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CO-DESIGN AND USER-CENTERED PRODUCT DEVELOPMENT: ENGAGING SOCIALLY VULNERABLE GROUPS IN THE DESIGN PROCESS

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ABSTRACT

User-centered design has long held that products are improved when designed around the needs of those who will use them, while co-design extends this commitment by inviting users to act as creative partners rather than research subjects. The shift carries particular weight for socially vulnerable groups, including older adults, disabled people, children and migrant or low-income communities, whose needs are frequently under-represented in mainstream product development and who may face additional barriers to participation itself. This paper examines how co-design and user-centered product development can be adapted to meaningfully include such groups. Through a conceptual and integrative review of literature in participatory design, human–computer interaction, inclusive design and research ethics, it develops a five-part framework covering recruitment and representation, the adaptation of participatory techniques, power-sharing and consent, the facilitator's relational role, and the evaluation of participatory impact. The analysis shows that including vulnerable groups in co-design is not a simple extension of standard methods but requires deliberate redesign of the participatory process itself, and that failure to do so risks tokenistic involvement that produces the appearance, but not the substance, of participation. The paper closes with implications for practice and five propositions for empirical testing.

Keywords: Co-Design; Participatory Design; User-Centered Design; Vulnerable Groups; Inclusive Design; Disability; Ageing; Children; Research Ethics

1 INTRODUCTION

Product development has moved, over the past four decades, from designing *for* users towards designing *with* them. User-centred design (UCD) formalised the principle that the needs, limitations and context of use of the intended user should guide every stage of development, from early concept to final evaluation [1, 2]. Co-design takes this a step further. Rooted in the Scandinavian participatory design tradition of the 1970s and 1980s, in which Nordic trade unions sought a voice in the computerisation of their workplaces [3, 4], co-design treats the people who will use a product not as sources of requirements to be studied but as creative partners in generating and evaluating ideas [5].

This shift matters more, not less, when the intended users belong to socially vulnerable or sensitive groups: older adults living with age-related change, disabled people, children, or members of migrant, refugee and low-income communities. Such groups are frequently under-represented in the samples that inform mainstream product development [6], yet they often depend more heavily on well-designed products, from assistive technology to public services, than the general population. At the same time, their inclusion in the design process itself raises distinctive challenges of recruitment, communication, consent and power that standard co-design toolkits were not built to address [7, 8].

The literature on participatory and inclusive design has grown in two directions that are rarely brought together systematically. One body of work refines co-design methods and tools for general audiences [5, 9]; another documents the specific adaptations needed to work respectfully and effectively with particular vulnerable populations, such as older adults [10], disabled people [11, 12] or children [13, 14]. This paper integrates the two, asking three research questions: RQ1, what distinguishes co-design from user-centred design as a mode of engaging vulnerable groups; RQ2, what adaptations to participatory process are required to include such groups meaningfully rather than tokenistically; and RQ3, what ethical safeguards are specific to participatory work with people in vulnerable circumstances.

The stakes of getting this right are not only methodological. Products and services designed without the involvement of the people who depend on them most, assistive devices, public transport interfaces, housing or welfare services, can fail in ways that standard usability testing with convenience samples does not reveal, sometimes only becoming apparent once a product reaches people whose needs differ substantially from those of the original test group [6]. Conversely, participatory processes that invite vulnerable people to take part without genuinely adapting to their circumstances can produce a different failure: participants attend, are thanked, and see little or no influence on the resulting design, an outcome the literature describes as tokenistic participation [15]. Distinguishing genuine inclusion from its appearance is therefore a central concern of this paper, not a peripheral one.

The paper makes three contributions. First, it synthesises literature on co-design, user-centred design, inclusive design and research ethics that is rarely integrated. Second, it proposes a five-part analytical framework describing the adaptations required to include vulnerable groups as genuine design partners. Third, it derives propositions for future empirical research and practical implications for design teams and organisations. Section 2 reviews the theoretical background; Section 3 sets out the methodology; Section 4 presents the results of the analysis; Section 5 discusses implications and limitations; and Section 6 concludes.

