, with regard to formal processes that apply equally to all employees. The relationship of these structures between organizations is therefore independent of individuals. If, however, the structures in the organizations are heterogeneous, as is the case, for example, with hierarchies, the position of the individuals is more crucial. In both cases, however, the focus is on the formal structural embedding of the individuals in the home organization. On the other hand, cooperation between organizations is also typically regulated by formal structures. Individuals are thus (additionally) embedded in these structures and boundaries are also defined by them. In the following, we will consider formal hierarchies, the functional differentiation of organizations, the concrete design of formal processes and structures in organizations, and the embeddedness of organizations in terms of

their importance for the constitution of boundaries between organizations (see Figure 3).

Figure 2: Formal Boundaries between Organization influence the transfer of organizational user knowledge



Source: elaborated by the authors (Roth & Diefenbach, 2022).

Hierarchies

Hierarchies are central elements of organizational structures, as they define functions, competencies, and responsibilities of individual positions in organizations. With regard to the transfer of user knowledge between organizations, hierarchies are significant in two respects (Hu *et al.*, 2017; Inkpen & Tsang, 2005; Seus, 2020) First, it is significant what hierarchical positions the individuals directly involved in interorganizational knowledge transfer occupy in their own organization. Because organizational user knowledge is generally more distributed, the transfer requires the commitment of the various carriers. The higher an actor stands in the hierarchy, the more likely he or she is to be able to persuade the relevant employees to share their knowledge and to make the necessary resources available for this purpose. Boundaries are thus harder the lower the position of the involved individuals in the organizational hierarchy. Second, with regard to identification, we had already pointed out that conflicts of interest may exist between the goals of one's own organization and the interorganizational project (Seus, 2020; Tsang, 2002). These conflicts can be exacerbated in terms of formal structure, by employees being directed both in their own organization, and in the interorganizational project. If the manager in one's own

organization formally has more far-reaching competencies and pursues interests that run counter to the interorganizational project, this makes the transfer of organizational user knowledge more difficult. How individuals involved in the knowledge transfer project are integrated into formal hierarchies therefore influences the chances of success of the knowledge transfer project. Boundaries between organizations are accordingly the harder, the less central and weighty the project management is positioned in the hierarchical structure in the boundary area of the participating organizations.

Functional Differentiation

We already pointed out that organizational user knowledge is generally more complex than private user knowledge because it is usually more distributed. How distributed it is, however, also varies due to how an organization is structured based on the division of labor. The more specialized individual employees are and the more people are involved in individual processes, the more difficult it is to transfer the corresponding user knowledge (Phelps *et al.*, 2012; Spanos *et al.*, 2015). Due to the strong differentiation of various divisions of work and the related "knowledge in practice" (Carlile, 2002), the boundaries within a company can make internal knowledge transfer more challenging. For example, management employees in a manufacturing organization are not only further removed from its shopfloor level in terms of content, but often have a different logic than their colleagues at the machines. This distance from specific practice makes the transfer process of tacit knowledge more difficult (Carlile, 2002; Phelps *et al.*, 2012). The tacit knowledge can only reach the person in charge of interorganizational transfer through a successful intraorganizational transfer. Since the extent of labor division correlates with the size of an organization, internal knowledge transfer is typically less costly in smaller companies (Spanos *et al.*, 2015). Here, because few people are less specialized and working more closely together, the processes of the organization are more transparent to each employee. Moreover, functional differentiation can be caused by the complexity of organizational processes themselves. Irrespective of its drivers, research shows that high functional differentiation of organizations makes the transfer of user knowledge between organizations more difficult because the distributed knowledge must first be transferred and integrated in the user organization. High functional differentiation thus leads to hard boundaries between organizations, while low differentiation, which is more common in smaller organizations, leads to softer boundaries that facilitate the transfer of user knowledge.

Workflow

In addition to the extent of functional differentiation of organizations, it is also relevant for knowledge transfer how similar formal processes and structures of organizations

involved in a knowledge transfer are. Dissimilarity in this respect is a hindrance to the transfer of organizational user knowledge for two reasons (Dyer & Hatch, 2006; Milagres & Burcharth, 2019; Zahra & George, 2002).

First, differences in this regard make mutual understanding more difficult. As already pointed out when discussing organization-specific cultures, the context of application of the user's knowledge must also be transported. This is easier in the case of formal structures in that they are more explicit. Nevertheless, formal differences can also be a barrier to knowledge transfer. In order to understand the concrete processes, the formal context must be understood and shared (Dyer & Hatch, 2006; Phelps *et al.*, 2012). This is easier if these resemble the structures and processes known from one's own organization. Dissimilarity, on the other hand, again leads to lower trust and a lower attribution of value and thus to harder boundaries.

