

Design and Evaluation of Digital Interventions Targeting Transgender Empowerment and Entrepreneurship: A Narrative Review

Ms. Priyadharshini R (*Corresponding Author*)

Ph.D. Research Scholar
Department of Mental Health Nursing
Kasturba Gandhi Nursing College,
Sri Balaji Vidyapeeth (Deemed to be University)
Pondicherry – 607402, India

ORCID iD: <https://orcid.org/0000-0001-6899-9189>

Dr. Prabavathy S

Professor and Head
Department of Mental Health Nursing
Kasturba Gandhi Nursing College,
Sri Balaji Vidyapeeth (Deemed to be University)
Pondicherry – 607402, India

ORCID iD: <https://orcid.org/0000-0003-3838-5252>

Dr. Saravanakumar S

Professor
Department of General Surgery
Mahatma Gandhi Medical College and Research Institute
Sri Balaji Vidyapeeth (Deemed to be University)
Pondicherry – 607402, India

ORCID iD: <https://orcid.org/0000-0002-7524-3328>

Dr. Vijay K Chavada

Ph.D. Research Scholar
Sri Balaji Vidyapeeth (Deemed to be University)
Pondicherry – 607402, India

ORCID iD: <https://orcid.org/0000-0002-4631-2339>

Mr. Rajprasath R

Ph.D. Research Scholar
Department of Biochemistry
Mahatma Gandhi Medical College and Research Institute,
Sri Balaji Vidyapeeth (Deemed to be University)
Pondicherry – 607402, India

ORCID iD: <https://orcid.org/0009-0002-9865-3423>

Mr. Gowtham K

Ph.D. Research Scholar

Department of Pharmacology

Mahatma Gandhi Medical College and Research Institute,

Sri Balaji Vidyapeeth (Deemed to be University)

Pondicherry – 607402, India

ORCID iD: <https://orcid.org/0000-0003-2506-8338>

Abstract

Background:

Transgender individuals, particularly trans women, face systemic marginalization in areas of employment, education, and healthcare. These challenges have led to increased interest in digital interventions as tools for empowerment and entrepreneurial development. However, the structure, implementation, and impact of such interventions vary significantly across contexts, and a comprehensive synthesis of their design and evaluation is lacking.

Objective:

This review aims to synthesize current evidence on the design and evaluation of digital interventions targeting transgender empowerment and entrepreneurship. Specific objectives include identifying effective design features, evaluation strategies, reported outcomes, and gaps in current research.

Methods:

A narrative review methodology was employed, drawing on peer-reviewed journal articles, program reports, and grey literature published between 2010 and 2024. Inclusion criteria focused on digital interventions involving transgender individuals and reporting on empowerment, economic inclusion, or entrepreneurial self-efficacy outcomes. Data were extracted across four domains: population characteristics, intervention design, evaluation methods, and reported impact. Thematic synthesis was used for data integration.

Results:

Twenty-three studies met the inclusion criteria. Effective interventions involved participatory design processes, culturally responsive content, hybrid delivery modes, and integrated psychosocial supports. Commonly evaluated outcomes included enhanced self-efficacy, skill development, digital literacy, mental wellbeing, and business readiness. Barriers to success included technological access limitations, stigma, low literacy, and lack of post-program funding.

or mentorship. Evaluation strategies varied, with minimal use of standardized frameworks and limited longitudinal assessment.

Conclusion:

Digital interventions offer promising avenues for advancing transgender empowerment and economic resilience. However, to ensure equity and impact, these interventions must be participatory, scalable, and enabled by policy frameworks supporting inclusive entrepreneurship. Future research should focus on intersectionality, sustainability, and integration with national digital and employment missions.

Keywords

Transgender empowerment, Digital interventions, Entrepreneurial self-efficacy, Gender inclusion

1. Introduction

1.1 Background and Rationale

Transgender individuals, particularly transgender women, remain among the most marginalized populations worldwide in terms of access to healthcare, employment, and social protections. In recent decades, research has increasingly recognized the disproportionate burden of psychosocial stress, stigma, and unemployment faced by transgender people [1]. Despite growing legal and social recognition in some regions, many continue to navigate systemic discrimination, leading to reduced opportunities for economic participation and increased vulnerability to mental health disorders [2].

Empowerment—often defined as the process of increasing personal, interpersonal, or political power—becomes essential in improving life outcomes for marginalized groups. For transgender individuals, empowerment intersects crucially with socioeconomic inclusion, particularly the ability to engage in self-directed employment or entrepreneurship [3]. This is especially meaningful in contexts where institutional employment discrimination remains a barrier.

Technological innovations, particularly digital platforms and mobile-based tools, provide an evolving opportunity for creating inclusive interventions targeting these domains [4]. These "TransTech" solutions—technology-based tools designed with and for transgender communities—are emerging as viable approaches to address gaps in access, support, and sustainability of empowerment-focused initiatives [5].

1.2 Significance of Transgender Empowerment and Entrepreneurship

Transgender empowerment is a multidimensional concept encompassing legal recognition, social inclusion, economic participation, and psychological agency. Among these, economic empowerment through entrepreneurship offers a pathway to autonomy and resilience. For many transgender individuals facing exclusion from conventional labor markets, self-employment and

micro-entrepreneurship present viable alternatives to financial dependence and vulnerable livelihoods [6].

Entrepreneurship not only provides financial autonomy but also fosters self-esteem, purpose, and community leadership among transgender individuals. Programs aimed at fostering occupational self-efficacy and marketable skills have shown promising psychosocial benefits in marginalized groups globally [7]. However, most conventional entrepreneurship development programs fail to incorporate gender-affirmative content or culturally responsive methodologies that cater specifically to the experiences of transgender people.

The exploration of entrepreneurship as a vehicle for transgender empowerment is especially relevant in resource-limited and culturally complex settings where gender minorities are structurally excluded from formal workforce participation [8].

1.3 Role of Digital Interventions

Digital interventions have redefined the landscape of public health and economic empowerment, especially for marginalized populations. Ranging from mobile applications and online learning platforms to social media-based peer support systems, digital technologies hold the potential to democratize access to information, mentorship, and entrepreneurship training [9].

For transgender individuals, digital interventions carry unique value—not only in their scalability and accessibility but in their ability to offer discreet and affirming spaces for learning, healing, and self-development. Studies have established that mobile-based mental health programs, digital storytelling platforms, and virtual marketplaces have the potential to address structural barriers related to stigma, geographic isolation, and limited employment opportunities [10].

Importantly, the participatory design of such interventions—that is, involving transgender individuals in co-creating tools relevant to their lived experiences—has been identified as a best practice to enhance relevance and user engagement [11].

1.4 Objectives of the Review

This narrative review aims to:

- Synthesize existing evidence on the design and evaluation of digital interventions targeting transgender empowerment and entrepreneurship;
- Identify the key components, frameworks, and evaluation strategies utilized in these interventions;
- Highlight successful models and identify barriers to implementation;
- Offer recommendations for future research, policy, and practice with a focus on inclusivity, effectiveness, and sustainability.

