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Designing Personalised Social-Environmental Interventions for Connection and Meaningful Productivity in Ageing Communities

Toh Hsiang Benny Tan[1], Iain Philip Werry [1], Sufang Lim[2]

[1] Joint NTU-WeBank Research Centre on Fintech),
Nanyang Technological University, Singapore
[2] Joint NTU-UBC Research Centre of Excellence in Active Living for the Elderly (LILY), Nanyang Technological University, Singapore

bennytanth@ntu.edu.sg, ipw@ntu.edu.sg, sufang@ntu.edu.sg

Abstract

Population ageing requires interventions that support not only health and safety, but also connection, contribution, and self-fulfilment. Older adults may experience loneliness and shrinking social networks alongside mobility constraints, chronic illness, and urban stressors that together limit participation in community life. At the same time, many interventions remain fragmented, focusing separately on digital tools, social activities, or built-environment improvements. This paper proposes a human-centred framework for personalised social-environmental interventions that integrate three mutually reinforcing layers: environmental enablement, social enablement, and digital enablement. Environmental enablement concerns the places people move through and gather in: accessible routes, age-friendly neighbourhoods, green and cultural spaces, and the community hubs that anchor them. Social enablement focuses on the human infrastructure that turns access into participation, from trained facilitators and peer supporters to family and volunteer involvement and inclusive programming that opens genuine opportunities for contribution. Digital enablement, finally, brings in usable

technologies — speech interfaces, location-aware nudging, personalised routing, digital twins, and hybrid virtual-real tools — that should support, rather than replace, human relationships. The paper argues that meaningful productivity in later life should be understood not as economic output alone, but as valued participation that brings contribution, purpose, and recognition. It concludes with implementation and evaluation recommendations for designing interventions that are at once personalised and place-based, culturally sensitive, and sustainable enough to be measured over time.

Keyword: ageing, social isolation, meaningful productivity, built environment, human-centred AI

I. Introduction

Population ageing is one of the defining social transformations of the twenty-first century. Longer life expectancy creates opportunities for continued learning and creative expression, for caregiving and volunteering, and for civic contribution well into later life. However, older adults may also face social isolation and loneliness, reduced mobility and bereavement, chronic illness, and the difficulty of navigating increasingly complex urban and digital environments. The challenge is therefore not merely to extend life, but to support lives that remain socially connected, purposeful, and personally meaningful.

Healthy ageing has been defined by the World Health Organization as the process of developing and maintaining functional ability that enables well-being in older age [1]. This definition is important because it shifts attention from disease alone to the interaction between individual capacities and supportive environments. Similarly, age-friendly city frameworks emphasise that participation and well-being depend on outdoor spaces and transport, on suitable housing, and on social inclusion, civic participation, communication, and broader community support [2]. These perspectives suggest that interventions for ageing should be ecological and multi-level, rather than narrowly medical or individualistic.

Social connection is a central component of this agenda. Stronger social relationships are associated with reduced mortality risk [3], while loneliness and social isolation have been linked to

adverse physical and mental health outcomes [4], [5]. Yet connection alone is insufficient. Older adults do not simply need more activities; they need opportunities that are meaningful and accessible, culturally resonant, and well aligned with their own identities and capacities. Meaningful productivity in later life may take many forms, from volunteering and mentoring to gardening and caregiving, from artistic participation and peer support to cultural transmission and neighbourhood stewardship. These activities matter because they provide purpose and recognition, together with a sense of continuing contribution.

This paper proposes a conceptual framework for personalised social-environmental interventions that promote connection and meaningful productivity for self-fulfilment in ageing communities, integrating three mutually reinforcing layers: environmental, social, and digital enablement. The central argument is that successful interventions must align accessible places, supportive relationships, and usable technologies around what older adults themselves value.

II. From Isolation Reduction to Meaningful Participation

Social isolation is commonly understood as an objective lack of social contact, whereas loneliness refers to the subjective feeling that one's relationships are insufficient or unsatisfactory [4], [6]. Both are important, but interventions should avoid treating older adults as passive recipients of contact. The more ambitious goal is meaningful participation: engagement in activities, relationships, and roles that offer a sense of belonging, a feeling of purpose, and the chance to contribute.

