INITIATIVE ON
Digital Innovation

CGIAR

Working paper

Fostering social inclusion in digital food system interventions

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Date August 4, 2023

Work package Digital Inclusion (WP 2)

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1. Shortcomings in the digital inclusion discourse

Numerous digital technologies and data-driven services have emerged in support of most aspects of food systems in low- and middle-income countries (CTA 2019, FAO & ICRISAT 2022, Porciello et al. 2022). Digital services can, for example, improve farmers' access to agronomic and climate information, help coordinate agricultural in- and output markets, or ease smallholders' access to crop insurance and credit (Ochieng Ogutu et al. 2014, Fabregas et al. 2019, Ceballos et al. 2019). However, increasing digitalization also risks consolidating or widening already existing social disparities (van der Burg et al. 2019, Hackfort 2021, McCampbell et al. 2019, Abdulai 2022). For example, by relying on mobile internet connectivity via smartphones, some digital services potentially increase the competitive advantage of wealthier, less remote, and more educated farmers while offering little benefits to the most marginalized (Wyche & Steinfield 2016, Bronson 2019, Mehrabi et al. 2021, Coggins et al. 2022, GSMA 2023).

Like all development-oriented interventions, digital innovation processes must 'do no harm', and therefore, designers of digital food systems interventions should actively consider inclusivity concerns (Dette 2018). In practice, smallholder farmers and other

stakeholders targeted by digital interventions often have little digital skills and experience, as well as limited access and exposure to mobile networks and data streams (Mehrabi et al. 2021, McCampbell et al. 2023). While there is evidence that many smallholders already integrate digital tools in farming, this often involves creative use of rather simple services – such as phone calls, SMS, or WhatsApp groups – rather than dedicated agri-apps (Coggins et al. 2022, Porciello et al. 2022, Abdulai et al. 2023). Relatively low 'digital readiness' of smallholder farmers, as well as highly heterogeneous information needs and preferences, imply that many nascent, sophisticated digital solutions may not be inclusive to large shares of their intended target group (McCampbell et al. 2021, 2022, Daum et al. 2022).

These observations suggest that digital innovation agents, such as researchers, social entrepreneurs, donors, or investors, need to more consciously – and more successfully – ensure inclusivity towards marginalized social groups. There is no clear vision, however, regarding the goal: 'digital inclusion' remains a vaguely defined concept. To date, there is limited agreement among researchers and practitioners about what digital inclusion entails and how it can be assessed. For example, the *National Digital Inclusion Association*, a US-based NGO, provides a definition centered on first-level digital divides (quality infrastructure, accessible hardware), and second-level digital divides (user skills) (NDIA, online). Many authors also consider third-level digital divides, related to *"uneven capacities to capitalize on the access and use of ICTs and transform it into tangible and concrete outcomes."* (Ragnedda & Gladkova 2020:19f). And McCampbell et al. (2021) point out that individuals

can simultaneously be included and excluded, for different reasons and at varying degrees. This current lack of conceptual precision challenges the ability of designers and researchers to actively consider inclusivity concerns. Without a clear definition, it also remains difficult for donors and funding agencies to determine inclusivity-related targets and demand accountability from funding recipients.

In this article, a group of digital development researchers presents and reflects on three aspects of academic and institutional progress that could help achieve more inclusive digital innovation. Our perspective centers on public-good, research-for-development experiences within CGIAR. This is a global partnership for food system transformation where multiple centers and units work on digital innovation. In result, our analysis might not equally apply to the for-profit agritech sector. Based on an analysis of recent literature and a reflection of our own experience with digital food system innovation processes within CGIAR, the three action areas are: First, the development of universal minimum standards and procedures for assessing the inclusivity of digital food system innovations. Second, the creation and diffusion of actionable decision-support tools that enable innovation agents to actively consider and enhance inclusivity. And third, the provision of stronger incentives for researchers and other innovation stakeholders to actively cater for inclusivity in digital interventions. The article intends to spark wider academic thought and stakeholder discussions on how digital food system innovation processes can lead to more inclusive outcomes.