By mapping the current landscape, the review intends to bridge the knowledge gap between transgender-specific needs and the potential of tailored digital innovations.

1.5 Scope and Limitations

This review specifically focuses on peer-reviewed literature, grey literature, and program reports (where relevant) discussing the design, implementation, and evaluation of digital interventions aimed at empowering transgender individuals, with specific attention to entrepreneurial development. The temporal scope includes literature published between 2010 and 2024, considering the recent yet rapid evolution of digital technologies.

While digital tools geared towards mental health, education, and employment support are all relevant, this review emphasizes interventions that address empowerment outcomes through economic independence, entrepreneurship skill-building, and digital literacy.

However, due to the limited volume of transgender-specific digital entrepreneurship interventions, this review may draw on analogous evidence from other marginalized or gender-diverse populations to derive transferable insights. In addition, non-English literature and interventions not documented with sufficient detail in public sources may be excluded from analysis.

2. Conceptual Framework

2.1 Defining Transgender Empowerment

Transgender empowerment refers to a process by which transgender individuals gain greater control over decisions and actions affecting their lives, particularly in the face of systemic marginalization. It encompasses aspects such as identity affirmation, social inclusion, legal protections, access to healthcare, and economic autonomy. Empowerment in a transgender context also involves dismantling institutional barriers that contribute to discrimination, stigma, and invisibility within mainstream systems [12].

At an individual level, empowerment can translate to increased self-efficacy, agency, and resilience, which are crucial for engaging in entrepreneurial activities. Community empowerment involves collective action, resource mobilization, and network-building, which can be facilitated through peer-led initiatives and community-based digital platforms [13]. Importantly, empowerment is not merely the end goal but also a constituent process in intervention development, ensuring that transgender voices drive design, implementation, and evaluation.

2.2 Entrepreneurial Self-Efficacy in Marginalized Populations

Entrepreneurial self-efficacy refers to an individual's belief in their ability to perform tasks and roles associated with entrepreneurship. For marginalized populations, including transgender individuals, this construct is significantly influenced by external barriers such as discrimination, access to education, capital, and supportive networks [14].

Research has shown that entrepreneurial self-efficacy is a strong predictor of entrepreneurial intention, persistence, and success, particularly when traditional employment avenues are inaccessible. Among socially excluded groups, fostering self-efficacy involves not only skill development but also addressing internalized stigma, fear of failure, and lack of role models [15]. Digital interventions—when designed using strengths-based and inclusive approaches—can help improve entrepreneurial confidence by providing access to skills, mentorship, and real-world simulations [16].

2.3 Theoretical Models Guiding Digital Interventions (e.g., Empowerment Theory, Technology Acceptance Model)

Digital interventions implemented for transgender empowerment and entrepreneurship are often anchored in multidisciplinary theoretical frameworks. The Empowerment Theory offers a useful foundation by emphasizing individual control, critical awareness, and participatory decision-making [17]. This theory supports the co-creation and adaptiveness of interventions, ensuring that marginalized users transform from passive recipients into active shapers of their own development pathways.

The Technology Acceptance Model (TAM), originally proposed to explain user acceptance of digital technologies, posits that perceived usefulness and ease of use predict adoption behavior. In marginalized populations, including transgender individuals, an expanded TAM must factor in social determinants such as safety, identity validation, and engagement habits [18]. Other frameworks such as the Diffusion of Innovations Theory and the Health Belief Model have also been adapted to evaluate uptake of digital platforms among underrepresented users [19].

An effective digital intervention should integrate both behavioral theories and empowerment principles to not only facilitate technological access but also motivate use, retention, and meaningful impact.

2.4 Intersectionality and Digital Access

Intersectionality provides a foundational framework to understand how overlapping identities—such as gender identity, socioeconomic status, caste, ethnicity, and geographical location—jointly shape a transgender person's access to empowerment and entrepreneurship opportunities. Transgender individuals often navigate multiple oppressions that limit their educational attainment, capital access, digital literacy, and safe internet usage environments [20]. These compounded disadvantages must be acknowledged when designing digital interventions.

Digital inequality, often defined as disparities in access, usage patterns, and benefits derived from technology, disproportionately affects transgender communities in rural and low-income settings. Interventions that do not address such contextual barriers risk replicating existing disparities rather than alleviating them [21]. Therefore, applying an intersectional lens is essential not only for reaching those at the margins of the transgender population but also for producing inclusive and equitable technological solutions with long-term relevance.

3. Methodology

3.1 Review Design and Rationale

This study employed a narrative review methodology to explore how digital interventions are designed and evaluated in the context of transgender empowerment—with an emphasis on entrepreneurial outcomes. A narrative review was selected as the most suitable approach due to the interdisciplinary and evolving nature of the topic, which encompasses multiple domains such as public health, digital technology, gender studies, psychology, and entrepreneurship. Unlike systematic reviews that follow narrowly defined hypothesis-driven protocols, narrative reviews allow for a broader synthesis of conceptual, empirical, and methodological literature on emerging topics that are not yet amenable to meta-analysis or standardization across studies [22,23].

The purpose of this review was not to evaluate effectiveness per se, but rather to identify and summarize the key design elements, implementation strategies, and evaluation practices informing digital interventions targeting transgender empowerment and economic resilience—particularly as mediated through skill building, entrepreneurial self-efficacy, and inclusive technological access.

3.2 Inclusion and Exclusion Criteria

A set of pre-determined inclusion and exclusion criteria was used to select relevant sources for this review. To ensure academic rigor and relevance to the review objectives, only studies and sources that met the following inclusion criteria were considered:

- Focused explicitly on transgender or gender-diverse populations, with clearly segregated data or theoretical focus
- Described or evaluated the design and/or implementation of digital or technology-based interventions
- Included indicators of empowerment—psychological, economic, social—or entrepreneurial aspects such as training, digital skill development, or self-employment promotion
- Published between January 2010 and March 2024
- Written in English
- Peer-reviewed journal articles, program evaluation reports, doctoral dissertations, or white papers from reputable agencies

Articles were excluded if they:

- Focused exclusively on medical transitioning, hormone therapy, or clinical healthcare interventions without any reference to empowerment or economic outcomes

- Described digital projects lacking formal intervention design or evaluation (e.g., descriptions of websites or apps without user testing or impact feedback)
- Clustered transgender participants into broader LGBTQ+ categories without disaggregated analysis or reporting
- Were non-academic sources such as newspaper articles, social media content, blog posts, or purely opinion-based narratives without empirical grounding
- Duplicated findings in multiple versions (e.g., conference abstract plus full-length publication; only the full article was retained)

Applying these criteria allowed a focus on literature demonstrating direct relevance to the thematic areas of the review, while excluding generalized or non-empirical content.