Social participation has been defined in multiple ways in ageing research, including involvement in activities that provide interaction with others and engagement in society [7]. In practice, it ranges from formal volunteering and civic activities to informal socialising with family, neighbours, and friends, and includes religious life, cultural events, and exercise or interest groups. However, attendance alone is a limited indicator. An individual may attend a community activity without forming meaningful ties, while another may derive substantial fulfilment from a small but trusted network. Social relationships influence health by providing emotional and instrumental

support, shaping behaviour through social influence, opening access to information, and sustaining engagement in valued roles [8].

Meaningful productivity extends this view by emphasising contribution and purpose. It should not be reduced to paid work or economic output. For older adults, productivity often takes everyday forms such as caring for grandchildren or supporting peers, sharing skills and maintaining cultural practices, and helping organise community events or contribute to local green spaces. Psychological well-being theory describes flourishing along several connected dimensions, including a sense of purpose, positive relationships, autonomy, environmental mastery, and continued personal growth [9]. These dimensions suggest that self-fulfilment depends not only on being included, but on being able to act and contribute in ways that are recognised by others.

A personalised approach is necessary because older adults are not a homogeneous group. They differ in health and mobility, language and culture, digital literacy, family and financial circumstances, and personal preferences. While some value large community events, others prefer small-group or one-to-one engagement; some need mobility support, while others need help rebuilding confidence after illness or bereavement; and digital tools that one person welcomes another may find burdensome. Personalisation should therefore begin with the question: what does this person value, and what environmental, social, or technological support would make valued participation possible?

III. Problem Theoretical Foundations

The proposed framework is informed by three bodies of theory. First, environmental gerontology emphasises the relationship between personal competence and environmental demand. Lawton and Nahemow's ecological model of ageing suggests that well-being depends on the fit between individual capacities and environmental press [10]. Environments that are too demanding tend to produce stress, withdrawal, and eventual dependency, whereas appropriately supportive environments enable autonomy and continued engagement. Later work in environmental gerontology similarly argues that

ageing well depends on the homes and neighbourhoods people inhabit, alongside the institutions and public spaces that support their agency and participation [11].

Second, social capital and social network perspectives highlight the role of trust and reciprocity, weak ties, and broader community embeddedness. Social networks supply emotional support and practical help, circulate information, and open opportunities for participation [8]. Weak ties may be especially useful because they connect individuals to broader resources and opportunities beyond close family and friends [12]. Social capital can strengthen community life, although it may also be unevenly distributed across groups [13]. Effective interventions accordingly need to build both bonding ties within familiar groups and bridging ties across different social communities.

Self-efficacy theory, finally, helps explain why some older adults may need gradual pathways back into participation. Bandura argues that people are more likely to engage in behaviours when they believe they can perform them successfully [14]. For an older adult recovering from illness, grieving, or socially withdrawn, participation may require small and achievable steps, repeated encouragement over time, and supportive environments around them. Personalised interventions should therefore build confidence progressively rather than assuming immediate readiness for group engagement.

IV. A Three-Layer Framework for Personalised Social-Environmental Intervention

A. Environmental Enablement

The first layer, environmental enablement, is about designing or adapting physical places so that older adults can reach and use them, and so that they can enjoy spending time in them. Built environments shape how older adults move, stay physically active, participate socially, and ultimately how healthy they remain [15], [16]. Barriers can prevent participation even when activities are available, whether physical obstacles such as poor walkability, unsafe crossings, and distant facilities; environmental discomfort such as heat exposure or lack of shelter; or service gaps such as inadequate seating, poor signage, and inaccessible toilets.

Age-friendly communities require accessible outdoor spaces and reliable transport, suitable housing and well-located community facilities, and genuine opportunities for social and civic participation [2], [17]. In dense urban settings, small environmental improvements can have large effects. Shaded walking routes with benches and covered walkways, combined with safe crossings, accessible entrances, and clear wayfinding to nearby community nodes, can substantially reduce the effort required to participate. These features matter most for older adults coping with mobility limitations or fatigue, those who fear falling, and those living with cognitive impairment.

Green and cultural spaces are also important. Contact with nature has been associated with mental health and restorative benefits [18], [19]. Parks, gardens, and tree-planting activities, alongside art spaces, museums, libraries, and cultural festivals, can support both belonging and meaning. Such spaces allow older adults to engage not only as service users but as active contributors, gardening or guiding visitors, telling stories, volunteering, making art, and acting as custodians of local culture. Well-designed environmental enablement supports both access and contribution.