The importance of all digital technologies in the field of education is highlighted in our final point. ICTs support universal access to education and design, provide innovative approaches for effective teacher training, enhance learning retention, promote cooperation, increase openness, develop learner-centered approaches, and hasten the process of learning. Additionally, by using virtualization, mobilization, artificial intelligence, and new learning environments like virtual worlds, support educational activities and methodologies. More specifically, ICTs are very effective and productive in ADHD training, facilitating and improving the assessment, intervention, and educational procedures via mobile devices that bring educational activities everywhere [31] and through a variety of ICT applications that serve as the backbone of education [32-33]. While games turn education into a multimodal, incredibly amiable, and enjoyable interaction, the use of AI, STEM, and ROBOTICS raise educational procedures into new levers of adaptation, creativity, and performance [34-37]. Furthermore, the adoption, improvement, and fusion of ICTs with theories and models of metacognition, mindfulness, meditation, and emotional intelligence cultivation [38-41] place the development of mental abilities at the center of educational and design procedures and policies, which accelerates and improves educational practices and outcomes, particularly in User-Centered Product Development domain and its procedures like assessment and intervention.

2 THEORETICAL BACKGROUND AND LITERATURE REVIEW

2.1 From user-centred design to co-design

User-centred design treats usability and user needs as design constraints to be studied through methods such as interviews, observation and usability testing, with the designer retaining authorship over the resulting solution [1]. The approach was formalised in international standards: [2] defines human-centred design as an iterative process in which the design is based on explicit understanding of users, tasks and environments, and is refined through user-centred evaluation. Surveys of industry practice confirm that UCD methods, particularly usability testing and field studies, became embedded in mainstream product development from the 1990s onward [16].

Co-design, and the broader participatory design (PD) tradition from which it draws, repositions the user from an object of study to a co-creator. Early Scandinavian PD projects such as UTOPIA involved typographers directly in the design of newspaper production systems, on the premise that workers possess tacit, situated knowledge of their practice that no amount of external observation can fully capture [3, 4]. Sanders and Stappers [5] distinguish the two traditions along

two axes: the research perspective (user-centred versus participatory) and the role played by people in the process (passive subject versus active co-creator), and argue that the fuzzy front end of innovation, where problems are still being framed, is where co-design contributes most. Steen et al. [9] report that co-design projects in Dutch industry were associated with better alignment between products and user needs, although they also note implementation costs in time and organisational buy-in.

These findings sit within a longer-running methodological debate about where in the development process participation delivers most value. Spinuzzi [17] and Sanders and Stappers [5] both locate the greatest value of co-design in the earliest, most open-ended phase of a project, when the problem itself is still being defined, because this is also the phase in which conventional UCD methods, built around evaluating relatively well-formed concepts, are least well suited. Later-phase participation, such as usability testing of a near-final prototype, remains valuable but tends to surface narrower, more incremental feedback than the reframing of the problem that early-phase co-design can produce; this distinction becomes important in Section 4, where it recurs as a design choice about when, not only how, vulnerable groups are invited to take part.

2.2 Participation, power and the designer's role

Participation is not a single, well-defined practice but a spectrum. Kensing and Blomberg [18] identify recurring issues in PD research: the politics of participation, that is, who gets a say and over what; the nature of the knowledge that participants and designers each bring; and the methods and tools used to bridge them. Spinuzzi [17] describes PD as unfolding in phases, from initial exploration through discovery and prototyping to final production, with the designer's role shifting across phases from facilitator to synthesiser. Bratteteig and Wagner [15] caution against treating participation as a uniform good, arguing that genuine influence over decisions, not merely consultation, is what separates participatory design from the mere solicitation of opinions.

This concern with power is central to co-design with vulnerable groups. Light and Akama [7] studied community-based design work in the aftermath of a natural disaster and introduced the notion of self-determined co-design, in which the facilitator's role is to build the community's own capacity to organise and design, rather than to extract input for a predetermined solution. Costanza-Chock [19] extends this critique through the concept of design justice, arguing that design processes routinely reproduce existing structural inequality unless power is deliberately redistributed toward those most affected by a design and most likely to be excluded from conventional processes.