2. Three action areas for more inclusive digital food system innovation

2.1 Agreed minimum standards for assessing digital inclusivity

Discussions around digital inclusion frequently focus on overcoming or mitigating existing digital divides (Ng et al. 2021, GSMA 2023). Policy makers and researchers tend to emphasize inequalities regarding access to infrastructure and hardware (i.e., divides in availability and affordability; USAID 2020). Often, less attention is placed on socio-culturally shaped dimensions of digital exclusion, such as unequal levels of digital skills or unequal willingness to engage with digital services, that is, the ability and appetite dimensions of digital inclusion (Digital Future Society 2019). Whether individuals are inclined to use a digital innovation ('appetite') is influenced by an interplay of many factors that are highly context-specific, fluid, and generally harder to assess than availability and affordability. Such factors may include the specific contents of a digital intervention, but also previous digital experiences, online insecurity concerns, language and literacy barriers, or social norms that restrict certain individuals' use of digital media (Shang et al. 2021, Porciello et al. 2022).

Depending on the local context and type of digital solution, any of these factors may or may not mediate exclusion of individuals from digital interventions. Given this high context-specificity, it is no surprise there is a lack of transparent and holistic standard

criteria for approaching the question: how inclusive is a digital innovation? Yet in current research-for-development practice, the lack of analytical instruments for assessing digital inclusion means that donors cannot easily demand inclusivity. Without generalizable, auditable criteria, donor-funded innovation processes risk ignoring locally relevant dimensions of exclusion. Many projects, for example, focus on metrics that are relatively easy to observe and report, such as gender-disaggregated innovation uptake, but provide little evidence on the distribution of benefits from a digital intervention. Moreover, potential harm caused by digital interventions to targeted individuals is rarely assessed (Stone 2022). This means that donors and researchers often have insufficient knowledge about the state of inclusivity of their digital innovations, which limits their ability to improve it. A transparent, generalizable, and holistic standard for assessing digital inclusivity may therefore be useful.

The development of such a universal standard faces at least three challenges. First, digital inclusion is highly context-specific. Individuals may face different kinds of exclusion from different digital services for different reasons. This raises the question of 'who' is being considered by a standard, and who may be overlooked. That is, what social determinants should be taken into account to make the assessment holistic and generalizable, and yet applicable in practice. Gender, ethnicity, education, wealth, digital literacy, rurality, disability, and many more variables could be considered. McCampbell et al. (2021:207) argue that such decisions require some subjective judgments, since "(...) trade-offs make

exclusion almost inevitable as design-for-all or one-size-fits-all solutions are highly complex and oftentimes simply impossible". This complexity is exacerbated by the fact that different stakeholders involved in digital food system innovation pursue different goals, currently leading to different priorities regarding inclusion (McGrath et al. 2023). Second, it is difficult to observe and measure inclusivity at levels beyond individual users, such as the design process or the institutional context (Heeks et al. 2013). There is general agreement that active, ongoing involvement of diverse members of the target group along the design process can help mitigate risks of exclusion (Waller et al. 2015, Patrick & Hollenbeck 2021). However, the intensity of user engagement in the design and governance of digital innovations is hard to measure and monitor. This said: third, there is no 'ideal' level of user participation in digital design processes. Co-designing digital solutions with target users, such as smallholder farmers or agricultural advisors, is often beneficial for inclusivity. In some contexts, however, participatory design can be particularly challenging, misleading, or even unfeasible. If implemented with insufficient time, skill, or institutional support, for example, participatory design processes may create an illusion of inclusivity, leading to unsatisfactory outcomes (Norman 2005, Mani-Kandt & Robinson 2021, McCampbell et al. 2022, Steinke et al. 2022). These challenges contribute to fuzziness and potential disagreement in trying to assess digital inclusivity.

In light of this complexity, researchers, funding agencies, and other innovation agents would benefit from clear and unambiguous guidelines for envisioning desired

inclusivity-related outcomes. We suggest that the digital-for-development research community should collaborate to agree on a common minimum standard for assessing digital inclusivity. The challenges mentioned above require careful attention. Nonetheless, it is possible to define universal, normative standards that are applicable across highly heterogeneous contexts. Prominent examples include assessment standards for organic agriculture, the UNDP's Human Development Index, or the Women's Empowerment in Agriculture Index (WEAI; Alkire et al. 2013).