B. Social Enablement

Where environmental enablement opens up places, social enablement provides the human infrastructure that turns access into actual participation. Physical spaces alone do not create meaningful connection. Many older adults need encouragement and accompaniment, skilled facilitation, or a trusted introduction before they will participate, and this is particularly true for those who are socially isolated, recently bereaved, living with disability, or lacking family support.

Social prescribing provides one useful model. It connects individuals to non-clinical community resources ranging from arts activities and exercise groups to volunteering, peer support, and social clubs [20], [21]. Evidence suggests that social prescribing depends heavily on implementation context, including the role of link workers, the strength of local resources and referral pathways, and the specific needs of participants [20], [22]. For ageing communities, this implies that social interventions should bring together trained facilitators and befrienders alongside volunteers and peer connectors who can sustain participation over time.

Inclusive programming is also essential. Social activities should be culturally sensitive, linguistically accessible, and responsive to different abilities. Mixed-community events can build bridging ties, but they require careful facilitation to avoid exclusion or clustering within familiar groups. Family involvement may help some older adults participate, but interventions should not assume that family support is available or positive. Alternative pathways are therefore necessary, including peer support, volunteer accompaniment, and neighbourhood-based facilitation.

Social enablement should also create roles for contribution. Older adults may be invited to welcome newcomers and co-organise events, mentor peers or share stories from their experience, and help maintain community gardens or advise on neighbourhood improvements. These roles support meaningful productivity because they recognise older adults as contributors rather than only beneficiaries.

C. Digital Enablement

The third layer, digital enablement, applies technology to reduce participation barriers and support personalised engagement. Potential tools range from speech-based interfaces and location-aware reminders to personalised routing and digital community platforms, and extend to digital twins for planning and hybrid virtual-real environments for training or engagement.

However, technology must be designed carefully. Older adults' adoption of technology is shaped by how useful and easy to use the technology appears, by the user's confidence and prior experience, by available social support, and by concerns about affordability, privacy, and trust [23], [24], [25]. Poorly designed applications can increase frustration or exclusion. A useful starting point for digital enablement is therefore practical needs, such as helping a person find an accessible route or remember an activity, identify nearby support, and communicate preferences or connect with a trusted facilitator.

Speech interfaces may reduce barriers for users who struggle with typing or complex navigation, while location-aware systems can suggest nearby activities or accessible paths. Personalised routing can go further still, accounting for the use of mobility aids, the slope and distance

of a route, the availability of shade, seating, and shelter along the way, and the level of crowding likely to be encountered. Digital twins may help planners simulate how changes to buildings, parks, or neighbourhood layouts affect everyday movement and heat exposure as well as patterns of social interaction [26]. Human-centred AI principles are essential: systems should be reliable and understandable, remain under user control, preserve privacy, and ultimately align with human agency [27], [28].

Hybrid virtual-real tools may also be useful. Virtual environments can allow older adults to preview spaces and rehearse social situations, or to participate at all when illness or mobility barriers prevent physical attendance. Nevertheless, digital tools should augment rather than replace real-world relationships. Loneliness and lack of meaning are not merely information problems; they are relational and existential concerns. The most appropriate role for technology is to reduce friction and strengthen human connection.

V. Design Principles

The proposed framework should be guided by several design principles that help translate the broad goal of self-fulfilment into practical intervention design. A central principle is that interventions should begin from valued roles rather than deficits. Older adults are often described in terms of vulnerability and loneliness, frailty, or unmet service need. While these concerns are real, a deficit-based framing can unintentionally position older adults as passive recipients of support. A more enabling approach asks what roles individuals wish to sustain, recover, or develop. These roles can be relational, such as being a neighbour, friend, or peer supporter; generative, such as mentoring, volunteering, or caregiving; or expressive and reflective, such as learning, gardening, making art, or sustaining a faith practice. This orientation is consistent with psychological well-being theory, which describes flourishing in terms of purpose in life and positive relations, autonomy and environmental mastery, and continued personal growth [9]. It also shifts the aim of intervention from simply reducing

isolation to enabling older adults to experience recognition and agency through meaningful contribution.