3.3 Search Strategy

A comprehensive and structured literature search was carried out between February and June 2025. The search was conducted across six electronic databases: PubMed, Scopus, Web of Science, CINAHL (Cumulative Index to Nursing and Allied Health Literature), PsycINFO, and Google Scholar. To maximize the sensitivity and specificity of the search, a combination of controlled vocabulary (e.g., MeSH terms) and free-text keywords was used. Boolean operators (AND/OR) were applied to combine terms and filter results.

Keywords and phrases included:

"transgender", "trans women", "trans people", "digital intervention", "technology-based intervention", "mobile application", "e-health", "digital health", "entrepreneurship", "entrepreneurial self-efficacy", "economic empowerment", "skills training", and "psychosocial support".

Sample search string (adapted for PubMed):

("transgender persons"[MeSH Terms] OR "transgender"[All Fields] OR "trans women"[All Fields]) AND ("digital intervention"[All Fields] OR "technology-based"[All Fields] OR "mobile application"[All Fields]) AND ("empowerment"[All Fields] OR "entrepreneurship"[All Fields] OR "self-efficacy"[All Fields])

In addition to database searching, backward citation chaining was performed by screening the reference lists of included studies. A few seminal gray literature sources (e.g., project evaluations or summaries from relevant NGOs) were also handpicked if they met the review criteria.

All retrieved citations were first imported into Zotero software for reference management. Duplicates were removed manually. Titles and abstracts were screened for relevance, followed by full-text review based on the inclusion and exclusion criteria.

3.4 Data Extraction and Synthesis Approach

A structured data extraction process was used to ensure consistency in information collection across diverse sources. A customized extraction form was developed to collect the following data from each article:

- Author(s), year of publication, and country of study
- Characteristics of the target population (gender identity, age range, geographic setting, etc.)
- Type of digital intervention (e.g., mobile app, web platform, blended learning program)
- Delivery mode, duration, and technological platform used
- Empowerment and/or entrepreneurship indicators targeted
- Stakeholder involvement in design (e.g., participatory/co-design methods)
- Theoretical framework (if any) underpinning the intervention design
- Evaluation strategy and metrics (qualitative, quantitative, or mixed methods)
- Key outcomes, findings, and limitations reported

Data were initially grouped and coded thematically using a basic framework informed by the review objectives. Open coding was employed to identify recurrent patterns, innovations, and variations in intervention design. Salient themes such as user-centered design, inclusivity of content, challenges in implementation, and methodological strengths and gaps in evaluation strategies were clustered under broader domains.

Given the heterogeneity in study design, population characteristics, and outcome measures, a meta-analytic approach was not suitable. Instead, a thematic narrative synthesis was conducted, allowing integration of findings across multiple types of evidence while preserving their contextual richness.

No formal risk of bias or quality assessment tools were used due to the broad and interpretive nature of the review focus, and because many included studies used exploratory or participatory methodologies not amenable to standard quality grading frameworks. However, transparency in reporting, clarity of intervention design, and methodological rigor were documented for each study and reflected upon during synthesis.

4. Characteristics of Included Studies

The final sample for this narrative review comprised 23 studies and program evaluations published between 2011 and 2023. The studies varied in research design, intervention type, target outcomes, and geographic location. Despite these variations, all sources met the eligibility criteria outlined and addressed either the design or evaluation—often both—of digital interventions aimed at transgender populations, with a specific focus on empowerment, skill-building, or entrepreneurial capacity development.

4.1 Geographic Distribution and Population Profiles

The majority of the included studies originated from high-income and middle-income countries, particularly the United States (n = 10), India (n = 5), Canada (n = 3), Brazil (n = 2), South Africa (n = 1), and Thailand (n = 2). While several interventions targeted LGBTQ+ populations broadly, only those that disaggregated transgender-specific needs and outcomes were selected. Where samples included broader gender-diverse individuals (e.g., nonbinary or genderqueer persons), transgender women remained the primary focus in 17 of the 23 studies.

Participants largely ranged in age from 18 to 45 years, with many programs targeting young adults or mid-career individuals facing unemployment or social stigma. Several interventions recruited participants from urban or peri-urban settings, though three studies explicitly worked with rural transgender populations who had limited digital access [24,25].

4.2 Types of Digital Interventions

The reviewed literature showcased a range of digital modalities used to deliver empowerment-based content and supportive entrepreneurial training. These included:

- Mobile applications tailored to mental health, goal setting, and self-agency
- Web-based e-learning platforms featuring business development modules
- Online mentorship programs delivered via video conferencing or chat forums
- Blended models incorporating both face-to-face and online components
- Interactive storytelling and digital media creation platforms
- SMS- and WhatsApp-based economic literacy programs for low-literacy groups

Of note was the integration of culturally sensitive visual design and language across most interventions, such that both visual cues and text content affirmed trans identities and socioeconomic realities [26].

4.3 Intervention Settings

Interventions were delivered through varied platforms, and their operational settings ranged from community-based organizations to public health clinics and educational institutions. Nine interventions were designed and implemented in partnership with grassroots transgender collectives or nonprofits, which facilitated community trust, enrollment, and culturally grounded content creation. Some programs operated largely online to maximize reach across rural or low-access areas, addressing geographic dispersion and local stigma [27].

Three studies emphasized scalable digital ecosystems, combining health promotion, career support, and peer interaction in a single application or interface. These 'bundled' platforms incorporated mental health self-assessments, entrepreneurship training modules, and microgrant application features within the same technological infrastructure [28].

4.4 Stakeholder Engagement and Co-Design

Participatory design approaches were reported in 16 of the 23 studies, demonstrating a growing trend toward user-centered and inclusive development practices. Transgender peers, community advocates, and knowledgeable NGOs were involved in early needs assessment, content design workshops, pilot testing, and iterative revisions. Such participation has been positively linked to increased user satisfaction, cultural specificity, and product credibility [29].

Several interventions engaged advisory boards made up of transgender entrepreneurs, educators, and allied tech developers, indicating a shift from traditional top-down program development to co-created solutions that align more closely with community-identified needs.

4.5 Intervention Duration and Follow-up

The duration of digital interventions ranged from 4 weeks to 12 months, with most spanning 8 to 16 weeks. Short-format pilot programs were more common in low-resource settings, often due to limited funding or technological constraints. Six studies included follow-up assessments beyond three months post-intervention to assess retention of empowerment gains or entrepreneurial skill application. However, challenges with attrition and sustained digital engagement were noted across many programs, particularly among low-income participants with intermittent internet access [30].

4.6 Evaluation Strategies and Outcomes

Evaluation methods varied in rigor and scope. Mixed methods ($n = 12$) constituted the most prevalent approach, combining pre-post surveys, focus group discussions, and key informant interviews. Quantitative-only evaluations ($n = 6$) focused primarily on measurable changes in self-efficacy, digital literacy, or employment status. Qualitative-only methodologies ($n = 5$) relied on narrative accounts, case studies, and phenomenological approaches to evaluate user experience and perceived improvements in agency, wellbeing, or entrepreneurial readiness.

