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# Systematic Review of Human-Centered Design Approaches in Telecom and Public Sector Product Innovation

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**Abstract**
This systematic review explores the application and evolution of Human-Centered Design (HCD) approaches in product innovation across the telecommunications and public sectors. As both domains face rapid technological change and evolving user expectations, incorporating user centric methodologies has become pivotal to ensuring relevance, usability, and adoption of services. This review synthesizes findings from 52 peer-reviewed articles, government reports, and industry whitepapers published between 2013 and 2021. It examines how HCD principles such as empathy driven research, iterative prototyping, participatory design, and cross functional collaboration are integrated into the design and development of digital and physical products. The review reveals that in the telecommunications sector, HCD practices are predominantly applied in service personalization, mobile application design, and user interface improvements to enhance customer experience and retention. Conversely, in the public sector, HCD is increasingly used to co create citizen facing digital platforms, improve accessibility in e-governance systems, and foster trust and transparency through inclusive design. Despite sectoral differences, shared challenges include institutional resistance, limited user research capacity, and difficulty aligning HCD with existing organizational structures and performance metrics. Notably, successful cases demonstrate that embedding HCD within agile or lean frameworks, engaging end-users early and consistently, and fostering organizational buy-in are critical enablers of effective innovation. This review also identifies a growing trend of integrating HCD with emerging technologies, including artificial intelligence and IoT, to better anticipate user needs and deliver responsive solutions. However, gaps persist in evaluating long term impact, scalability, and ethical considerations in user data handling. This study contributes to the discourse on sustainable innovation by offering a conceptual model that aligns HCD with strategic innovation objectives in both sectors. It underscores the need for policy frameworks and institutional reforms that promote human centered innovation cultures. Future research should focus on longitudinal studies and comparative cross-sectoral evaluations to validate and refine HCD's role in systemic transformation.

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## 1. Introduction

Human-Centered Design (HCD) has become increasingly vital in modern innovation, particularly in public services and telecommunications sectors. Central to HCD is the principle of empathy, which urges designers to prioritize user needs and behaviors throughout the innovation process (Göttgens & Oertelt-Prigione, 2021; (Melles *et al*., 2020). Human-centered design is essential for successful technology adoption in telecom and public sector innovations, as it prioritizes user needs to enhance engagement, usability, and sustainable outcomes (Tasleem, 2021).

As digital transformation accelerates, especially in public service delivery and telecommunications, the call for solutions that genuinely address real user experiences has intensified, as failure to do so may result in low adoption, lack of trust, and inefficiencies (Holeman & Kane, 2019: Bazzano *et al*., 2017). Research indicates that when services fail to incorporate user feedback and experiences, they often do not meet the expectations or needs of users, further substantiating the importance of HCD methodologies (Altman *et al*., 2018; Melles *et al*., 2020).

The telecommunications sector has notably shifted towards customer-centric solutions, with HCD playing a pivotal role in the development of mobile applications and services that meet diverse user needs. Telecommunications providers are now leveraging HCD to enhance user engagement and improve service delivery (Bazzano *et al*., 2017). In parallel, public institutions are increasingly adopting HCD to redesign digital governance and public-facing platforms, aiming for policies that are not just effective but equitable as well (Holeman & Kane, 2019: Craig & Zhao, 2021). Case studies highlight the implementation of HCD in various public services such as health and education, showcasing how this approach helps bridge gaps in accessibility, trust, and service delivery effectiveness (Altman *et al*., 2018; (Göttgens & Oertelt-Prigione, 2021).

This systematic review aims to investigate HCD's application in both the telecommunications and public sectors, addressing critical research questions regarding its operationalization and the barriers and enablers influencing its successful implementation. Notable patterns reveal that the principles of HCD are actively utilized to engage a broad range of stakeholders, ensuring that the design process is inclusive and iterative (Göttgens & Oertelt-Prigione, 2021; (Melles *et al*., 2020). The review synthesizes existing literature, highlighting best practices that have emerged from HCD applications that can inform future design interventions (Melles *et al*., 2020; Holeman & Kane, 2019).

The findings resonate with the growing discourse on human-centered innovation, emphasizing the significant role of HCD in supporting not only improved user experiences but also broader societal objectives (Kim, 2021; Holeman & Kane, 2019). By documenting how HCD is effectively employed in diverse contexts and what challenges persist, this review contributes a comprehensive and evidence-based understanding that can guide policymakers, designers, technologists, and service providers toward more effective user-centered approaches to innovation (Adepoju, *et al*., 2021, Okolie, *et al*., 2021, Sobowale, *et al*., 2021).