A useful, if older, frame for assessing how much power participation actually transfers is Arnstein's [20] ladder of citizen participation, developed outside design research in the context of urban planning but widely borrowed within PD and co-design. Arnstein distinguished degrees of participation ranging from manipulation and therapy, at the bottom of the ladder, through informing, consultation and placation, to partnership, delegated power and citizen control at the top, arguing that activities below partnership amount to forms of non-participation dressed in participatory language. Applied to co-design with vulnerable groups, the ladder offers a useful diagnostic: a workshop in which older adults are shown finished concepts and asked for reactions sits closer to consultation than to partnership, however warmly it is facilitated, and the framework developed in Section 4 can be read as specifying what would be required to move a given project further up the ladder.

2.3 Defining socially vulnerable and sensitive groups in design research

Research-ethics literature uses “vulnerable” to describe groups whose capacity to give informed, voluntary consent, or whose ability to protect their own interests in a research or design process, may be reduced or constrained by age, cognitive or sensory impairment, institutional dependency, language barriers, poverty or social marginalisation [21]. The designation is contextual rather than fixed: a group may be vulnerable with respect to one kind of participatory activity, such as a long, text-heavy survey, and not to another, such as a visual or object-based exercise, and an individual may move in and out of vulnerability as circumstances change, for example following a diagnosis, a migration, or the onset of caring responsibilities. This paper follows design and HCI literature in treating four, partially overlapping, populations as illustrative cases: older adults, particularly those experiencing cognitive or sensory decline; disabled people; children; and migrants, refugees or members of low-income and marginalised communities. These four were selected because each has generated a substantial, methodologically explicit co-design literature from which recurring adaptations can be identified, not because they exhaust the populations to whom the term vulnerable might reasonably apply; Section 5 returns to this limitation.

Across these groups, two reinforcing issues recur: a documented tendency for mainstream product development to under-represent their needs [6, 11], and a set of practical and ethical obstacles to including them as active co-designers, which the sections below examine in turn. A third, more subtle issue also recurs across the literature: the risk that designers and researchers, in the course of trying to protect vulnerable participants from burden or harm, inadvertently under-estimate their competence and over-simplify the participatory process to the point where it no longer elicits genuine design contribution. Several of the studies reviewed below were explicitly motivated by this risk, and the

adaptations they report are better understood as attempts to preserve the richness of participation while changing its form, rather than as a general lowering of expectations.

2.4 Co-design with older adults

Population ageing has made older adults a frequent focus of co-design, particularly for health and assistive technologies. Vines et al. [10] reviewed HCI research involving older people and found that many studies positioned them as passive recipients of technology rather than as configurable participants with their own expertise, and proposed principles for more genuinely participatory engagement. Lindsay, Jackson, Schofield, and Olivier [22] reported that older co-design participants engaged more readily with concrete, tangible prototypes than with abstract brainstorming, and that sessions needed to be shorter and more frequent to accommodate fatigue. Branco, Quental, and Ribeiro [23] developed a co-design methodology specifically for people living with dementia, adapting sessions to shorter duration, strong visual and tactile cues, and the consistent presence of a trusted companion, illustrating that cognitive change requires process redesign rather than simplification of the same process.

A further strand of this literature examines co-design in the specific context of serious illness and end-of-life care among older adults, where participants' capacity and priorities can change rapidly over the course of a project. Studies in this setting report that flexible scheduling, willingness to pause or end a session at the participant's signal, and close coordination with clinical or care staff who know the participant well are treated as preconditions for ethical participation rather than optional courtesies, extending the general finding that older-adult co-design requires structural, not merely stylistic, adaptation.

2.5 Co-design with disabled people and inclusive design

The disability rights movement provides a normative foundation for participatory work in this area through the principle of “nothing about us without us,” formalised in the United Nations Convention on the Rights of Persons with Disabilities, which obliges states to consult closely with and actively involve disabled people in decisions that affect them [26, Art. 4(3)]. Inclusive design research translates this principle into practice. Clarkson et al. [6] and Keates and Clarkson [12] argue that many products unintentionally exclude disabled and older users through demands on vision, dexterity or cognition that exceed population capability data, and propose inclusive design as a structured method for identifying and countering such exclusion during development. Newell and Gregor [11] argue for “user sensitive inclusive design”, emphasising that designers need direct exposure to the extremes of user capability rather than reliance on statistical personas alone. Hussain, Sanders, and Steinert [24] report a co-design project with children with limb difference in Cambodia who were invited to prototype their own prosthetic and assistive devices, and found that direct participation surfaced functional and aesthetic preferences that clinicians and designers had not anticipated.