Commonly reported outcomes included:

- Increases in entrepreneurial self-efficacy and confidence to initiate ventures
- Improved digital literacy and familiarity with business tools (e.g., Canva, Zoom, accounting apps)
- Greater self-reported autonomy, identity affirmation, and community connectedness
- Enhanced capacity to market hand-made or digital goods via social media
- Inclusion in mentoring or funding opportunities due to platform exposure

While evidence for financial outcomes (e.g., revenue generation or capital growth) was often limited or self-reported, subjective empowerment and psycho-emotional transformation were recurrent themes in nearly all studies [31].

5. Design Features of Digital Interventions

This section presents an in-depth synthesis of the core design features, principles, and digital infrastructure used in transgender-focused empowerment and entrepreneurship interventions across the reviewed literature. Attention is paid to how these design elements engage with the contextual realities of transgender communities, including issues of safety, accessibility, interactivity, and cultural responsiveness.

5.1 Needs Assessment and Co-Design with Trans Individuals

A unifying aspect of many successful interventions was the early inclusion of transgender individuals in the needs assessment and content development stages. Participatory design approaches were noted in 16 out of the 23 studies reviewed. These studies emphasized that co-design processes enabled the incorporation of culturally resonant language, visuals, psychosocial issues, and lived realities, thus making the tools more relevant and empowering to users [32].

Needs assessments were often conducted via focus groups, rapid ethnographies, community stakeholder interviews, or surveys. Findings revealed common challenges such as low financial literacy, fear of discrimination in venture registration processes, limited peer mentorship, and anxiety linked to technology use among older trans individuals [33]. These insights shaped the resulting curricula and functionality of the digital platforms, helping to reduce user alienation.

5.2 Content Development and Personalization

The scope of content delivered through digital interventions varied widely depending on program goals. However, most interventions included modules or activities focused on skill development, emotional strength-building, and goal orientation. In models targeting entrepreneurship, content featured:

- Basics of business ideation and feasibility analysis
- Digital marketing and social media presence creation
- Micro-enterprise budgeting and cost tracking
- Negotiation skills and client communication strategies
- Case studies of successful transgender entrepreneurs

Many platforms provided content in multiple languages, employed voice-assisted tools for low-literacy users, or allowed users to customize learning paths based on their existing knowledge levels [34]. Personalization helped keep users engaged and ensured that content was paced and contextualized appropriately.

5.3 Technology Platforms Used

Platforms used for delivering interventions were tailored to suit participants' access and familiarity with digital technology. The following models were common:

- Mobile applications for Android operating systems due to their cost efficiency and widespread use in low-income settings
- Web-based portals that could be accessed via browser on phones or desktops
- SMS-based modules for individuals in areas with limited internet connectivity
- WhatsApp or Telegram groups for ongoing communication and mentorship
- Hybrid platforms combining synchronous (e.g., live webinars) and asynchronous content (e.g., video tutorials, toolkits)

The scalability and compatibility of these platforms with low-bandwidth environments were key design considerations, particularly in interventions conducted in rural or semi-urban settings [35].

Accessibility audits were rarely formalized but were indirectly addressed through simplified interfaces, offline content downloads, and anonymous log-in features designed to reduce data tracking. Some apps offered gender-affirming avatars and privacy settings inspired by safety concerns reported by users.

5.4 Accessibility, Usability, and Cultural Relevance

A critical design priority for all reviewed interventions was the need to ensure usability among gender-diverse individuals facing digital exclusion due to economic conditions, stigma, or misinformation. Barriers such as lack of personal devices, shared internet usage within households, and fear of exposure were discussed in at least 12 studies [36].

Accordingly, user interfaces were designed with visual clarity and minimal cognitive load in mind. Icons were tested for cultural resonance and instructional videos were designed to avoid heteronormative or binary representations. Color schemes, voice narration, and examples were frequently adapted based on regional inputs and diversity through pilot testing phases.

Mobile applications specifically emphasized progress tracking, gamification strategies, badges, and achievements to encourage ongoing participation and skill mastery. These features had a dual effect: improving learning outcomes and promoting users' sense of agency and self-direction.

5.5 Privacy, Ethics, and Data Security Considerations

Confidentiality and data security emerged as critical cross-cutting concerns. Transgender individuals often face violence, social exclusion, or economic loss upon disclosure of their gender identity. Hence, digital interventions were designed with features to obscure profile information whenever possible. Username aliases, password recovery options without the use of legal names, and gender-neutral sign-up procedures were among the design elements used to prioritize user safety [37].

Ethical frameworks were rarely articulated in formal publications, but ethics-related practices included data encryption, user-informed consent for data collection, and storage on secure servers. In community-partnered projects, local transgender leaders provided feedback on perceived risks associated with use, which led to further iteration of ethical design concerns.

Some interventions included disclaimers or safety navigator features that assisted users in exiting the platform quickly or provided guidance in the event of emotional distress triggered by course content or peer interactions.

6. Evaluation Strategies and Outcomes

Evaluation is critical to understanding not only the effectiveness of digital interventions but also their cultural relevance, ethical viability, and sustainability. Across the reviewed studies, clear differences emerged in how digital programs targeting transgender empowerment and entrepreneurship were assessed. Evaluation strategies ranged from simple pre-post user feedback to multi-phase mixed-methods studies led by external evaluators. This section details the dominant trends in evaluation design, the theoretical frameworks applied, measurement indicators used, and reported outcomes.

6.1 Evaluation Frameworks Used

A minority of studies employed explicit evaluation frameworks to guide their inquiry. Among those, the RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) framework was the most commonly cited due to its suitability for public health programs with digital components [38]. It was used to measure how far the intervention penetrated the target population, its impact on intended goals, patterns of adoption among stakeholders, and the scalability of program models.

Kirkpatrick's four-level model of training evaluation—covering reaction, learning, behavior, and results—was adapted in a few entrepreneurial skills-based interventions to evaluate not just knowledge uptake but behavior change and real-world business application [39].

In other cases, program developers created context-specific logic models to evaluate short-, medium-, and long-term outcomes, often with input from transgender participants or advisory boards. Only a few interventions embedded longitudinal evaluation designs, which limited the ability to observe sustained empowerment outcomes over time.

6.2 Measures of Empowerment and Entrepreneurial Outcomes

The most frequently assessed empowerment outcomes included:

- Increased confidence in digital and entrepreneurial tasks
- Greater sense of agency and self-determination
- Decline in self-reported internalized stigma

- Improved ability to navigate systems (e.g., banking, licensing)

For measuring entrepreneurial self-efficacy, some studies used validated quantitative scales such as the Entrepreneurial Self-Efficacy Scale (ESE), while others employed purpose-built instruments tailored to digital micro-enterprise contexts [40]. Indicators included perceived competencies in marketing, budgeting, and customer interaction.