Another important consideration is the need for co-design with older adults and the communities in which they live. Personalisation cannot be achieved if interventions are designed only by researchers and planners or by clinicians and technology developers. Older adults should be involved throughout, from identifying barriers and defining what counts as a meaningful outcome to testing prototypes and refining how the intervention is implemented. Co-design is particularly important because age alone is a poor predictor of need. Older adults differ substantially in mobility, cognition, and health, in language and culture, in the family support available to them, and in their digital confidence and preferred forms of participation. Participatory and co-design approaches can improve relevance by involving intended users in problem framing and decision-making, rather than limiting their role to late-stage feedback [29]. This is especially important for interventions that involve digital tools or environmental changes, where assumptions about usability or accessibility may not match everyday experience.

Universal design and personalised pathways should also be combined rather than treated as alternatives. Some environmental and service features need to be broadly accessible to all users, including safe walking routes with sheltered pathways and shaded seating, clear signage, and accessible toilets and barrier-free entrances. These features reduce participation costs for a wide range of people, not only older adults. At the same time, universal access does not remove the need for personalisation. Individuals may still require tailored reminders and route guidance, social introductions or language support, mobility-specific advice, or gradual exposure to group activities. The most effective approach is therefore not to create entirely separate services for each subgroup, but to design flexible systems that can adapt to different capacities and preferences.

Technology belongs at the intervention's enabling layer, not at its centre. Digital systems can coordinate activities and send reminders, recommend accessible routes, and connect users to facilitators while personalising the information they receive. However, social connection depends on

trust and familiarity, on reciprocity, and on being recognised by others, qualities that cannot be fully automated. Human-centred AI and digital tools should therefore support relationships rather than replace them [27], [28]. For example, a speech-based assistant may help an older adult identify a nearby activity, but a trusted volunteer or peer may still be needed to encourage attendance. Similarly, a routing system may help a wheelchair user reach a venue, but the activity itself must still be welcoming and meaningful. Digital tools are most valuable when they reduce friction in real-world participation.

Sustainability is another essential design concern. Many interventions succeed as pilots but fail to become part of routine community life. This often occurs when long-term ownership and funding, staffing and maintenance, and broader institutional integration are not considered early enough. Implementation science emphasises outcomes such as the acceptability and feasibility of an intervention, its adoption and fidelity in practice, and its cost, penetration, and long-term sustainability [30]. These outcomes need to be designed for from the beginning rather than measured only at the end. Interventions should consider who will maintain the programme and how staff or volunteers will be trained, how digital systems will be kept up to date, how costs will be covered, and how the work will fit within existing community organisations. Without this planning, even well-designed interventions may disappear once initial funding or research attention ends.

Finally, interventions should be culturally and contextually sensitive. Meaningful productivity and self-fulfilment are not universal in form. They are shaped by culture and religion, by family expectations and neighbourhood identity, by language, and by the socioeconomic conditions and life histories that people bring with them. A programme that works in one estate, town, or cultural group may not transfer directly to another. This does not mean that every intervention must be entirely unique, but it does mean that implementation should allow local adaptation. The most useful design logic is therefore modular: core principles can be shared across settings, while the specific activities and communication styles, facilitation methods, and community partnerships are adapted to local needs.

VI. Implementation Pathway

Figure 1 below shows the proposed implementation pathway, which consists of four key phases.