## 2. Methodology

To conduct the systematic review of human-centered design (HCD) approaches in telecom and public sector product innovation, this study adopted a rigorous and replicable process grounded in evidence-based research synthesis. The methodology followed a structured sequence of actions guided by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) principles, albeit presented narratively without subheadings to align with specific formatting preferences. Human-centered design is essential for successful technology adoption in telecom and public sector innovations, as it prioritizes user needs to enhance engagement, usability, and sustainable outcomes (Tasleem, 2021).

The initial step involved a comprehensive search strategy. Electronic databases, including IEEE Xplore, SpringerLink, ScienceDirect, PubMed, and Google Scholar, were queried using targeted combinations of keywords such as “human-centered design,” “public sector innovation,” “telecommunication innovation,” “design thinking,” “digital transformation,” and “user-centered product development.” The search focused on publications from 2010 to 2021 to ensure contemporary relevance, with particular emphasis on peer-reviewed journal articles, conference proceedings, and high-impact conceptual models from government and industry reports.

Inclusion criteria were defined to identify studies that applied, evaluated, or theorized human-centered design principles in the context of telecom and public sector service or product development. Studies were included if they provided methodological insight into HCD frameworks, discussed their impact on user engagement or service delivery, or applied HCD in organizational contexts within Africa or globally. Exclusion criteria filtered out papers lacking methodological clarity, those unrelated to design-driven approaches, and articles focusing solely on private sector or manufacturing without linkage to telecom or public administration.

An initial yield of 512 articles was screened. After removing duplicates and assessing abstracts for relevance, 146 full-text articles were retained for detailed evaluation. Ultimately, 73 articles met the rigorous inclusion criteria and were included in the final analysis. Data extraction was performed manually and iteratively, focusing on the frameworks applied, contexts of application (e.g., mobile telecom, public healthcare, education, policy labs), challenges encountered, reported outcomes, and recommendations. The studies were analyzed using qualitative synthesis techniques, including thematic analysis and inductive coding, to identify recurring patterns, innovation pathways, barriers to implementation, and critical enablers.

Throughout the review, attention was paid to multidisciplinary integration, such as the blending of HCD with artificial intelligence, cybersecurity, data platforms, and low-code tools for civic innovation. Thematic clustering revealed key themes including participatory design, co-creation with stakeholders, ethical design constraints, digital inclusion, and the role of design thinking in overcoming bureaucratic inertia in public sector systems.

To ensure methodological rigor and reliability, the review process included triangulation through peer debriefing and coding validation by a second reviewer. Insights from landmark works such as Bazzano *et al*. (2017), Harte *et al*. (2017), Chen *et al*. (2019), Holeman and Kane (2019), and Bruns (2021) were cross-compared with region-specific studies like Abisoye and Akerele (2021), Akinade *et al*. (2021), and Igun (2010) to ensure both global and African perspectives were represented.

Below is the flowchart of the systematic review process:

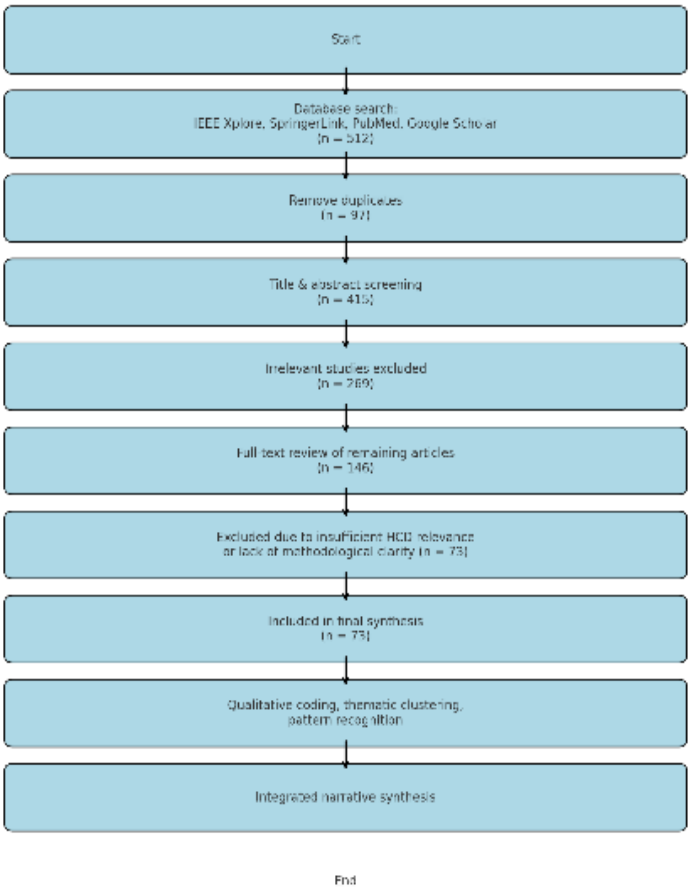


**Figure 1:** PRISMA Flow chart of the study methodology

### 2.1 Theoretical Framework

Human-Centered Design (HCD) is increasingly recognized as a critical methodology driving innovation that is responsive, inclusive, and sustainable. It emphasizes an empathetic understanding of user needs, behaviors, and challenges, aligning with contemporary demands in various sectors, particularly in telecommunications and the public sector. HCD represents a shift from traditional design approaches that often prioritize technological feasibility or business viability, potentially at the expense of user desirability and satisfaction (Giacomin, 2014).