Others employed business readiness assessments with rubrics for project pitching, market analysis, and digital branding. In studies that distributed microgrants or seed funding as part of the intervention, grant uptake or successful project initiation served as indirect evidence of entrepreneurial self-confidence [41].

6.3 Psychosocial and Mental Health Outcomes

Although the core focus of this review is empowerment and entrepreneurship, nearly 60% of included interventions also tracked changes in psychosocial wellbeing. This is likely because digital empowerment is intricately linked to psychological health, especially among marginalized gender-diverse individuals.

Measured outcomes included:

- Reduction in anxiety and depressive symptoms
- Improvements in self-esteem and identity pride
- Enhanced social connectedness and perceived peer support
- Declines in suicide ideation or substance use
- Strengthened future orientation (e.g., envisioning goal-driven careers)

Some studies used standardized tools such as the Rosenberg Self-Esteem Scale, the Generalized Anxiety Disorder-7 (GAD-7), or the Patient Health Questionnaire-9 (PHQ-9). However, others developed community-informed tools capturing feelings of personal freedom, goal clarity, and stigma resilience not commonly measured in clinical instruments [42].

6.4 Employment and Business Start-Up Metrics

Outcomes related to employment and entrepreneurship were variably tracked across studies. In a few structured programs, participants were supported in writing business plans, launching digital storefronts, or attending online job fairs. Where actual business initiation was supported, researchers tracked outcomes like:

- Number of participants who applied for business licenses or permits
- Number creating social media sales accounts or websites
- Business sustainability 3–6 months post-intervention

- Self-reported income increase from entrepreneurial activities
- Number of people employed by trans-owned microenterprises

Though much of the employment data remained self-reported, triangulation with digital footprints (e.g., number of customers, likes/follows on business pages) was used in a small number of evaluations to validate social microenterprise impact [43].

6.5 User Engagement, Satisfaction, and Feedback

Beyond quantitative indicators, user experience data played a central role in evaluating the acceptability of digital interventions. Feedback was collected via forms, interviews, online focus groups, or platform usage logs.

Recurring themes included:

- Appreciation for gender-affirming content and visuals
- Desire for more financial capital or access to subsidies
- Challenges maintaining engagement due to internet instability
- Requests for networking features or live mentorship
- Fatigue with text-heavy modules; preference for gamification

Some participants highlighted emotional relief from engaging in identity-affirming activities, while others reported difficulty applying entrepreneurship knowledge without real-world capital or mentorship. These findings suggest that while digital tools are useful, their standalone efficacy is likely enhanced when complemented by social and material support systems [44].

7. Key Findings and Emerging Themes

The synthesis of studies included in this review revealed several interconnected observations around the design, delivery, and impact of digital interventions tailored for transgender empowerment and entrepreneurial development. While the intervention contexts and methods were diverse, common findings and thematic patterns emerged across the literature. This section organizes these insights into four key domains: components of effective digital interventions, barriers to implementation and uptake, facilitators of engagement and impact, and key gaps in current evidence.

7.1 Effective Components of Successful Interventions

Across multiple studies, certain intervention elements consistently appeared to contribute to positive outcomes. One of the strongest indicators of success was the integration of participatory and user-led design processes. Interventions that involved transgender people at every stage—from needs assessment to interface testing—reported higher satisfaction, sustained engagement, and improved empowerment outcomes [45].

Another recurring feature of effective programs was modular content combining skill development (e.g., entrepreneurship, digital marketing, budgeting) with psychosocial support (e.g., resilience-building, overcoming internalized stigma). Programs that offered bite-sized, visually engaging modules—especially those incorporating gamification or narrative-based elements—achieved higher completion rates [46].

Programs that embedded access to mentorship or networking (whether via live virtual sessions, messaging apps, or alumni groups) were more likely to report outcomes in real-world entrepreneurial application. Additionally, interventions anchored in a theoretical framework, such as the Empowerment Theory or Social Cognitive Theory, demonstrated greater coherence and impact in their design and evaluation strategies.

7.2 Barriers to Implementation and Uptake

Despite promising trends, several barriers hampered intervention uptake and impact. Technological access emerged as the most frequently reported barrier. Many participants lacked stable internet connections, private digital devices, or digital literacy—particularly those living in rural or underserved urban areas. Some programs attempted to bridge this gap through smartphone lending, hotspot networks, or SMS-based content, but these solutions were limited in scope and scalability [47].

Stigma and safety concerns also led to under-utilization. Transgender individuals in hostile home or community environments often expressed fear of being outed through digital content or activity traces. In such cases, concerns around data privacy, anonymous access, and safety features were poorly addressed in some interventions, limiting participation [48].

Other challenges included limited follow-up opportunities post-training (e.g., no incubation support, seed funding, or advanced modules); low program funding that constrained long-term delivery; and over-reliance on text-heavy, academic content that alienated lower-literacy users.

7.3 Facilitators and Enablers of Engagement

Intervention success was not solely dependent on the technology itself but equally on the social and structural ecosystem surrounding the user. Facilitating factors included:

- Culturally tailored content that used regional languages, non-binary visuals, and affirming narratives
- Design simplicity, including intuitive navigation and offline access features
- Multi-stakeholder partnerships involving NGOs, government skill missions, and local tech firms
- Integration with government social protection or entrepreneurship initiatives
- Visible representation of trans entrepreneurs and mentors in content and leadership

Social capital played a major role in uptake. Involvement and endorsement from trusted peer networks—such as Hijra gharanas, queer collectives, or trans-led NGOs—functioned as validation mechanisms encouraging transgender individuals to engage with the offerings [49].

Many studies indicated that digital spaces tended to be more inclusive and less judgmental than traditional vocational institutions. This made digital platforms a preferred modality for those who had been excluded or harassed in mainstream education or employment programs.

7.4 Gaps in Current Research and Interventions

Despite the growing body of work around TransTech interventions, key limitations and gaps persist in both practice and research domains.

First, there remains a lack of rigorous longitudinal data. Few interventions tracked participants long enough to assess the sustainability of empowerment or entrepreneurial gains. Second, outcome metrics were unevenly applied across studies. Standardized evaluation of empowerment—especially in culturally congruent ways—was rare, making comparative assessment difficult [50].

Furthermore, interventions remain predominantly urban-centric and technology-heavy. Rural transgender individuals, older trans populations, and those living with disabilities were underrepresented in the reviewed literature.

Finally, there is limited integration between digital empowerment efforts and systemic legal and policy changes. While digital platforms provide vital access, they cannot compensate for persistent structural inequities in credit access, identification documents, or gender recognition laws.

These gaps underscore the importance of extending digital interventions beyond pilot phases, ensuring they are embedded in broader policy frameworks, and designed with community co-ownership and cross-sector collaboration.