Such an index would fulfill several functions. First, by providing clearly formulated, verifiable criteria and corresponding assessment methods, an index for digital inclusivity would provide researchers and digital designers with concrete guidance for enhancing the inclusivity of the innovations they develop. Second, by fostering greater agreement on targets, a standardized inclusivity index might support more effective collaboration between digital innovation stakeholders. It would also enable donors and investors to set realistic targets and include clear inclusivity-related requirements already in the call for proposal. In result, otherwise marginalized communities and individuals are likely to participate more meaningfully in digital innovation processes, leading to more inclusive and beneficial digital solutions. Third, in light of limited resources available for digital design processes, the index could help innovation stakeholders prioritize which aspects of inclusivity to emphasize most strongly. In the future, a digital inclusivity index should also allow for context-specific adaptations that might ease its usability. It may also be valuable

to develop abbreviated or extended versions, for different types of use cases or user groups. For example, there are multiple versions of the WEAI, for use in different contexts (e.g., intervention projects or baseline research).

2.2 Greater capacity for considering inclusivity in the design process

Design processes that are properly inclusive themselves are likely to generate more inclusive digital solutions. Inclusive design processes acknowledge diversity within the target group, allowing innovation agents to recognize potential exclusion at early stages. Participatory design methodologies, such as human-centered design, can promote inclusion only if design participants represent diversity: different members of the target group are likely to face different forms of exclusion. Therefore, an inclusive design process typically implies intense and continued participation of a diverse sample of the target group. But many international agriculture-for-development projects face challenges that hinder the implementation of thorough user research and socially inclusive design processes. Challenges include, for example, tight deadlines, limited budgets, pressure to demonstrate pre-determined impacts, and limited human-centered design skills and awareness among CGIAR researchers (Leeuwis et al. 2018, McCampbell et al. 2022, Steinke et al. 2022). These pressures – which all boil down to the scarcity of time, budget, and staff – often confront digital development projects with trade-offs.

One trade-off relates to project resources: researchers may consider inclusivity by facilitating a participatory design process involving an adequately sized group of diverse target users from the very beginning, including the stage of problem definition. But this initially costs time, requires skilled staff, and can delay project delivery due to unforeseen iterations. Moreover, participatory problem definition can highlight needs that lie outside the project scope, which can be restricted by donor priorities. In these cases, it may make little meaningful impacts on further design process (see Section 2.3 below). As a consequence of these challenges, inclusivity often becomes a conscious concern only at later stages, for example, when collecting feedback from diverse test users. Delaying inclusivity efforts in design processes saves resources during the project period. But it limits opportunities for addressing the needs, challenges, or fears of excluded social groups. This, however, can turn out more costly in the longer run: retroactively improving the inclusivity of digital innovations that have already been designed and deployed may be near impossible if the digital service was not designed to address their needs and technology preferences in the first place.

Another trade-off relates to the concept of inclusivity itself: in many cases, actively catering for inclusivity requires conscious and transparent decisions on ‘who’ is meant to be included. For example, efforts to enhance the inclusion of women may have little or no effect on the exclusion of people with disabilities (such as impaired vision or hearing) or those living in extreme poverty. Much like one-fits-all solutions, there are no one-fits-all

design challenges. So, on the basis of available resources for user research and prototyping, digital design teams may need to prioritize the forms of potential exclusion that shall be mitigated. To avoid disappointing design participants (and donors), transparent communication is crucial about who is being targeted and actively included, and who is not. Other excluded social groups can be addressed in future iterations – but this may be hard to do successfully (see previous paragraph).

Given these pressures, gold-standard inclusive design processes are likely to be the exception within CGIAR. Therefore, we believe there is a need for simple, rapid, and heuristic design tools that enable motivated researchers to actively pursue inclusivity despite the described pressures. These tools should fulfill four criteria: First, they should be easy to learn and apply by researchers with limited experience in design methods. Second, they should require limited time commitment, for example, for data collection and analysis. Third, they should go beyond raising new questions and should generate concrete, actionable insights for mitigating exclusion. Fourth, they should be globally applicable while delivering context- or project-specific insights. As one example of such heuristic design tools, we present the 'Rapid Inclusivity Assessment for Digital Agriculture' (RIA; Steinke & Schumann 2022). RIA is a guided analysis process that supports designers of farmer-facing digital solutions in enhancing the inclusivity of their designs. The tool relies on user journey mapping, a common design method for improving user satisfaction in commercial settings (Howard 2014). A user journey map outlines the sequential flow of motivations, actions, and

challenges a user may experience while interacting with a product. The RIA tool provides a simple template for user journey mapping that is adapted to typical user experiences in digital agriculture services.