A recurring theme across this literature is that many of the barriers disabled participants encounter in co-design sessions are environmental and procedural rather than inherent to disability itself: inaccessible venues, materials that assume full vision or fine motor control, or scheduling that does not allow for personal assistance or transport arrangements. Keates and Clarkson [12] argue that applying the same population-capability data used in inclusive product design to the design of the participatory process itself, for example checking whether session materials and venues meet the access needs of the full range of capability the project intends to design for, is a comparatively simple step that is nonetheless frequently overlooked when a design team's attention is focused on the product rather than on the process producing it.

2.6 Co-design with children

Children raise distinctive questions of consent, communication and developmental capability. Druin [13] proposed the “cooperative inquiry” framework and the role of children as “design partners” who work alongside adult researchers as full members of the design team throughout a project, rather than as testers consulted only at the end. Guha et al. [14] extended this model with techniques such as “bags of stuff” and sticky-note brainstorming suited to children's physical and conceptual ways of engaging with ideas, and documented how facilitation must balance adult guidance against the risk of adults dominating the children's own ideas. Yip et al. [25] studied intergenerational co-design sessions involving children and their parents, finding that family power dynamics could suppress children's contributions unless the facilitator actively created turns for the child to speak and be heard.

2.7 Co-design with migrants, refugees and marginalised communities

Work with migrant, refugee and low-income communities foregrounds language, trust and structural inequality. Dell and Kumar [26] reviewed information and communication technology for development (ICT4D) research and warned that well-intentioned participatory projects can still impose external agendas onto marginalised communities if facilitators do not relinquish control over the framing of the problem itself. Light and Akama's [7] study of community-led design after the Christchurch earthquakes similarly found that a community's capacity to self-organise, rather than a single designed artefact, was often the most valuable outcome of co-design conducted in conditions of social and

material precarity. These findings echo the design-justice literature's broader claim that participation which does not also redistribute agency and resources risks reproducing the inequalities it sets out to address [19].

2.8 Ethical considerations in participatory work with vulnerable groups

Frauenberger et al. [8] propose a situated, reflective approach to ethics in participatory design, arguing that fixed ethical checklists cannot anticipate the specific dilemmas that arise when working with people in vulnerable circumstances, and that ethical judgement must instead be exercised continuously throughout a project. Recurring concerns in this literature include informed consent that is genuinely understood rather than merely signed, the risk of participation fatigue or distress when sessions touch on difficult personal experience, and the question of what, if anything, participants receive in return for their time and knowledge [21]. Bossen, Dindler, and Iversen [27] further note that evaluation of PD projects rarely captures these longer-term relational and ethical outcomes, tending instead to measure the usability of the resulting artefact alone.

A further ethical tension concerns the gap between informed consent as a legal and procedural requirement and consent as participants' lived understanding of what a project will ask of them and how their contributions will be used. For participants with communication differences, limited prior exposure to research or design processes, or institutional dependency on the organisation running the project, a written consent form signed once at the outset may satisfy procedural requirements while leaving genuine understanding, and genuine freedom to decline, substantially incomplete [21]. The literature's response is not a single alternative procedure but a shift in orientation: consent is treated as a relationship to be maintained rather than a document to be filed, with facilitators checking understanding in accessible formats at each stage and treating continued participation as something to be actively supported rather than assumed once initial consent has been given [8].

3 METHODOLOGY

The study adopts a conceptual and integrative narrative review design, appropriate for a topic that spans the separate literatures of participatory design, human–computer interaction, inclusive design and research ethics, and for which the aim is to build an integrative framework rather than to estimate effects. No primary data were collected; accordingly, the findings reported in Section 4 are analytical propositions grounded in the literature, not empirical measurements, and should be read as hypotheses for future testing.