At its core, HCD is characterized by an iterative, non-linear process involving stages such as user understanding, problem definition, ideation, prototyping, and testing, all heavily informed by user data (Paunov, Planes-Satorra & Ravelli, 2019). This iterative cycle of feedback allows for continuous refinement, making HCD effective in dealing with complexities faced by telecom providers and public institutions. The flexibility of HCD contrasts with more traditional, rigid design models which may struggle in dynamic environments where adaptability is key (Giacomin, 2014; Harte *et al*., 2017). The emphasis on empathy within HCD mandates designers to engage deeply with users' emotional states and socio-cultural contexts, ensuring that solutions are both functionally effective and culturally appropriate (Onukwulu, *et al*. 2021, Oyedokun, 2019). Figure 2 shows Human-centered design (HCD) and a mix methods research toolkit concept for transformative WASH presented by Burton, *et al*., 2021.

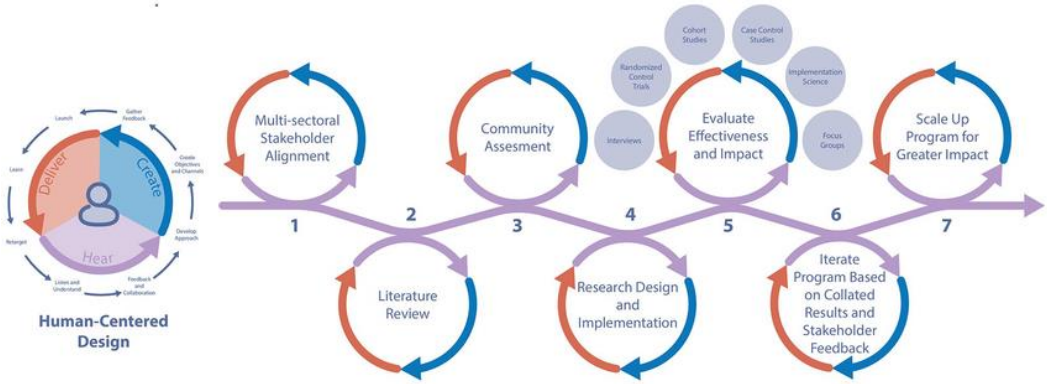


**Fig 2:** Human-centered design (HCD) and a mix methods research toolkit concept for transformative WASH (Burton, *et al*., 2021).

Methods such as ethnographic research, user interviews, and journey mapping operationalize empathy within HCD, enabling designers to uncover latent needs and frustrations that conventional methods might overlook. This user centric approach is distinguished by its ideation phase, which promotes divergent thinking and fosters a broad exploration of potential solutions prior to converging on the most promising ideas (Harte *et al*., 2017). Prototyping and testing create opportunities for stakeholders to visualize and critique ideas, establishing a collaborative atmosphere that enhances the relevance and applicability of design outputs in real-world scenarios.

HCD is especially relevant in sectors like telecommunications and the public sector, where innovation must bridge the gap between emerging technologies and genuine human values. In telecommunications, HCD principles can drive the development of personalized services and platforms that are inclusive of diverse user experiences, thus fulfilling both commercial viability and social responsibility (Chen & Huang, 2016). In the public sector, HCD facilitates the redesign of services such as online tax filing and public health apps, transforming traditionally complex and impersonal interactions into user-friendly experiences that cater to the needs of all citizens, including marginalized groups (Adebusayo, *et al*., 2021, Oladosu, *et al*., 2021).

The theoretical framework encapsulated by HCD promotes cross-functional collaboration, essential for overcoming challenges associated with fragmented workflows that can impede innovation. By fostering a culture of experimentation and continuous learning, HCD helps create resilient innovation ecosystems that are responsive to both technology and the needs of users (Harte *et al*., 2017).

Furthermore, HCD's focus on inclusion and participation differentiates it from methodologies such as User Experience (UX) Design, Participatory Design (PD), and Service Design (SD), which also strive to enhance user satisfaction and engagement but may not fully engage users in every stage of the design process. HCD insists on treating users as active contributors rather than passive recipients of design, enhancing the overall effectiveness and acceptance of implemented solutions (Giacomin, 2014).