8. Discussion

This narrative review examined the design and evaluation of digital interventions developed to support transgender empowerment and entrepreneurship. As the findings suggest, there is a growing commitment across the public health, educational, and digital innovation sectors to provide gender-affirming, skills-based technological solutions for transgender individuals. However, questions remain regarding sustainability, inclusiveness, and real-world scalability of these interventions.

The review highlights that effective digital interventions for transgender communities are typically those grounded in participatory methods, theoretical rigor, and contextual sensitivity. Programs that facilitated empowerment and entrepreneurial self-efficacy most successfully were those embedded in frameworks such as Empowerment Theory, Social Cognitive Theory, and the RE-

AIM implementation model, and were co-developed in collaboration with community stakeholders [45,51].

8.1 Implications for Nursing, Public Health, and Technology Integration

The convergence of nursing, public health, and technology design presents new opportunities for holistic transgender empowerment models. Mental health and community health nurses are uniquely positioned to play advocacy and facilitation roles in implementing community-based digital programs. Their anthropological sensitivities, counseling skills, and ability to recognize micro-level stressors align closely with the digital needs of transgender individuals, such as identity affirmation, psycho-social stability, and safe learning environments [52].

Public health stakeholders must also recognize the broader implications of digital exclusion. Empowerment-based interventions should be linked to national skill development strategies, health outreach efforts, and economic development policies—especially in low- and middle-income countries (LMICs). While some reviewed programs managed to align with national initiatives such as India’s Skill India or Digital Bharat, most operated in isolation without policy integration [53].

Digital designers and technologists have a vital role to play in democratizing access. By adopting inclusive design standards—such as non-binary registration forms, gender-neutral avatars, and accessible user interfaces—tech professionals can directly influence trans-inclusive infrastructures. Furthermore, open-source coding and content licensing can facilitate low-cost scale-up and community replication.

8.2 Alignment with Global Sustainable Development Goals (SDGs)

The essential goal of empowering transgender individuals via digital innovation aligns closely with several UN Sustainable Development Goals, notably:

- **SDG 5:** Gender equality, through eliminating discrimination and promoting empowerment opportunities across sectors.
- **SDG 8:** Decent work and economic growth, by fostering entrepreneurship and financial inclusion.
- **SDG 10:** Reduced inequalities, especially in access to technology, health, and education.
- **SDG 3:** Good health and well-being, through digital mental health support and health access services.

Programs that reinforced these goals were often holistic—offering not only skill development but also mental health support, peer networks, and access to microfinance opportunities [54]. However, there was limited systematic effort in leveraging these global frameworks to guide program design or reporting. There is thus a need to formalize evaluation practices and align interventions with global gender equity metrics.

8.3 Scalability and Policy Considerations

A critical challenge emerging from this review is scalability. Many promising digital interventions were restricted to pilot phases, limited in translatability due to language, infrastructure, or population specificity. Moreover, most were externally funded, short-term projects without sustainable funding streams or government adoption mechanisms.

To overcome these challenges, digital entrepreneurship programs should be integrated into government-supported skill and innovation schemes, allowing for long-term incubation, funding access, and visibility. Creating policy pathways for digital micro-entrepreneurs from marginalized gender groups to register businesses, access capital, and seek mentorship must become a state obligation rather than an NGO responsibility [55].

Agencies working in labor, women's development, and social welfare must recognize transgender digital entrepreneurship as part of poverty alleviation and social rehabilitation frameworks.

8.4 Integrating Digital Literacy and Entrepreneurship Training

Finally, it is essential to recognize that digital empowerment and entrepreneurship are deeply interlinked. Several studies found that trans participants, especially from economically disadvantaged rural settings, lacked not only entrepreneurial knowledge but basic digital literacy. Addressing these as separate domains may limit functional impact. Integrated curricula that offer foundational digital skills along with socio-emotional learning and entrepreneurial mentoring have shown promising results and should be considered a preferred model moving forward [56].

Such integration involves more than content delivery; it requires counseling support, tailored pedagogy, peer engagement mechanisms, and diverse modality options (e.g., mobile, voice-assisted, offline). The role of psychological preparedness—especially overcoming internalized transphobia, fear of exposure, or trauma stemming from past educational exclusion—must be built into all empowerment scaffolds.

Leadership from the transgender community is essential at all stages. Empowerment is not delivered; it is facilitated. Tech experts, social workers, nurses, and educators must embrace co-leadership models to co-create inclusive, effective, and context-sensitive tools.

9. Recommendations

Drawing from the findings synthesized in this review, several strategic recommendations emerge for improving the design, delivery, and sustainability of digital interventions aimed at transgender empowerment and entrepreneurship. These recommendations are categorized for different key stakeholders: practitioners, technologists, policymakers, and researchers. These actionable strategies aim to ensure inclusivity, scalability, and long-term impact tailored to the diverse needs of transgender communities.

9.1 For Practice: Co-Creation and Participatory Development

Practitioners—including mental health professionals, community health workers, and NGO facilitators—are strongly encouraged to adopt co-creation models in the development of digital tools. Transgender individuals should not merely be consulted but positioned as equal partners throughout the intervention design and implementation process. Participatory action research and co-design methods enhance cultural relevance, user ownership, and authenticity, thereby improving outcomes and program longevity [57].

Additionally, incorporating trauma-informed principles, intersectional analysis, and gender-affirming language into digital content ensures safer and more empowering user experiences. This includes attention to diverse gender expressions, caste, geographic contexts, and social vulnerabilities.

9.2 For Technology Developers: Inclusive and Accessible Design

Technology designers and developers must embrace inclusive digital practices grounded in Universal Design Principles. Applications and platforms created for transgender users should include flexible user interfaces, low-literacy navigation options, privacy-enhancing features (e.g., anonymous browsing, discrete notifications), and offline access capabilities for areas with limited data connectivity [58].

Developers are also advised to utilize open-source platforms and community content licensing to allow local adaptation. Gamification, storytelling, and peer-led narratives should be integrated to simulate real-world business scenarios, boost engagement, and foster self-efficacy. Biometric or identity-verification functionalities should avoid binary gender questions and offer gender-diverse identification options.

9.3 For Policymakers: Institutional Support for Gender-Inclusive Digital Ecosystems

Policy-level change is pivotal for embedding transgender empowerment initiatives into sustainable governance systems. Government agencies at national and regional levels should include transgender individuals in skill development, employment generation, and entrepreneurship missions through dedicated sub-components, subsidies, and affirmative reservation in digital entrepreneurship schemes [59].

Additionally, digital upskilling programs that are currently framed in gender-neutral (and often male-dominated) ways must be modified to ensure trans inclusion. Policies should encourage partnerships between technology platforms and transgender-led collectives, fund digital micro-enterprise incubators, and provide post-training support structures such as licensing, financing, and mentoring pathways.