The analysis proceeded in three steps. First, literature was purposively selected from four streams: (i) participatory design and co-design theory and method; (ii) human–computer interaction research involving older adults, disabled people and children; (iii) inclusive and universal design; and (iv) research ethics concerning vulnerable populations. Sources were chosen for conceptual relevance, influence within their field, and explicit bearing on either the process or the ethics of including vulnerable groups as design participants. Second, each source was analysed to identify the specific adaptation, safeguard or mechanism it proposed, in response to the research questions set out in Section 1. Recurrent mechanisms were grouped iteratively into categories until a stable set of five emerged. Third, the resulting framework was examined against documented cases drawn from the literature, including co-design with people living with dementia [23], with children as design partners [13, 14], with disabled children in a low-resource setting [24], and with communities following a natural disaster [7], to test whether it could account for the reported patterns across very different populations and contexts.

Quality was pursued through transparency of reasoning, triangulation across the four literature streams, and conceptual coherence of the resulting framework. The principal limitations are the absence of a systematic, protocol-driven search, which makes the review illustrative rather than exhaustive; reliance on cases reported by other researchers, which limits the framework's empirical grounding; and a focus on four illustrative populations that does not capture the full diversity of socially vulnerable groups, such as people experiencing homelessness, linguistic minorities, or people with serious mental illness. These limitations are revisited in Section 5.

4 RESULTS AND ANALYSIS: A FRAMEWORK FOR INCLUSIVE CO-DESIGN

The analysis yields a five-part framework describing the adaptations that distinguish co-design conducted with socially vulnerable groups from standard user-centred or co-design practice. Table 1 summarises the five elements, each of which is examined in the subsections that follow with reference to the populations and cases reviewed in Section 2.

Table 1: Framework for including socially vulnerable groups as genuine co-design partners

Element	Core concern	Typical adaptation	Illustrative sources
1. Recruitment and representation	Who is invited, and who is systematically missed	Partnering with gatekeeper organisations; flexible, low-burden recruitment; compensation for time	Clarkson et al. [6]; Dell & Kumar [26]
2. Adapting participatory techniques	Whether methods match participants' communication, sensory and cognitive capacities	Tangible and visual materials; shorter, more frequent sessions; trusted companions present	Lindsay et al. [22]; Branco et al. [23]; Guha et al. [14]
3. Power-sharing, consent and safeguarding	Whether participants have genuine influence and informed, ongoing consent	Layered or ongoing consent; shared framing of the problem; design-justice awareness of structural inequality	Frauenberger et al. [8]; Light & Akama [7]; Costanza-Chock [19]
4. The facilitator's relational role	How trust is built and maintained across a project	Continuity of facilitators; relationship-building before design activity begins	Druin [13]; Yip et al. [25]
5. Evaluating participatory impact	Whether evaluation captures more than artefact usability	Process and relational outcome measures alongside usability testing	Bossen et al. [27]; Steen et al. [9]

4.1 Element 1: Recruitment and representation

The first element concerns who is invited into the process at all. Standard recruitment channels, such as university participant pools, online panels or clinic waiting rooms, systematically under-represent people who are institutionalised, who lack digital access, who are undocumented, or whose daily lives leave little discretionary time [6, 26]. The literature reviewed suggests that reaching vulnerable groups typically requires partnership with organisations that already hold the community's trust, such as care homes, disability advocacy groups, schools or community associations, rather than direct recruitment by the design team. It further suggests that participation needs to be made low-burden, through flexible timing, transport or accessible venues, and that fair compensation for participants' time and expertise should be treated as standard practice rather than an optional extra, in recognition that participants are contributing knowledge, not merely volunteering opinions.

Representation also has a compositional dimension that recruitment channels alone do not resolve: within any vulnerable population there is substantial internal diversity, and a project that reaches only the most articulate, mobile or digitally connected members of a group, for instance the older adults most comfortable attending a workshop unaided, or the disabled participants with the most experience of research settings, risks reproducing a narrower version of the same exclusion it set out to correct. Dell and Kumar [26] make a related point about ICT4D projects, observing that partnership with a single gatekeeper organisation can itself introduce bias if that organisation represents only part of the community it serves. The practical implication is that recruitment strategy needs to be planned with explicit attention to who, within the target population, is still likely to be missed even after an intermediary partnership is in place, and adjusted accordingly, for example by using several intermediary organisations with different reach rather than one.