In summary, the trajectory of Human-Centered Design as a theoretical and methodological framework illustrates its potential to foster genuine innovation that prioritizes human values in both technological advancements and public service delivery. By embedding empathy and user feedback at every stage of the process, HCD ensures that solutions are not only efficient but also equitable and meaningful, addressing the evolving expectations of users in an increasingly digital world (Giacomin, 2014; Harte *et al*., 2017).

### 2.2 Applications of HCD in the Telecommunications Sector

Human-Centered Design (HCD) is increasingly shaping the telecommunications sector as companies strive to differentiate themselves within saturated markets. The transition from product-centric models to experience-oriented service delivery necessitates integrating HCD methodologies to enhance innovation and meet the shifting needs of users (Dehmolaee & Rashnavadi, 2019). Companies like Verizon and Vodafone have begun employing design thinking principles to inform product development aimed at enhancing user experiences through comprehensive data collection and ethnographic research, showcasing a dedication to understanding user behaviors (Wang *et al*., 2021). The development of customer-facing applications and smart device interfaces exemplifies these practices; for instance, Vodafone's MyVodafone app was redesigned based on direct user feedback and usability testing, resulting in improved navigation and accessibility features (Khan *et al*., 2016).

The design of onboarding processes and customer support services is another area where HCD plays a vital role, particularly in markets with low digital literacy. Telecommunications companies have embraced HCD to simplify these processes through intuitive visual cues and chatbot interactions, facilitating easier navigation (Dehmolaee & Rashnavadi, 2019). In regions like India and Nigeria, innovations such as USSD-based service models have emerged, catering specifically to users with limited smartphone access. This adaptation is indicative of a profound understanding of the contextual constraints that impact user engagement within these markets, enhancing overall user satisfaction and service accessibility (Onukwulu, Agho & Eyo-Udo, 2021).

HCD's application extends to improving network services through co-creation with users. Telecom providers are increasingly utilizing community feedback platforms designed for customers to report service issues, thus integrating participatory design techniques within their operational frameworks (Abisoye & Akerele, 2021, Oladosu, *et al*., 2021). This strategy fosters a collaborative environment where user inputs contribute to service improvements and quality assurance processes (Wang *et al*., 2021). Such platforms facilitate data driven decisions that inform network engineers, leading to proactive maintenance and optimized resource allocation. These initiatives illustrate HCD's versatility, extending beyond mere interface design to encompass critical functionalities that enhance service delivery (Khan *et al*., 2016).

Moreover, the alliance of HCD with agile methodologies and lean product development practices has further supported the telecommunications sector's innovative trajectory. Agile practices emphasize rapid iterations and user-centric feedback loops, which are essential for aligning product development with user expectations (Oladosu, *et al*., 2021, Olutimehin, *et al*., 2021). For instance, T-Mobile employs real-time feedback mechanisms within their applications to continuously iterate on features based on user ratings and suggestions, demonstrating how HCD complements agile frameworks (Dehmolaee & Rashnavadi, 2019). This synergy helps to facilitate a more responsive design process that capitalizes on user insights to drive service personalization, such as AI-driven packages that adjust according to actual user consumption patterns (Dehmolaee & Rashnavadi, 2019).

Different human-centred design approaches, with different starting points and emphases presented by Steen, 2011, is shown in figure 3.