RIA can be implemented at any stage of innovation development, for example, as soon as the first concrete design idea has been created, or as late as intending to increase the inclusivity of a digital solution that has already been released. Through a systematic, self-facilitated workshop of roughly three hours, design teams (1) uncover potential risks of exclusion in the current service concept or existing digital service, and (2) generate improved design ideas that mitigate these risks of exclusion. They then develop a research plan to quantify the extent to which the identified, potential risks (see point 1 above) actually lead to exclusion, which helps to prioritize the inclusivity-oriented design adjustments (see point 2 above). As an output, RIA provides design teams with clear follow-up activities for enhancing inclusivity.

The RIA tool requires design teams to critically inspect the generic user journey of their digital service from the perspective of three 'proto-personas': Sarah, Florence, and Joy. These proto-personas are brief profiles of fictional female smallholder farmers from sub-Saharan Africa, with attributes that lead to relatively strong digital exclusion, such as not owning a mobile phone, having limited literacy, no mobile network on the farm, etc. (Figure 1). User personas are a common tool in digital design. Based on actual data collection, they provide a realistic representation of the target group's habits, preferences, fears, and

aspirations. User personas help designers stay focused on the target group's identified needs and emotions. The proto-personas created for RIA, however, are not based on real data: they were created explicitly to highlight a wide range of risks of digital exclusion. Like all personas, they are meant to catalyze empathy: Sarah, Florence, and Joy provide a human face to the abstract concept of 'digital exclusion'. As such, they help to recognize potential exclusion. In many contexts, actual levels of digital exclusion may be less serious on average. Nonetheless, by scrutinizing a design idea from the perspective of these extreme cases, digital designers can conceive improvements that are likely to also benefit people affected by milder forms of digital exclusion. This principle of practicing inclusive design is known as "solve for one, extend to many" (Microsoft Design 2016, Holmes 2018).

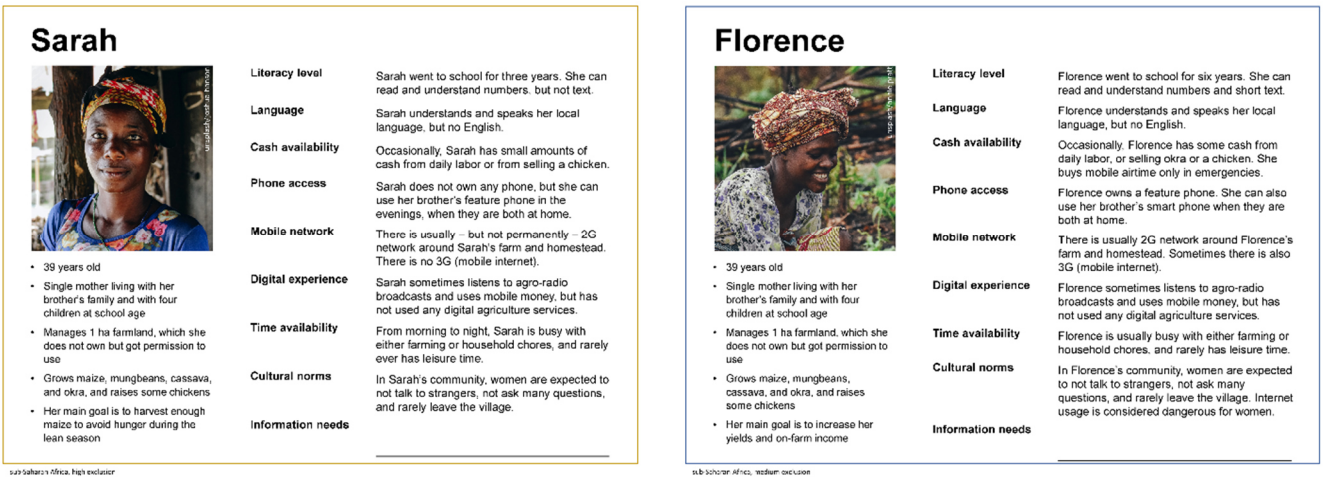

Figure 1: Two of three fictional 'proto-personas' used to evaluate the inclusivity of digital agriculture services, as part of the RIA tool. The proto-personas are meant to embody the abstract concept of digital exclusion in a tangible, concrete form. 'Sarah' represents stronger overall exclusion than 'Florence'.