SUBCONCLUSION 1. Co-design projects that recruit through trusted intermediary organisations and offer low-burden, compensated participation will achieve more representative participant samples than projects relying on direct, open recruitment.

4.2 Element 2: Adapting participatory techniques

The second element concerns the fit between participatory methods and participants' communication, sensory, cognitive and physical capacities. Techniques developed for general adult populations, such as open-ended brainstorming, long interviews or abstract card-sorting, can be poorly matched to the needs of young children, people with cognitive impairment, or participants with limited literacy in the language of the session. The cases reviewed point to several recurring adaptations: tangible, visual or object-based materials that reduce reliance on abstract verbal reasoning [22, 24]; shorter, more frequent sessions that accommodate fatigue, attention span or institutional schedules [23]; and the deliberate structuring of turn-taking so that less assertive participants, including children in the presence of parents, are not crowded out by more dominant voices [25, 14]. A recurring finding across these cases is that

adaptation is a matter of redesigning the participatory process to fit the population, not of simplifying a standard process or lowering expectations of what participants can contribute.

SUBCONCLUSION 2. Co-design sessions that are structurally adapted to participants' communication and cognitive capacities, rather than simplified versions of standard adult methods, will generate design input of comparable richness and specificity to that produced with general adult populations.

4.3 Element 3: Power-sharing, consent and safeguarding

The third element concerns whether participants exercise genuine influence over decisions and give consent that is both informed and sustained. Standard one-time, signature-based consent procedures may be poorly suited to participants whose capacity, circumstances or understanding can change over the course of a longer project; the literature instead points toward layered or ongoing consent, in which permission is revisited at each stage and participants can withdraw specific contributions as well as themselves [8]. Power-sharing also concerns who frames the problem in the first place: Light and Akama [7] found that design work was most beneficial to a vulnerable community when the community itself retained authority over what counted as the problem worth solving, rather than being invited to respond to a brief set by outside designers or funders. Costanza-Chock's [19] design-justice perspective adds that facilitators should remain alert to how structural inequalities outside the design session, such as poverty, language barriers or institutional power, continue to shape what participants feel able to say within it.

SUBCONCLUSION3. Co-design processes that use layered consent and allow participants or their communities to help frame the design problem will be associated with higher participant-reported influence over outcomes than processes using one-time consent and externally set briefs.

4.4 Element 4: The facilitator's relational role

The fourth element concerns the facilitator, whose role with vulnerable groups extends well beyond running a single workshop. Druin [13] describes cooperative inquiry as depending on a sustained relationship between adult researchers and child design partners built up over repeated sessions, in which trust is a precondition for honest contribution rather than a by-product of it. Branco et al. [23] similarly found that the presence of a familiar, trusted companion, often a family carer, was necessary to enable people living with dementia to participate at all. Across the cases reviewed, continuity of facilitators, time invested before formal design activity begins, and sensitivity to participants' cues of discomfort or fatigue recur as conditions for productive sessions, suggesting that relationship-building is itself a core design activity rather than a preliminary to it.

SUBCONCLUSION 4. Co-design projects in which the same facilitators maintain continuous relationships with vulnerable participants across multiple sessions will report higher participant engagement and retention than projects using single-session or rotating facilitation.

4.5 Element 5: Evaluating participatory impact

The fifth element concerns how success is measured. Conventional design evaluation typically asks whether the resulting artefact is usable and satisfies requirements. Bossen et al. [27] argue that this leaves unmeasured the process-level and relational outcomes that matter most in participatory work with vulnerable groups: whether participants felt heard, whether the process built lasting capacity within a community or organisation, and whether any inequalities in whose voice counted were reduced or reproduced over the course of the project. Steen et al. [9] report that organisations adopting co-design often struggled to demonstrate its added value using conventional product metrics alone, pointing to a need for evaluation frameworks that combine artefact-level usability measures with process-level indicators of genuine participation and relationship quality.