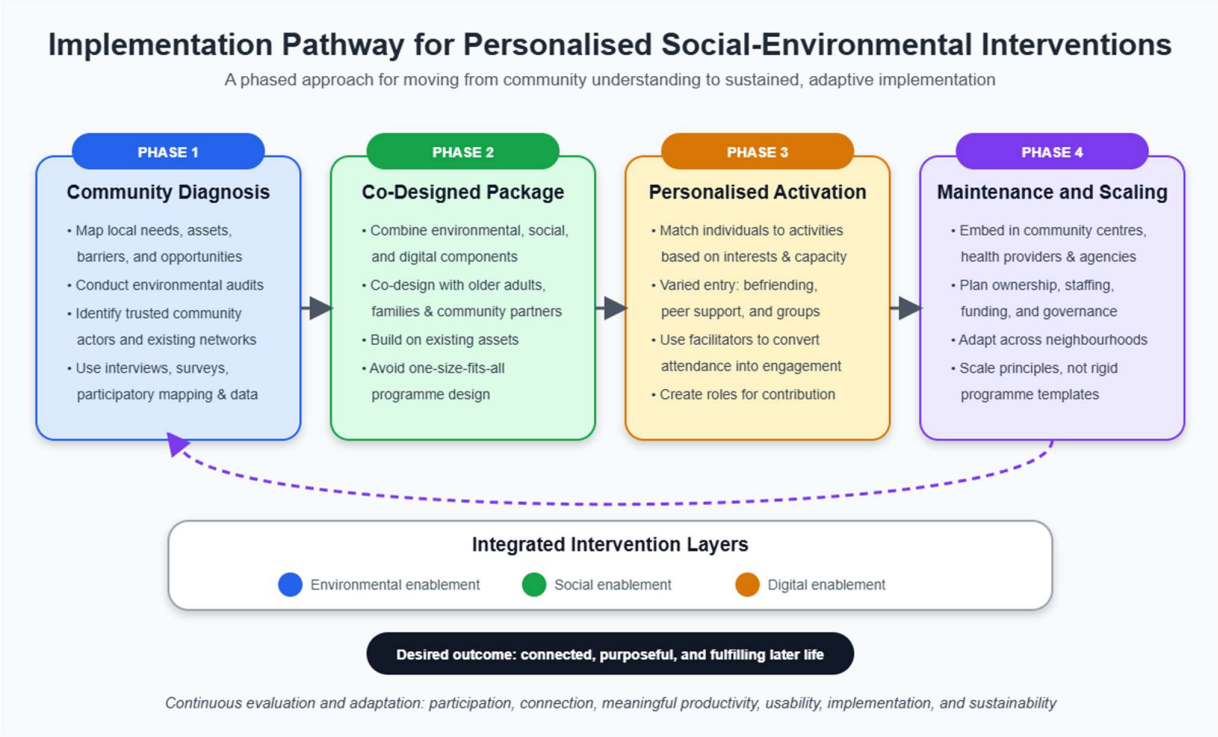

Fig. 1. Implementation pathway for personalised social-environmental interventions.

A practical implementation pathway begins with a careful understanding of the community context. This initial phase can be described as community diagnosis. It involves mapping local needs and assets together with the barriers and opportunities they generate, before any specific interventions are selected. Environmental audits can identify whether older adults face unsafe crossings or poor lighting, inadequate seating or lack of shelter, heat exposure, or inaccessible entrances. Social mapping can identify existing community groups and the trusted leaders and volunteers within them, alongside cultural organisations, faith groups, health providers, and informal neighbourhood networks. A combination of surveys and interviews, participatory mapping, and observational methods can help reveal how older adults actually move through and use their neighbourhoods. Where appropriate and

ethically permissible, service data may also be used to identify areas with low participation or high unmet need.

The purpose of this diagnostic phase is not only to identify problems, but also to recognise existing strengths. Many communities already possess significant assets that can support intervention development, from active residents, informal helpers, and shared cultural practices to parks and libraries, community centres, and religious or voluntary organisations. Building on these assets is often more sustainable than creating entirely new programmes. It also helps avoid duplicating existing efforts and increases the likelihood that interventions will be both trusted and used.

After community diagnosis, the next stage is co-designed intervention packaging. Rather than implementing a single solution, communities should develop a coordinated package that combines environmental, social, and digital components. For example, one neighbourhood intervention might combine sheltered route improvements leading to a community hub with a peer-led gardening or arts programme, supported by trained volunteer connectors and a simple speech-based reminder system for participants who want digital support. Elsewhere, the package may instead pair small-group social prescribing and peer mentoring with transport coordination and accessible wayfinding. The exact combination should depend on the barriers and aspirations identified in the diagnostic phase.

This packaged approach is important because social participation is rarely blocked by one factor alone. One older adult may be interested in attending an activity but unable to walk there safely; another may be physically able to attend but lack confidence or fear not knowing anyone; a third may want to participate but never receive the information in an accessible format. Combining environmental, social, and digital supports increases the chance that the intervention addresses the full participation pathway, from initial awareness and access through attendance and interaction to continued engagement over time.

Once an intervention package is developed, personalised activation becomes the next priority. This phase focuses on matching individuals to appropriate opportunities based on their interests and capacities, alongside their confidence and social preferences. Some older adults may be ready to join

group activities immediately. Others may need gradual engagement, beginning with a phone call or home visit, perhaps followed by one-to-one befriending or accompaniment to a first group session. For individuals recovering from illness or experiencing long-term isolation, small early successes may be especially important for rebuilding self-efficacy [14]. Personalised activation therefore needs to allow different entry points and progression routes.