Second, the differences in formal structure in the immediate cooperation become effective in the interorganizational knowledge transfer project itself. A particular challenge in interorganizational cooperation is the development of a *modus operandi* on the basis of which individual actors interact in a coordinated manner.

The formal structures of interorganizational projects are usually not very precise with regard to concrete procedures and therefore unsuitable for the coordination of everyday cooperation practices. For each individual actor, it is obvious to transport the formal structural rules known from their own organizations into the interorganizational project. The more similar the formal structures of the participating organizations are, the more likely the application of these will lead to a coordinated and thus smooth process. If, on the other hand, the formal self-similarity of organizations is low, frictional losses result (Dyer & Hatch, 2006; Seus, 2020, p. 11). Differences in the formal structures relevant to the coordination of the project accordingly make it more difficult to develop efficient communication channels between the organizations and thus create hard boundaries.

Organizational Networks

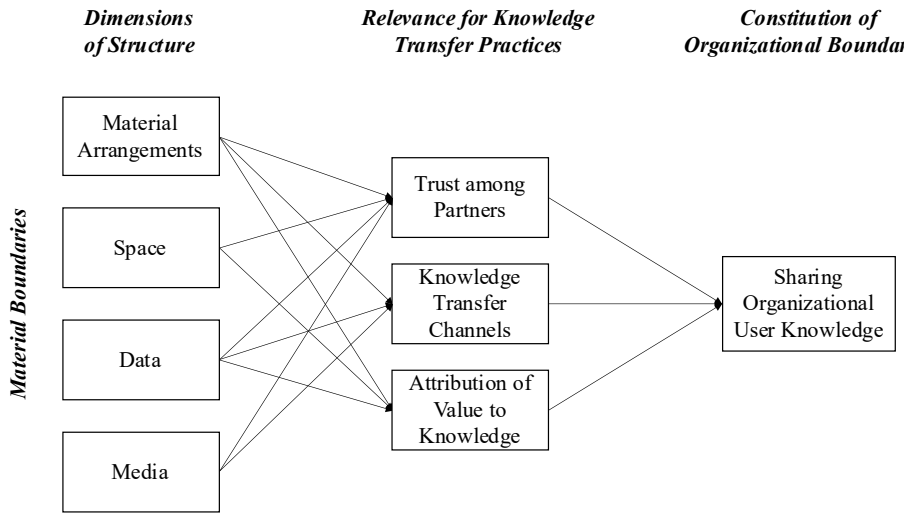
Organizations are generally not only internally structured, but also embedded in structures. They maintain formal relationships with other organizations, which result in corresponding networks. Companies, for example, usually operate in a relatively stable network of suppliers, partners and customers. If there is a high degree of similarity between the structural embedding of organizations and if they are active in a competitive environment, it is possible that they perceive each other as competitors to a certain extent or in certain areas. To the extent that the possibility is seen that user knowledge intended for transfer contains competition-critical knowledge, there is reason for concern. Actors involved in knowledge transfer then tend to be less open, making the knowledge transfer process as a whole more difficult (Hu *et al.*, 2017;

Leonard-Barton, 1992; Milagres & Burcharth, 2019). Organizations that are in a competitive relationship through their formal external relationships thus develop harder boundaries with each other, making the transfer of organizational user knowledge more difficult.

Material Boundaries between Organizations

Organizational practices are not only distributed among people, but they are also materially distributed and constituted (Orlikowski & Scott, 2021). In the following, we present how material arrangements structures the constitution of boundaries between organizations (see Figure 4). We will focus on four types of materiality: the material arrangements in which user practices are embedded, space as the geographical distances between organizations, data as the digital dimension of an organization, and media as communication channels.

Figure 3: Material Boundaries between Organization influence the transfer of organizational user knowledge



Source: elaborated by the authors (Roth & Diefenbach, 2022).

Material Arrangements

Users' knowledge is tied to practices that relate to material arrangements in an organization as an accumulation and arrangement of things (Carlile *et al.*, 2013;

Orlikowski, 2002). In the interaction between organizational users and the material environment knowledge is generated, stored, and transformed. Paths that are walked, data that is shared in a certain way and machines that are operated in specific ways, to name just a few points, testify to a materialization of knowledge. To transfer this tacit user knowledge, their usage practices have to be considered in their material embedding. A shared understanding of user practices is facilitated by the physical presence of related objects and their arrangement (Star & Griesemer 1989; Leonardi *et al.*, 2019). Thus, shared material arrangements can foster the development of a common language for understanding the innovation project and form a project identity (Carlile, 2002, p. 451-452). It can be noted that organizational boundaries are particularly hard when the knowledge of organizational users is strongly bound to the material environment in the respective arrangements.