SUBCONCLUSION 5. Co-design projects that evaluate both artefact usability and process-level participatory quality will more accurately identify tokenistic involvement than projects that evaluate artefact usability alone.

4.6 How the five elements interact across populations

The five elements are presented sequentially for clarity, but the cases reviewed suggest they function as an interdependent system rather than a checklist to be worked through in order. Table 2 maps four illustrative cases from Section 2 against the framework, showing that a weakness in one element typically undermines the others. In the Cambodian prosthetics project [24], recruitment through a local clinic secured access to children with limb difference who would otherwise have been unreachable by an external design team, but this access alone would not have produced useful design input without technique adaptation, namely object-based prototyping that did not depend on the children's literacy or on a shared spoken language with the researchers. In the dementia co-design case [23], the relational element, the presence of a trusted companion, was simultaneously a safeguarding mechanism and a

precondition for any of the other elements to function: without it, neither technique adaptation nor evaluation of genuine participant influence would have been possible.

Table 2: Mapping of the five-element framework against four illustrative co-design cases

Case	Population and context	Elements most salient in the case	Reported outcome
Cooperative inquiry [13, 14]	Children as long-term design partners in technology research	Facilitator continuity; technique adaptation (tangible brainstorming)	Sustained design contributions judged by researchers as comparable in originality to adult input
Prosthetics co-design [24]	Children with limb difference, Cambodia, low-resource setting	Recruitment via local clinic; technique adaptation; power-sharing over design priorities	Functional and aesthetic preferences surfaced that clinicians had not anticipated
Dementia co-design [23]	Older adults living with dementia	Relational safeguarding (trusted companion); shortened, tangible sessions	Participation sustained despite cognitive impairment; sessions adapted iteratively
Post-disaster community design [7]	Residents of earthquake-affected neighbourhoods, New Zealand	Power-sharing over problem framing; community self-organisation as outcome	Community capacity to self-organise reported as more valuable than any single artefact

A further implication of this interdependence is that under-resourcing any single element tends to produce a recognisable failure pattern: adequate recruitment combined with unadapted technique yields participants who are present but unable to contribute meaningfully; adapted technique combined with weak power-sharing yields rich-looking input that nonetheless fails to change the eventual design, the pattern most consistent with tokenism; and attention to recruitment, technique and power-sharing without facilitator continuity risks losing participants' trust before the project concludes. This suggests that the five elements should be planned and resourced together from the outset of a project, rather than treated as sequential stages where early success guarantees that later elements will take care of themselves.

5 DISCUSSION

5.1 Synthesis

Read against the ladder of participation introduced in Section 2.2 [20], the five-element framework can be summarised as specifying what moving a co-design project from consultation toward partnership actually requires in practice when participants belong to a socially vulnerable group: representative reach (Element 1), techniques participants can genuinely use (Element 2), real influence over decisions and consent that keeps pace with participants' understanding (Element 3), a relationship participants can trust (Element 4), and a way of knowing whether any of this worked (Element 5). None of the five is reducible to good intentions on the facilitator's part; each corresponds to a concrete decision about project design, budget and timeline that is typically made, explicitly or by default, before a single participant is approached.

Read together, the five elements suggest that including socially vulnerable groups in co-design is not a matter of applying standard participatory methods more gently or more slowly, but of reconsidering, at each stage of the process, who is reached, how they can meaningfully take part, who holds authority over decisions, how trust is established and sustained, and how success is judged. In response to RQ1, co-design differs from user-centred design precisely in making this reconsideration necessary: where UCD can treat the user as a source of data captured through largely standardised methods, co-design asks what it would take for this particular person or community to act as a genuine creative partner, a question that has a different answer for a child, an older adult living with dementia, and a newly arrived refugee family. In response to RQ2, the five elements together describe the minimum adaptation required for participation to carry real influence rather than merely the appearance of it. In response to RQ3, ethical safeguarding in this context is best understood as continuous and relational, exercised throughout a project, rather than as a one-time procedural clearance obtained before it begins.