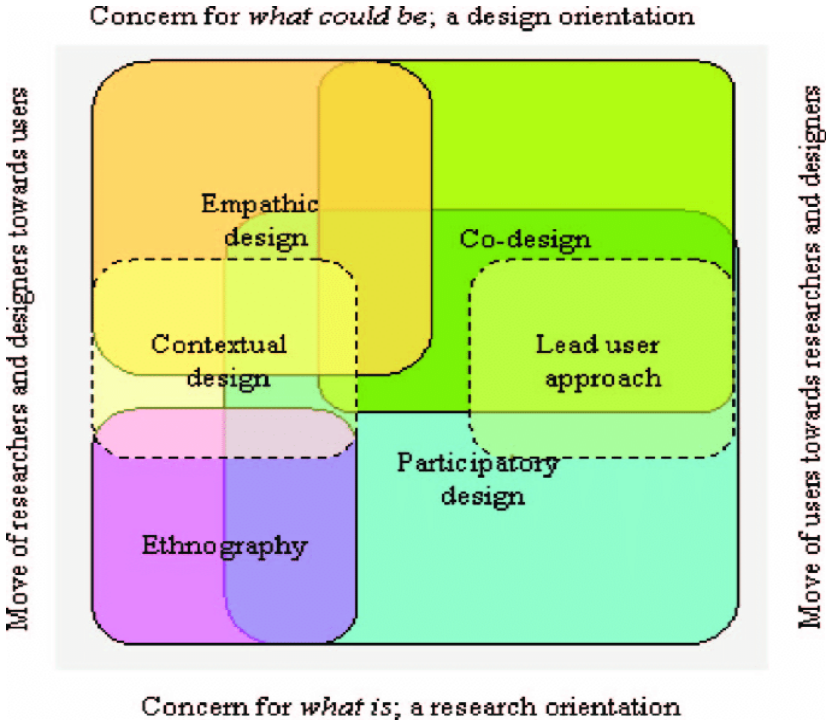


**Fig 3:** Different human-centred design approaches, with different starting points and emphases (Steen, 2011).

Despite significant progress, challenges remain in implementing HCD across telecommunications companies. Organizational silos hinder the necessary cross-functional collaboration required for effective HCD application, slowing decision-making processes and limiting the agility of product development teams (Wang *et al*., 2021). Additionally, some technical departments may prioritize infrastructure development over design-led initiatives, viewing HCD as secondary to their core responsibilities (Vetterli *et al*., 2013). Addressing these cultural and structural barriers necessitates stronger internal advocacy for design practices, as well as initiatives that foster a shared understanding of the importance of user experience across all departments.

Privacy and data governance challenges also affect the depth of user research that can be conducted in the telecommunications field. Compliance with regulations like GDPR requires that user data collection and analysis respect privacy standards and ethical considerations, which can restrict observational studies and limit the extent of user feedback incorporated into design processes (Dehmolaee & Rashnavadi, 2019). Furthermore, tailoring services for diverse markets adds layers of complexity, as companies must balance standardized systems with localized insights to ensure service relevance across various demographics and user abilities (Wang *et al*., 2021). Such challenges underline the importance of adaptive research methodologies and inclusive testing frameworks that consider varying user contexts and needs (Mustapha, Ibitoye & AbdulWahab, 2017).

In summary, the telecommunications sector is increasingly adopting HCD to enhance service innovation and customer experience. From the development of intuitive applications to the integration of user feedback into innovative service models, HCD is at the forefront of shaping a user-centered approach within the industry. However, addressing structural, cultural, and regulatory barriers remains critical to fully realizing the potential benefits of HCD, encouraging telecom companies to create more meaningful and personalized user interactions in an ever-evolving digital landscape (Dehmolaee & Rashnavadi, 2019).

### 2.3 Applications of HCD in the Public Sector

The application of Human-Centered Design (HCD) in public sector service delivery has witnessed a significant uptick as governments strive to enhance accessibility, inclusivity, transparency, and responsiveness in their offerings. Unlike their private sector counterparts, public institutions contend with unique challenges such as bureaucratic inertia, constrained procurement processes, a wide array of user requirements, and intricate policy structures, which necessitate a robust yet adaptable design approach (McGann *et al*., 2018). HCD addresses these complexities by prioritizing the needs and experiences of citizens over internal processes or technological capabilities (Blomkamp, 2018). This systematic review will delve into HCD's relevance, efficiency, and obstacles in public service design, digital governance transformation, and inclusive policy-making (Ajayi & Akerele, 2021, Odio, *et al*., 2021).

HCD has significantly transformed policy design and the development of digital government services. Traditionally, government policies emerged from top-down processes that often sidelined the real experiences of the targeted populations (Blomkamp, 2018). Through HCD, active involvement of citizens, frontline workers, and marginalized demographics in the initial stages of issue identification and solution ideation has been realized (McGann *et al*., 2018: Blomkamp, 2018). For example, the UK's Government Digital Service has woven HCD methodologies into its policy experimental framework, employing tactics such as ethnographic fieldwork and service blueprinting (Ike, *et al*., 2021, Ogunnowo, *et al*., 2021). These approaches have enhanced understanding of user interactions with services like healthcare registration and social welfare, leading to a refinement in policies to better reflect user realities (McGann *et al*., 2018).

Moreover, HCD has revolutionized the design of digital public services. Governments globally have begun to innovate online platforms for service delivery applications for licenses, welfare aids, and benefits. Countries such as Estonia and Denmark have incorporated HCD into their national e-governance strategies, developing centralized platforms that streamline citizen interactions through extensive user testing (Chen *et al*., 2019). In the United States, the U.S. Digital Service has led efforts to identify barriers in legacy systems, creating user-friendly and responsive platforms for various federal services (Chen *et al*., 2019). These initiatives underscore the transformative potential of HCD in making public services more user-centric and effective (Akinade, *et al*., 2021, Babalola, *et al*., 2021, Fredson, *et al*., 2021).