The structural boundaries of organizations and their contextual factors also affect the exchange of knowledge about material arrangements. As the arrangements contain information about materialised actions and processes, they often also represent knowledge that is critical for competition. Hence, trust is a prerequisite for making accessible the material organization. If organizational users cannot grant other transfer partners insight into the material arrangements, they are thrown back on other communication channels for knowledge transfer, through which the tacit knowledge contained in the material arrangements becomes more difficult to convey. If trust between partners is low, the boundaries between the respective organizations are correspondingly hard, because the material contexts of user practices are not made accessible for partners and the transfer of tacit knowledge is impaired.

Space

Material boundaries between organizations are also created by spatial distances (Knoben & Oerlemans, 2006; Nilsson & Mattes, 2015; Small & Adler, 2019). As described in the previous section, it is crucial for the transfer of organizational user knowledge to consider the material embeddedness of user practices. Therefore, it is particularly important to transfer knowledge into and through the material arrangement of the organization.

In the "DigiWelder" example, this is evident from the effect of the different spatial distances between "Rabe" and the three customer companies. While the two partners several hundred kilometers away are only visited personally for a workshop, the "Rabe" developers visit the customer from the same region time and again spontaneously in order to discuss questions and problems on site and on the actual devices and workpieces.

On site, the partners gain mutual insights into the complex and specific material arrangements. Furthermore, the higher complexity of organizational user

knowledge means that its transfer is more demanding. Private users are easier to reach in this respect, as the practices that are central to their case are embedded in less complex and specific arrangements. Belief in the value of knowledge, trust in the transfer partner and appropriate channels for knowledge transfer are therefore particularly important. Knowledge transfer research shows that personal contacts are particularly conducive to all three factors. Personal encounters at the places where organizational user knowledge is used are therefore crucial for its transfer. To make such repeated encounters possible, the spatial distances between the different partner organizations must be overcome again and again. The spatial relationships, which are defined not only by physical distance but also by transport infrastructure connectivity (Torre & Rallet, 2005), thus determine the boundaries between organizations and influence how easily knowledge can be transferred between them. The harder the boundaries are, the greater the distance and the poorer the connectivity between organizations.

Data

The transfer of organizational user knowledge in interorganizational projects is also determined by the digitalization of each individual organization (Cepa & Schildt, 2019). More specifically, the increasing (re)networking of organizational processes produces data, which in turn leads to a datafication of the organization (Leonardi & Treem, 2020). The storage of data from and to organizational users in databases or even their representation at the interfaces between humans and machines leads to their materialization (Häußling, 2020), with consequences for the entire knowledge transfer process. In this respect, it is not only relevant to illuminate which data are produced and stored in what way to be able to link to them, but also how data is transferred in the first place. Thus, the materialization of data in relation to the boundaries between organizations in the interorganizational knowledge transfer process is of particular importance.

This contextualizing has an impact on organizational boundaries in the different organizations and thus on the knowledge transfer process. The changed materiality of the knowledge to be transferred not only affects the knowledge itself, but also provides additional information about the respective organization. For example, data logs or even technical drawings materialize when they are stored, read or interpreted (Häußling, 2020). In their specific representation (Häußling, 2020), they represent, among other things, not only the specific knowledge about a project, but also the knowledge about the organizational user of a project partner organization and its technological prerequisites. Thus, they also have an influence on the knowledge transfer practices of individual organizational users in the sense of Orlikowski and Scott (2021). While individual private users might be better integrated into the existing

structures of an organization, so that it becomes clearer which data are shared and how they are processed, data of project partner organizations and at the same time of organizational users are, among other things, the result of organizational and thus also far-reaching decisions, e.g. for a certain technology and its settings. Moreover, data represent what is possible through a technology (Flyverbom *et al.*, 2016). This alone demonstrates the sensitivity of data and its sharing, and further illustrates that knowledge transfer across organizational boundaries can be complicated. For all the sensitivity of the data, the added value of transferring it across organizational boundaries must outweigh the risk of transferring it in the context of the inter-organizational project. A lack of insight into how data is viewed and further processed by project partner organizations can lead to mistrust. But also, the data storage of the sensitive data itself can promote this and thus constitutes hard boundaries between the partner organizations.

Media

Typically, user knowledge is also transferred medially. Which communication media is chosen and how it is used fundamentally structures the transfer of knowledge (Levina & Vaast, 2005; Orlikowski, 2000). Three structural characteristics of the organizational embedding of the actors are particularly crucial for the media selection (Leonardi *et al.*, 2019). First, organizations regulate which media members may use and how. Second, the use of specific media is linked to technical requirements such as proper equipment or licensed software, which are available to varying degrees in different organizations. Third, the everyday use of communication media differs systematically between organizations and, as a result, so do the competencies of the actors. Accordingly, which media is used how differs based on the legal, technical and practical structures of the organizations.