Facilitators and volunteers, together with peer connectors, play a crucial role during this phase. Their task is not simply to recruit participants, but to help convert attendance into meaningful engagement. This may involve introducing newcomers and helping them identify shared interests, encouraging quieter participants, supporting those with mobility or communication difficulties, and gradually helping participants take on small roles within the group. As they grow into those roles, participants should be offered opportunities to contribute, welcoming others and helping organise activities, sharing skills or mentoring peers, and taking part in community decision-making. In this way, the intervention moves from service delivery toward meaningful productivity.

The final phase is maintenance, adaptation, and scaling. Interventions should be embedded within existing institutions where possible, such as community centres and libraries, health providers and voluntary organisations, housing bodies and parks agencies, or local councils. Embedding interventions in established organisations improves the likelihood of continuity, but it also requires careful attention to staff workload and training as well as to funding and governance arrangements. Digital components add a further layer of planning, including technical support and user assistance, regular software updates, and the ongoing protection of users' privacy.

Scaling deserves careful thought. A successful intervention cannot simply be copied from one community to another without adaptation. Local cultures and social networks differ, as do built environments and the service ecosystems around them. A more appropriate approach is to scale the underlying principles and adaptable components. For instance, the general model of combining accessible routes with facilitated social participation and personalised digital support may be broadly transferable, while the specific activities and venues, partners, and languages used should be

determined locally. This balance between fidelity and adaptation is central to sustainable implementation.

Evaluation should also be integrated throughout the implementation pathway rather than added only at the end. Early feedback can surface usability problems and unintended exclusions, identify pressure on staff, and reveal mismatches between activities and participant interests. Ongoing monitoring can help refine the intervention and support long-term ownership. In this sense, implementation should be treated as a learning process. The goal is not merely to launch a programme, but to build a community system that can continue adapting to older adults' changing needs and aspirations.

VII. Evaluating the System

Evaluation should go beyond attendance and technology use, taking a multi-dimensional approach instead. Participation outcomes may include attendance and repeat attendance over time, retention, the diversity of participants reached, and the range of activities offered. Connection outcomes may capture the formation of new relationships, perceived support and loneliness, and the size of an individual's social network. The Lubben Social Network Scale is one established measure for assessing social networks among older adults [31].

Meaningful productivity outcomes call for attention to contribution and role-taking, volunteering and peer support, skill-sharing, and perceived purpose; because meaning is subjective, qualitative interviews and narrative methods remain important. Psychological outcomes may cover well-being and self-efficacy, environmental mastery, mood, and overall quality of life, while digital outcomes are best assessed through usability and accessibility, trust and privacy concerns, perceived usefulness, and sustained use.

Implementation outcomes encompass adoption by organisations and the resulting cost and staff workload, the fidelity and adaptation of the intervention as it is delivered, and its overall reach and sustainability [32], [30]. The RE-AIM framework is useful for assessing an intervention's reach and

effectiveness, its adoption and implementation, and its longer-term maintenance [32]. Such evaluation can help distinguish interventions that are promising in pilot form from those that can be sustained in real communities.

VIII. Discussion and Conclusion

Personalised social-environmental interventions should be understood as place-based and relational systems supported by technology. Older adults may be unable to participate not because they lack motivation, but because routes are inaccessible or activities are culturally misaligned, because information is difficult to access or technology is confusing, or simply because no trusted person has invited them. When accessible environments meet meaningful activities, trusted facilitators, and digital tools that lighten rather than add to the burden of taking part, participation can flourish instead.

The proposed framework contributes by integrating environmental enablement, social enablement, and digital enablement into a single approach. It also reframes meaningful productivity as valued contribution rather than economic output. This matters because older adults are too often positioned only as recipients of care. Many wish to contribute to their families and peers, to the neighbourhoods they live in, and to the cultural life and broader well-being of their communities.

Future research should test integrated intervention packages in real communities, comparing different combinations of built-environment, social, and digital supports while developing practical measures of social health and meaningful productivity. Policymakers and funders should support not only innovation, but also the maintenance and adaptation of interventions and their long-term ownership by communities. If designed with older adults rather than merely for them, personalised social-environmental interventions can move beyond reducing loneliness toward enabling later lives that are connected and purposeful as well as deeply fulfilling.

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