Engagement platforms also serve as a fertile ground for HCD application, enhancing how citizens interact with their governments (Blomkamp, 2018). Initiatives like participatory budgeting and digital town halls have been designed through HCD principles to facilitate user-friendliness and empower citizens in decision-making processes (McGann *et al*., 2018). For instance, Helsinki's participatory budget app utilized user interviews and iterative testing to allow residents to propose and vote on local projects, effectively simplifying complex budgetary matters into accessible interactions for citizens (Blomkamp, 2018). HCD isn't merely about improving service functionality; it aims to foster greater trust, transparency, and inclusivity in governance (Egbuhuzor, *et al*., 2021, Ezeife, *et al*., 2021, Fredson, *et al*., 2021). Van der Bijl-Brouwe, 2016, presented a pattern found through an exploration of the theme 'drive' as shown in figure 4.

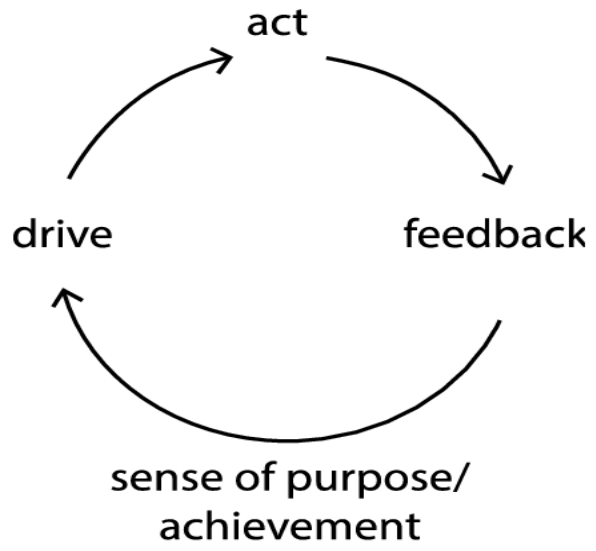


**Fig 4:** A pattern found through an exploration of the theme 'drive' (Van der Bijl-Brouwe, 2016).

However, inclusivity and accessibility remain crucial challenges. HCD practices in public service design must cater to diverse user demographics, including individuals with disabilities and varying digital literacies (McGann *et al*., 2018). Governments moving beyond merely adhering to compliance standards toward creating genuinely inclusive experiences is essential. Such initiatives often include designing adaptive interfaces, multilingual content, and multiple access channels for service delivery (McGann *et al*., 2018). The commitment to user inclusivity is illustrated by initiatives such as those undertaken by the Canadian Digital Service, which incorporates direct feedback from disadvantaged groups to enhance service accessibility (Austin-Gabriel, *et al*., 2021, Balogun, Ogunsola & Ogunmokun, 2021).

Numerous case studies illustrate HCD's effectiveness in public service reformation. For example, Argentina's Ministry of Modernization enhanced its procurement system's transparency through HCD methods. Additionally, India's Aadhaar system refined its registration processes by integrating user insights from various cultural and linguistic backgrounds (McGann *et al*., 2018; Blomkamp, 2018). These examples highlight how HCD can unite various stakeholders in co-creating services that resonate meaningfully with users, demonstrating HCD's capacity for fostering efficiency and compassion in service design (Ibitoye, AbdulWahab & Mustapha, 2017).

Despite its advantages, there are significant barriers to HCD integration within government structures. The hierarchical nature of public institutions, coupled with rigid operational protocols, often conflicts with the iterative and user-focused approach of HCD practices (McGann *et al*., 2018). Procurement policies typically emphasize strict timelines and outcomes, complicating the incorporation of user feedback and iterative design processes (Balogun, Ogunsola & Ogunmokun, 2021). Additionally, inter-agency silos hinder collaborative efforts that are vital for HCD's success, often leaving designers and public servants working in isolation toward fragmented solutions (Blomkamp, 2018).

To address these challenges, adopting a culture that embraces HCD principles is paramount. This requires not merely pilot projects but also solid institutional commitment to integrating design thinking into broader strategic agendas (McGann *et al*., 2018: Blomkamp, 2018). Moreover, the establishment of evaluation frameworks tailored to the unique contexts of public service design can help measure HCD's impact beyond traditional metrics, capturing improvements in equity and user satisfaction as well (Hassan, *et al*., 2021, Hussain, *et al*., 2021). Training public servants in HCD methods and creating designated roles for service designers within public agencies can facilitate these transformations (Bazzano *et al*., 2017; McGann *et al*., 2018).

Ethical considerations and privacy concerns also loom large in HCD applications, especially given the sensitivity of data collected in public sector designs (Blomkamp, 2018). Ensuring user autonomy through informed consent and transparency is critical as governments navigate the complexities of digital services enhanced by data-driven methodologies. HCD principles must incorporate ethical practices to safeguard citizens' rights as digital governance continues to evolve towards personalization and artificial intelligence (Blomkamp, 2018: Ihirwe, *et al*., 2020).