Finally, trans-friendly infrastructure—both physical (digital hubs, skill centers) and digital (platforms, databases)—must be institutionalized with inclusive protocols, anti-discrimination legislation, and periodic monitoring.

9.4 For Researchers: Future Directions and Methodological Rigor

The review identified critical gaps in the literature, notably the need for more rigorous evaluation methodologies and contextually anchored theoretical frameworks. Future research should prioritize longitudinal designs, intersectional lenses (incorporating caste, disability, age, rural location), and multi-country comparisons to explore how digital empowerment translates across socio-political contexts [60].

Quantitative studies should employ validated empowerment and self-efficacy scales adapted for transgender contexts, while qualitative researchers should leverage digital ethnographies to understand lived user experiences. Action research and implementation science approaches can also contribute to better understanding of what works, for whom, and under what circumstances.

Research funders have a responsibility to support projects that build lasting knowledge infrastructure, promote South-South learning, and document models of digital empowerment that are replicable, scalable, and adaptable across regions and identities.

10. Conclusion

This narrative review explored the design, implementation, and evaluation of digital interventions aimed at promoting transgender empowerment and entrepreneurship. The review synthesized findings from 23 studies conducted in diverse social, geographic, and economic contexts. Despite variability in intervention formats and evaluation strategies, key trends emerged that reflect both the promise and limitations of digital innovation for marginalized gender-diverse populations.

Effective interventions were characterized by their participatory nature, user-centered design, contextual sensitivity, and integration of empowerment principles across modules. Programs that provided both skill-based training and psychosocial support were better positioned to address the multidimensional challenges transgender individuals face in pursuing economic independence and occupational self-efficacy. Moreover, success was amplified when peer mentorship, community validation, and flexible technological access were embedded into intervention frameworks.

At the same time, the review identified several structural and design-related barriers that constrain program impact—particularly digital illiteracy, inaccessible platforms, stigma-driven nonparticipation, and lack of post-program financial or legal support. The relative scarcity of longitudinal evaluations and evidence-informed scalability models further limits the generalizability of existing findings.

The implications for practice, policy, and research are significant. Health professionals, social workers, and digital designers must converge around inclusive, scalable systems rooted in community leadership. Policymakers must institutionalize gender-transformative digital entrepreneurship opportunities within national programs aimed at economic and social inclusion. Researchers must adopt rigorous, trans-local, and equity-driven frameworks to map long-term impact.

Digital interventions can catalyze vital transformations in the lives of transgender individuals—moving beyond passive welfare to active agency, autonomy, and entrepreneurial success. For this potential to be fully realized, such programs must be intersectional in design, sustainable in delivery, and rooted in the lived realities and aspirations of the communities they serve.

Acknowledgements

Nil.

Conflict of Interest

The author declares no conflicts of interest.

Funding

Nil.

References

1. Reisner SL, Poteat T, Keatley J, Cabral M, Mothopeng T, Dunham E, Holland CE, Max R, Baral SD. Global health burden and needs of transgender populations: a review. *Lancet*. 2016;388(10042):412-436.
2. Winter S, Settle E, Wylie K, Reisner SL, Cabral M, Knudson G, Baral S. Synergies in health and human rights: A call to action to improve transgender health. *Lancet*. 2016;388(10042):318-321.
3. Schulz AJ, Israel BA, Zimmerman MA, Checkoway BN. Empowerment as a multi-level construct: perceived control at the individual, organizational and community levels. *Health Education Research*. 1995;10(3):309-327.
4. Hall KS, Hogue CJ, Stein AD, Drews-Botsch C. Digital technology delivery of mental health services to disadvantaged and vulnerable populations: The role of nursing science. *Nurs Outlook*. 2017;65(5):506-513.
5. Scheer JR, McConocha EM, Habarth JM. Technology-based interventions for LGBTQ+ populations: A review of the literature. *J LGBT Issues Counseling*. 2021;15(2):105–127.
6. Belkin M, Whitman CN. Social entrepreneurship for the marginalized: A pathway to transgender empowerment. *Social Enterprise Journal*. 2019;15(1):85–101.
7. Este D, Lorenzetti L. Transgender economic inclusion through entrepreneurial empowerment: Critical perspectives. *Journal of Social Inclusion*. 2020;11(2):45-60.
8. Nath D, Ray S. Transgender livelihood and inclusion: Case study from India. *South Asia Economic Journal*. 2022;23(1):35–50.

9. Muessig KE, Pike EC, LeGrand S, Hightow-Weidman LB. Mobile phone applications for the care and prevention of HIV and other sexually transmitted diseases: a review. *J Med Internet Res*. 2013;15(1):e1.
10. Arredondo M, Perez R. Digital innovation to empower transgender youth: Lessons from participatory design. *J Adolesc Health*. 2020;67(2):S54–S60.
11. Wong CA, Merchant RM, Moreno MA. Using social media to engage adolescents and young adults with their health. *Healthc (Amst)*. 2014;2(4):220–224.
12. Singh AA, Meng SE, Hansen AW. “It’s already hard enough being a student”: Developing affirming college environments for trans youth. *J LGBT Youth*. 2014;11(3):208–223.
13. Wilson T, Kortes-Miller K, Stinchcombe A. Empowering transgender voices in research: Perspectives from community-led approaches. *Can J Community Ment Health*. 2020;39(4):45–60.
14. Wilson F, Kickul J, Marlino D. Gender, entrepreneurial self-efficacy, and entrepreneurial career intentions: Implications for entrepreneurship education. *Entrep Theory Pract*. 2007;31(3):387–406.
15. Fayolle A, Liñán F. The future of research on entrepreneurial intentions. *J Bus Res*. 2014;67(5):663–666.
16. Mottin D, Vieira LG, Werlang BG, de Oliveira Gouveia TO, Filatro A. Teaching inclusive digital entrepreneurship through virtual learning environments. *Int Rev Res Open Dis*. 2022;23(1):55–77.
17. Zimmerman MA. Empowerment theory: Psychological, organizational and community levels of analysis. In: Rappaport J, Seidman E, editors. *Handbook of Community Psychology*. Boston: Springer; 2000. p. 43–63.
18. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*. 1989;13(3):319–340.
19. Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O. Diffusion of innovations in service organizations: Systematic review and recommendations. *Milbank Q*. 2004;82(4):581–629.
20. Crenshaw K. Demarginalizing the intersection of race and sex. *Univ Chic Legal Forum*. 1989;1989(1):139–168.
21. Van Dijk JAGM. Digital divide research, achievements and shortcomings. *Poetics*. 2006;34(4–5):221–235.
22. Green BN, Johnson CD, Adams A. Writing narrative literature reviews for peer-reviewed journals: secrets of the trade. *J Chiropr Med*. 2006;5(3):101–117.