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In Ethiopia, RIA has helped CGIAR researchers identify potential barriers excluding farmers from accessing a digital fertilizer recommendation service. This has motivated concrete design adjustments (Müller & Schumann 2023). Future modifications of the RIA tool should include a male proto-persona, to avoid the misperception that digital exclusion affects women only. It will also be helpful to create regionally adapted proto-persona sets, for example, in Spanish. While we presented RIA as one example of simple design tools for actively addressing inclusivity, a larger suite of such tools would be useful. For example, Ali et al. (2023) provide a validated, simple questionnaire for estimating digital skill levels in low-income populations. Such analyses can be a valuable input to empathizing with the target group and generating early ideas.

2.3 More inclusivity-oriented management of the research-for-development system

Current management of the research-for-development system insufficiently caters for inclusivity in digital innovation processes. We identify at least three reasons: first, competitive grant allocation often prioritizes the development and introduction of novel digital technologies over using existing ones. But novel technologies typically emerge in privileged parts of society. Using established technologies in creative ways may allow for more inclusive innovation. Second, an overly linear and predetermined design of project logframes leaves little scope for involving marginalized voices in defining problems and

solutions. And third, there are insufficient safeguards against potential negative impacts of digital interventions beyond the immediate target group. The three following paragraphs elaborate on these aspects.

1. Focus on novel technology rather than social innovation. Agricultural research-for-development is funded, for the most part, by donors from the humanitarian or public sector, including Global North governments, charitable foundations, and international organizations, such as the World Bank (Beintema & Echeverría 2020). Funds for research staff and operations are often allocated based on competitive grants. This system aims to ensure that research generates cutting-edge outcomes at reasonable costs. However, it may also incentivize researchers to focus on more privileged social groups. Competitive grants usually demand that researchers push the boundaries of science by delivering an entirely novel (digital) solution and demonstrating its potential impacts. But donors, as well as researchers, often assume the groundbreaking nature of digital innovation to come from harnessing a new technological opportunity, rather than from creative use of established technologies. By default, new technological opportunities tend to first appear in less marginalized parts of society. Think of smartphone apps, or even SMS services that require literacy or numeracy. Thus, designing and testing a novel digital innovation is often more easily achieved through working with wealthier, more educated, less remote, and more digital-ready farmers. Under current grant allocation systems, projects that suggest innovation can emerge from designing open-endedly in resource-poor and vulnerable

contexts, combining existing digital technologies with established non-digital processes, are less likely to get funded.

2. Overly linear and pre-determined project execution. Donors and policy makers provide funding for innovative research ideas that promise to promote expected development outcomes (Leeuwis et al. 2018). While grant managers tend to care for delivery of outputs and adherence to project timelines, researchers usually enjoy autonomy in designing the process for ending up with said outputs on time. This incentivizes researchers to present linear project logframes with predetermined outcomes. But an overly linear project design also risks focusing on the more obvious needs of more outspoken, opinion-leading, and socially privileged groups. The often heterogeneous needs and aspirations of marginalized groups are harder to anticipate during proposal development. Thus, by putting little emphasis on iteration and context exploration, projects reduce the 'risk' of questioning original hypotheses and diverting substantially from the proposed digital innovation. After all, many researchers also tend to consider such adjustments as failure, rather than as outcomes of the necessary, unfolding dialogues with the project target group.

3. Weak safeguards against negative side-effects. For reasons of accountability, researchers, donors, development agencies, and policy makers all need to assess the quality and impact of digital interventions. To measure and demonstrate the success of their work, they typically use performance metrics that are easy to quantify and report.

Examples include adoption rates, user satisfaction rates, changes in on-farm practices, or effects on users' yields and incomes (Ortiz-Crespo et al. 2021, Porciello et al. 2022). Sometimes, outcomes are disaggregated by gender or social strata to monitor the social equity of direct impacts. But digital interventions can cause unintended social repercussions, also beyond the immediate target group. Uptake of digital agri-services may, for example, influence gender roles and contribute to women's disempowerment (Adeyeye 2021), undermine farmers' skills and experiential knowledge (Ingram & Maye 2020), or expose farmers to risks of surveillance and behavioral manipulation (Stone 2022). Currently, stakeholders of digital food system interventions have little incentive to assess and mitigate potentially negative effects.