5.2 Implications for practice

For design teams, the framework suggests that projects intended to serve vulnerable populations should budget time and resources for relationship-building and intermediary partnerships before formal design activity begins, rather than

treating recruitment as a logistical afterthought. It further suggests that facilitators benefit from a repertoire of tangible and visual techniques that can be adapted on the spot to participants' capacities, and that project plans should specify, in advance, how consent will be revisited and how participants can withdraw specific contributions without being made to feel they must withdraw from the whole project. Organisations commissioning co-design work with vulnerable groups would also benefit from requiring process-level evaluation, not usability testing alone, as a condition of calling a project participatory.

5.3 Implications for design education and organisational practice

Design curricula have historically emphasised technique, that is, how to run a brainstorming session, a usability test or a prototyping workshop, more than the relational and ethical judgement that the framework identifies as central to working with vulnerable groups. The cases reviewed suggest that competence in this area is built through supervised, repeated practice with real communities over time rather than through a single methods course, which points toward studio and placement-based pedagogy, ideally in partnership with the intermediary organisations identified in Element 1, as a more effective preparation than classroom instruction alone. For organisations, the framework suggests that co-design with vulnerable groups should be resourced as a distinct activity with its own timeline, budget and success criteria, rather than scheduled and costed as a faster or smaller version of standard user research [30]. Procurement and funding bodies that commission such work could usefully require, as a condition of funding, an explicit account of how a project will address each of the five elements, which would also make tokenistic proposals easier to identify before a project begins rather than only after it has concluded.

5.4 Limitations and directions for future research

This paper is conceptual, its propositions are untested, and its review is purposive rather than systematic, drawn from four illustrative populations that do not exhaust the range of socially vulnerable groups. A further limitation is that the cases reviewed come disproportionately from well-resourced research projects, often university-led and reported in peer-reviewed venues with the time and funding to document process in detail; co-design conducted under the tighter budgets and timelines typical of commercial product development may find some of the framework's recommendations, particularly sustained facilitator continuity and layered consent, difficult to resource fully, and future work should examine how the five elements can be adapted, rather than abandoned, under such constraints.

Future research could test the propositions directly: comparative studies of recruitment strategies and the representativeness of resulting samples; controlled comparisons of adapted versus standard participatory techniques with the same population; longitudinal studies of trust and engagement across facilitator-continuity conditions; and the development and validation of process-level evaluation instruments for participatory design. Extending the framework to populations not covered here, including people experiencing homelessness, linguistic minorities, and people living with serious mental illness, is a further priority, as is empirical work examining how the five elements interact when a project involves more than one vulnerable population at once, for example older migrants or disabled children in low-income households, where the adaptations appropriate to each population individually may not simply add together.

6 CONCLUSION

This paper has argued that extending co-design and user-centred product development to socially vulnerable groups requires more than translating existing participatory methods into gentler or more accessible versions of themselves. Drawing on literature from participatory design, human-computer interaction, inclusive design and research ethics, it proposed a five-part framework covering recruitment and representation, the adaptation of participatory techniques, power-sharing and consent, the facilitator's relational role, and the evaluation of participatory impact. Across the very different cases examined, from children as design partners to community-led design after disaster, the same underlying pattern recurs: participation that does not redesign its own process around the people it claims to include risks producing the appearance of involvement without its substance.

Two conclusions follow. First, the inclusion of vulnerable groups in product development is as much an ethical and relational undertaking as a methodological one, and the two cannot be fully separated. Second, the value of such inclusion lies not only in better-fitting products but in the capacity, trust and voice that a well-run participatory process can build within the community involved, outcomes that conventional usability metrics do not capture. A third, more cautionary conclusion follows from the interdependence documented in Section 4.6: because the five elements reinforce or undermine one another, partial implementation, adapting techniques without sharing power, or recruiting representatively without sustaining facilitator relationships, is unlikely to be sufficient on its own, and may do more to legitimise a predetermined design than to change it. Teams and organisations considering co-design with vulnerable groups should therefore plan for the framework as a whole rather than select from it piecemeal.

The five propositions offered here provide a basis for empirical work that can test, refine and extend these claims, as co-design becomes an increasingly ordinary part of how organisations develop products and services for the full diversity of the people who will use them.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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