In conclusion, HCD signifies a promising shift in how public services are conceived and delivered. Through policy co-design, digital platform development, and enhanced public engagement, HCD can align government innovation efforts closely with the real needs of citizens (Blomkamp, 2018: Kratzke & Peinl, 2016). However, to leverage its full potential, institutional barriers must be addressed. Embracing HCD isn't merely about a design methodology but represents a profound cultural shift toward empathy, inclusion, and responsiveness in public value creation. By adopting HCD frameworks, governments can not only improve their service delivery but also contribute to building a more democratic

and equitable society (Khorram, Mottu & Sunyé, 2020).

### 2.4 Comparative Analysis

The implementation of Human-Centered Design (HCD) within the telecommunications and public sectors has emerged as a critical approach to foster user-driven innovation. However, comparative analyses of its application reveal significant disparities stemming from sector-specific contexts. Both sectors have progressively embraced HCD to enhance the functionality, accessibility, and emotional resonance of their products and services; however, they diverge in their motivations, execution strategies, and institutional outcomes associated with HCD practices (Bruns, 2021: Ma, *et al*., 2014).

A key similarity lies in the shared emphasis on understanding user needs through empathy-driven research. In telecommunications, ethnographic interviews, persona development, usability testing, and journey mapping are employed extensively to develop customer-centric services such as mobile self-service platforms (Bazzano *et al*., 2017). Likewise, health initiatives leverage HCD techniques, ensuring interventions are contextually relevant through participatory design methods (Harte *et al*., 2017: Pahl, Jamshidi & Zimmermann, 2018). This user-focused approach affirms the importance of addressing user pain points and enables organizations to iteratively refine products based on direct feedback, enhancing overall user satisfaction and experience (Fakoya *et al*., 2021; (Chen *et al*., 2019).

Furthermore, both sectors increasingly adopt a multidisciplinary collaboration model as a fundamental strategy for implementing HCD. In telecommunications, product teams integrate UX designers, engineers, and customer service personnel to align insights with corporate goals (Bruns, 2021; Langham & Paulsen, 2018). Similarly, public sector entities often assemble cross-functional teams that include designers and policy analysts to co-create services, reflecting an understanding that HCD transcends mere design and necessitates diverse perspectives to flourish (Bruns, 2021: Sahay, *et al*., 2020). This collaborative framework underscores a broader recognition that HCD is a strategic approach essential for addressing complex and varied user needs across sectors.

Despite these converging methodologies, notable differences distinguish the application of HCD in telecommunications and public services. In the competitive landscape of telecommunications, HCD is driven by market forces that prioritize customer loyalty and profitability, facilitating rapid iterations and agile testing frameworks. The competitive nature of the sector supports fast-paced experimentation often needed in HCD, resulting in a nimble application of design principles. Conversely, the public sector faces procedural rigidity that can hinder iterative design and quick adaptations (Bayat *et al*., 2018: Sanchís, *et al*., 2019). Public institutions are typically motivated by the quest to enhance public value and address social equity, making their approach to HCD more conservative compared to the agile practices seen in telecommunications.

Success drivers also markedly differ across these sectors. Telecommunications companies benefit from real-time access to significant volumes of user data and advanced analytics. This wealth of information allows for swift design adjustments based on emerging user patterns. In contrast, successful HCD in the public sector often relies on political championing and external advocacy for user-centered reforms (Amankwah-Amoah, Boso & Debrah, 2018). Political will can greatly influence the adoption of HCD initiatives, particularly in times of increased public demand for transparency and inclusivity, such as during the COVID-19 pandemic (Chen *et al*., 2019). The call for equitable digital access has catalyzed a reevaluation of service design within the public sector, pushing for empathetic and responsive approaches (Ampaire, *et al*., 2019).

Shared enablers, like the integration of HCD into agile workflows and active stakeholder engagement, play crucial roles in enhancing the efficacy of HCD across both sectors (Bruns, 2021; Langham & Paulsen, 2018). Both fields benefit from frameworks that enable rapid feedback and quick adaptations, whether through design sprints, participatory workshops, or co-design sessions with diverse stakeholder groups (Chen *et al*., 2019). However, while telecom companies may have more financial agility to innovate, resource constraints significantly challenge public institutions, impacting the scope and depth of user research and the ongoing application of HCD methodologies (Antonio & Tuffley, 2014: Bayat *et al*., 2018).

In summary, while the telecommunications and public sectors exhibit a convergence in adopting HCD principles aimed at enhancing user experiences, the context of application reveals significant variations in motivations, execution strategies, and institutional hurdles. These insights underscore the importance of understanding sector-specific dynamics in leveraging HCD for sustainable innovation in complex systems, thus allowing practitioners to bridge the gap between intention and actual impact (Asongu, 2012).