When transferring user knowledge between organizations, the respective structures of the organizations involved limit which media can be used for transfer between them and how (Leonardi *et al.*, 2019; Orlikowski, 2000). Different types of media offer different means of expression (Dennis *et al.*, 2008). For example, video telephony allows non-verbal signals and personal information to be conveyed casually, as well as follow-up questions to be asked and answered immediately due to synchronicity, whereas all of this is not possible, or only possible to a limited extent, in writing or by telephone. Conversely, writing enables greater precision and repeated reception of messages. The media use practices that emerge between organizations affect the transfer of organizational user knowledge first, in that channels are more or less likely to convey the relevant dimensions of such knowledge (Leonardi *et al.*, 2019; Levina & Vaast, 2005). Further, communication media can impede the transfer of trust-building information (Nilsson, 2019; Nilsson & Mattes, 2015). The aforementioned

structures of the participating organizations thus structure the quality of the medial relationship between them, and by influencing the transfer of knowledge, they also structure the constitution of boundaries (Levina & Vaast, 2005). Moreover, this specific embedding of organizational users also distinguishes them from private users.

CONCLUSION

Until now, the integration of private and organizational users in innovation processes has hardly been distinguished from each other (Bogers *et al.*, 2010; Piller & West, 2017; Schweisfurth, 2017). Starting from a practice-theoretical perspective, we have challenged this equation by revealing the inconsistency of the previous conceptualization. While user knowledge is conceptualized as the outcome of situated practices, the practices that underlie the transfer of this knowledge and the structures that structure these practices are neglected. Especially in the case of organizational user knowledge, however, the structural embeddedness of actors appears to be highly relevant, since in this case not only the innovating actors act embedded in the material, social and formal structures of their organization, but also the users. By practically confronting the respective structures, the actors constitute specific boundaries between the organizations and thus structure the transfer of organizational user knowledge.

Our primary contribution is to highlight the need for a more precise distinction between private and organizational users when addressing the integration of their knowledge. On the one hand, we have highlighted the relevance of this distinction by pointing to the inconsistency in social theory between the conception of user knowledge as situated and implicit and the conception of the transfer process as independent of the structural embeddedness of the actors involved. On the other hand, we have substantiated our argument by integrating empirical findings on the importance of different social, formal and material structures for knowledge transfer between organizations. Following on from this, it seems extremely fruitful to differentiate users in further empirical research on the basis of their relational structural embeddedness.

Table 1: Boundaries between Organization structure the transfer of organizational user knowledge

	Dimensionen of Structure	*Trust among Partners*	*Knowledge Transfer Channels*	*Attribution of Value to Knowledge*
Social Boundaries	Social Network	x	x	x
	Identification	x		x
	Culture	x	x	x
Formal Boundaries	Hierarchy			x
	Functional Differentiation		x	
	Workflow		x	
	Organizational Networks	x		x
Material Boundaries	Material Arrangements	x	x	
	Space		x	x
	Data	x	x	x
	Media	x	x	

Source: elaborated by the authors (Roth & Diefenbach, 2022).

A second contribution is that by systematically integrating the literature on interorganizational knowledge transfer, we have modeled in detail how different dimensions of organizational structure shapes the transfer of user knowledge and thus constitute boundaries between organizations (see Table 1). The systematization can be used to consider forms of structural embedding in a nuanced way in further empirical research on user integration. It should be emphasized, however, that the relationships we have not described here can also be attributed to the fact that they have not been studied so far. This also includes that other structural dimensions are of importance that we have not considered (such as the legal and contractual conditions of collaboration). It therefore seems particularly worthwhile to critically review the gaps in our depiction in further research.

A third contribution of the paper concerns practice-theoretical research on the constitution of boundaries (Leonardi *et al.*, 2019; Levina & Vaast, 2005). In the case of material boundaries, we could build on an elaborated state of research. In contrast, in the case of social and especially formal boundaries, we have done some translation work. Since we were only able to illuminate the individual dimensions of structure in a very superficial way here, but nevertheless clarified their relevance, it seems very productive for further practice-theoretical research on the constitution of boundaries to take a closer look at social and formal boundaries.

Fourth, the paper extends critical studies of innovation (Godin & Vinck, 2017; Gold, 1969). In previous research on users in the innovation process, it was often assumed that users are generally motivated to engage in innovation processes. We have used boundaries to shed light on various reasons why this might not be the case.

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