To enable more inclusive digital innovation processes, the agricultural research-for-development system needs to be more strongly geared towards inclusivity. Donors and research organizations can play an active role in this transition.

- Donors should explicitly demand social inclusivity being considered in digital design processes. A shift is needed towards funding more open-ended innovation processes that do not presume problems and (digital) solutions at the proposal stage. Rather than pre-determining performance indicator levels that shall be achieved, these indicators, as well as the targeted levels, could be defined together with the project target group at the project outset. And beyond individual projects, donors could define funding priorities through more direct interactions with on-the-ground

organizations, including civil society or public authorities. This may help move the funding focus away from an emphasis on cutting-edge technology, and towards solving actual challenges.

- Until a universal digital inclusion standard emerges (see Section 2.1), and in absence of strong demand by donors, research organizations could go forward and establish internal monitoring and support structures. Mandatory ethics reviews for human-subject research are already widespread. For digital development projects, these could be expanded to include explicit social inclusivity considerations, providing researchers with advice on how to mitigate identified risks. In some private companies, including pharmaceutics giant *Merck* and communications start-up *Witty*, 'digital ethics boards' regularly review emerging digital innovations.[1,2]
- Beyond individual projects, research organizations should ensure there is adequately skilled staff to lead inclusive digital innovation processes. Digital development projects relying on a team of pure agronomists and IT developers should be a thing of the past. To ensure that design ideas in digital development processes rely on context-based, emerging insights, research organizations need to foster interdisciplinary teams. Such digital design teams unite agronomic knowledge and

[1] https://www.merckgroup.com/en/sustainability/business-ethics/advisors-for-bio-and-digital-ethical-issues.html
[2] https://www.witty.works/ethics-board

tech know-how, but also expertise in behavioral science and participatory design methods. Currently, user research is sometimes outsourced to external providers of design expertise.[3] This can be a viable approach, too. But in all cases, research-for-development organizations must ensure that agricultural researchers have the awareness and capacity to appreciate, and to act upon, processes of user research and iterative, user-centered development of design ideas.

3. Outlook

The global research-for-development system generates digital food system innovations that are, on the whole, insufficiently inclusive. Marginalized social groups, including poor farmers and rural women, do not adequately benefit from many donor investments into research. By analyzing the reasons that contribute to this unsatisfactory situation, this article shows how individual researchers, research organizations, donors, and policy makers can take action to embrace social inclusivity in digital innovation processes. A key next step for the digital development community is to operationalize the vague concept of digital inclusivity: innovation stakeholders require agreed-upon standards for setting goals, a wider range of actionable tools to work towards these goals, and the right incentives to put these tools into action.

[3] Examples include Rare (https://rare.org) or Busara Lab (https://busaracenter.org)

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In the medium run, there is a need for growing the human capacity of research-for-development organizations for facilitating inclusive design processes. This could be achieved by increasing the awareness and fostering the skills of existing agricultural, social, or economic researchers. Hiring inclusive design experts, for example, from the tech industry, at CGIAR centers could also help promote inclusive digital innovation processes. Ultimately, an innovation environment is needed where all key stakeholders – researchers, donors, policy makers – embrace inclusivity. With inclusivity considerations engrained in, for example, funding allocation, recruitment policies, and M&E systems, novel responses to emerging food system challenges would be as inclusive as possible by default.

And beyond CGIAR? To some extent, research-for-development innovation can mitigate systemic digital exclusion of marginalized social groups. But inclusive digital innovation processes can only be part of the overall digital transformation of food systems, driven by policy makers, local communities, and the private sector. This involves ensuring that digital infrastructure and hardware are universally accessible and affordable. Policy makers can regulate the ongoing digital transformation with a stronger emphasis on inclusivity. For example, lower costs of mobile data and devices may be achieved by fueling competition, or by providing fiscal incentives for companies that fulfill inclusivity-related targets. Mobile phone companies can emphasize features that matter in under-resourced environments, such as physical robustness, strong loudspeakers, or user-friendly text-to-speech functionalities (see Wyche & Steinfield 2016). In the future, a more inclusive digital

transformation should rely on national and regional partnerships between policy makers, civil society organizations, the private sector, and research organizations, aligning their efforts towards agreed digital inclusion goals.

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