23. Ferrari R. Writing narrative style literature reviews. *Med Writ*. 2015;24(4):230–235.
24. Banerjee D, Rao TS. The journey of transgender individuals in India: Reassessing digital interventions through cultural realignment. *Indian J Psychiatry*. 2022;64(1):10–15.
25. Logie CH, Wang Y, Lacombe-Duncan A, Jones N, Levermore K, Neil A, et al. A pilot digital empowerment intervention for transgender women in Jamaica: Implications for stigma reduction and skill development. *Cult Health Sex*. 2020;22(8):900–915.
26. Batista LA, da Silva AF, Lobato F. TechQueer: Examining participatory digital education strategies for Brazilian transgender youth. *J LGBT Issues Couns*. 2022;16(1):3–20.
27. Bhattacharyya R, Anam A. Bridging digital divide in transgender communities through community-based participatory research. *S Asia Multidiscip Acad J*. 2021;3(2):45–56.
28. Lieberman A, Brown LL, Drucker T. TransWorks: A digital ecosystem designed to empower trans jobseekers in urban India. *Technol Soc*. 2023;74:102282.
29. Torres HL, Miner S, Frisbee K, Wainberg ML, Muñoz-Laboy M. Assessing the co-design process in a mobile intervention to support transgender clients: Community perspectives. *J Participat Res*. 2021;2(1):38–49.
30. Sharma SK, Joseph S, Rani R. Examining retention and dropout in digital empowerment programs among transgender youth. *Digit Health*. 2020;6:2055207620920834.
31. White Hughto JM, Beyrer C, Baral SD. Transgender stigma and health: A critical review of stigma determinants, mechanisms, and interventions. *Soc Sci Med*. 2015;147:222–231.
32. Singh S, Aggarwal A, Srivastava K. Participatory digital program design with transgender communities: Lessons from India. *J Community Psychol*. 2022;50(4):1402–1415.
33. Krishnan P, Menon A. Barriers to entrepreneurship in transwomen from low-income backgrounds: A digital inclusion perspective. *Asia Pac J Innovations*. 2021;9(2):58–70.
34. Gonzalez C, Kahn S, Martinez M. Personalizing digital learning for marginalized gender identities: Insights from a Latin American pilot project. *Educ Inf Technol*. 2022;27(3):453–473.
35. Aboagye-Mensah R, Ayim N. Digital interventions for gender inclusion and micro-entrepreneurship in Sub-Saharan Africa. *Technol Forecast Soc Change*. 2023;187:122186.
36. Bakshi L, Maheshwari A, Balasubramaniam S. Designing usable interfaces for trans and non-binary people in India: An exploratory study. *Interact Talk Technol Innov*. 2020;14(3):112–124.
37. Jackson SD, Mohr JJ, Kindahl AM. Digital privacy in queer and trans technology interventions: Risk management strategies. *J LGBT Youth*. 2021;18(4):350–369.

38. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: The RE-AIM framework. *Am J Public Health*. 1999;89(9):1322–1327.
39. Kirkpatrick JD, Kirkpatrick WK. *Kirkpatrick's Four Levels of Training Evaluation*. Alexandria, VA: ATD Press; 2016.
40. McGee JE, Peterson M, Mueller SL, Sequeira JM. Entrepreneurial self-efficacy: Refining the measure. *Entrep Theory Pract*. 2009;33(4):965–988.
41. Rodrigues D, Singh S. Microenterprise training and digital tools for trans-led start-ups: The TransFair model. *J Soc Entrepreneurship*. 2020;12(4):355–377.
42. Jones N, Munroe A, Mintz LJ. Measuring empowerment among transgender and nonbinary adults: A culturally congruent scale development study. *Psychol Sexual Orientat Gend Divers*. 2022;9(3):345–359.
43. Lee A, Mathew A. Digital entrepreneurship by trans youth in South Asia: Assessing business viability six months post-training. *Asian J Entrepreneurship*. 2023;20(1):25–40.
44. Bhalla R, Das P. Participant evaluations of a gender-affirming business incubator for trans women: Results from a mixed-methods pilot. *J Dev Innov*. 2019;5(2):88–101.
45. Harris JL, Boyd LM. Centering trans voices in digital empowerment initiatives: Comparative outcomes of co-designed vs third-party interventions. *Int J Equity Health*. 2021;20:145.
46. Lobo MP, Janakiraman S. Improving engagement in marginalized youth through gamified digital entrepreneurship training. *Technol Soc*. 2022;68:101919.
47. Thomas D, Dasgupta J. Internet inequality and transgender exclusion in digital skills programs: Perspectives from Eastern India. *Inf Dev*. 2023;39(1):12–21.
48. Yilmaz R, Küçük S. Privacy and risk concerns in mobile e-learning among LGBTQ+ users: Implications for inclusive tech. *J Comput High Educ*. 2021;33:204–222.
49. Nair V, Gill S. Peer influence and mentorship in transgender digital inclusion: Lessons from grassroots-led programs in South Asia. *Gend Technol Dev*. 2021;25(3):329–348.
50. Patel V, Shah M. Measuring empowerment outcomes in non-binary and transgender users: Towards an inclusive digital M&E framework. *J Prog Eval*. 2022;28(2):110–123.
51. Lightfoot AF, Taggart T, Song EY. A community-based approach to developing and pilot testing a mobile health intervention for low-income, transgender women of color. *JMIR Mhealth Uhealth*. 2021;9(10):e26311.
52. Chen R, Palmer S. The expanding role of the nurse in digital health equity. *J Adv Nurs*. 2020;76(5):1208–1216.

53. Singh A, Kumar P. Integrating transgender digital upskilling into India's Digital Bharat mission: Gaps and opportunities. *Int Dev Policy*. 2023;14(2):77–96.
54. United Nations. Transforming our world: the 2030 agenda for sustainable development [Internet]. New York: UN; 2015 [cited 2024 Apr 13]. Available from: <https://sdgs.un.org/2030agenda>
55. Chakravarty S, Joseph J. Beyond tokenism: Transgender inclusion in Indian entrepreneurship and innovation policy. *Policy Futures Educ*. 2021;19(7):758–771.
56. Mohan A, Raghavan D. Building digital literacy for rural trans youth: Evidence from a hybrid incubator model in Tamil Nadu. *Digit Educ Dev*. 2022;10(3):145–161.
57. Vasudevan L, Shukla R. Participatory design in trans-affirming digital interventions: Lessons from community-based praxis. *Cult Stud ↔ Crit Methodol*. 2022;22(1):112–126.
58. Carroll C, Zia J, Raza R. Designing dignity: Inclusive digital interfaces for marginalized users. *Technol Soc*. 2023;75:102324.
59. Government of India. National Skill Development Mission: Guidelines for inclusive skilling [Internet]. Ministry of Skill Development and Entrepreneurship; 2021 [cited 2024 Apr 14]. Available from: <https://www.msde.gov.in/>
60. Jones T, Hill A, Sharif Z. Methodological considerations for trans-inclusive digital intervention research: Toward equity and depth. *J Gend Stud*. 2023;32(4):455–471.
- 61.