### 2.5 Emerging Trends and Innovations

The field of Human-Centered Design (HCD) is significantly evolving in response to rapid advancements in technology and increasing emphasis on ethical considerations within both the telecommunications and public sectors. The integration of emerging technologies, particularly artificial intelligence (AI), the Internet of Things (IoT), and big data analytics, is reshaping the frameworks through which services and products are designed and delivered (Asongu & Odhiambo, 2019).

The telecommunications sector is experiencing a transformation driven by HCD practices that leverage AI and big data analytics. Companies are now collecting extensive user data, including browsing habits, call logs, and geolocation information. Such data not only informs product innovation but also personalizes customer engagement through predictive analytics. AI algorithms can forecast user needs and optimize service delivery, emphasizing the importance of aligning these technologies with user expectations through rigorous user research and usability testing (Beck & Cull, 2015). This alignment ensures that technological advancements do not alienate users but instead enhance their experiences (Arnold *et al*., 2021). As companies explore IoT applications, HCD plays a crucial role in ensuring that devices are designed to be user-friendly and responsive to varying user contexts, ensuring seamless interactions within smart environments (Beck, Senbet & Simbanegavi, 2014: Kaur, 2021).

In the public sector, the deployment of AI and big data analytics is increasingly facilitating improved governmental services. Predictive analytics is utilized to identify at-risk populations in public health contexts, while machine learning aids in optimizing urban systems such as traffic flow

(Blackden, *et al*., 2007: Iio *et al*., 2021). However, without HCD principles guiding these technological implementations, there exists a risk of creating systems that are opaque and potentially discriminatory. Therefore, transparency, user education, and ethical considerations are paramount to foster trust in these automated systems. Design teams must navigate the ethical landscape carefully, ensuring that the incorporation of AI within public services addresses real-world needs and remains accessible and inclusive (Burns, 2018).

The growing recognition of systemic design approaches marks a shift from traditional isolated user-centric interventions to a more holistic view that acknowledges the interconnectedness of various components within service ecosystems. This transition is vital, particularly in the public sector where societal challenges often necessitate collaborative and interdisciplinary strategies (Chataway, Hanlin & Kaplinsky, 2014). Systemic design frameworks facilitate a comprehensive understanding of the interplay between technology, policies, and user experiences, allowing designers to visualize interactions among stakeholders and processes effectively. Such systems thinking not only assists in identifying leverage points for systemic improvements but also enhances the resilience and adaptability of designed services to future challenges (Chavula & Chekol, 2013: Lauff *et al*., 2021).

Ethical questions surrounding data privacy and inclusive practices have gained prominence amidst these technological advancements. As designers gain access to extensive user data, they must prioritize ethical data practices, including obtaining informed consent and ensuring anonymization of sensitive information (Cleeve & Yiheyis, 2014: Iio *et al*., 2021). Addressing the digital divide remains crucial as innovations may unintentionally exclude marginalized groups; thus, HCD can facilitate co-design processes that involve underserved communities, ensuring solutions are tailored to meet their specific needs (Costa *et al*., 2019). For instance, multilingual support and offline functionality are examples of design considerations that can enhance access for non-literate or technologically inexperienced users (Buchanan, 2019).

As organizations increasingly adopt frameworks for responsible innovation, the integration of ethical foresight elements into the HCD process has become essential. This evolution of HCD underscores the importance of reflecting on the societal implications of design choices, considering the values that should steer technology development, and ensuring inclusivity in stakeholder representation ("Entangling Corporate Innovation, Systems Thinking and Design Thinking", 2021). Such a reflective approach is vital in harmonizing the interplay between service efficiency, user empowerment, and ethical responsibility, ultimately leading to designs that foster equity and social justice (Crossan, McKelvey & Curran, 2018: Varianytsia, 2020).

In conclusion, the landscape of Human-Centered Design is significantly transforming as it engages with advanced technologies, ethical considerations, and systems thinking methodologies. The evolving role of HCD is evident in both the telecommunications and public sectors, where it prominently features in strategic decision-making and policy formulation. While the potential for innovation is vast, designers face emerging responsibilities to uphold ethical standards and promote stakeholder inclusivity (Edo, Okodua & Odebiyi, 2019). The future of HCD will hinge on its capability to navigate this evolving complexity while fostering human values and collective well-being within a rapidly changing digital landscape.

### 2.6. Conceptual Framework: Human-Centered Design (HCD) Approach

Human-Centered Design (HCD) is an iterative, user-first approach to problem-solving and innovation that places the **needs, experiences, and aspirations of people** at the center of the design process. It is not just a process or methodology—it is a mindset that empowers inclusive innovation and sustainable impact.

#### 2.6.1. Core Principles of Human-Centered Design

At the heart of HCD are four interdependent principles that serve as ethical and functional pillars for any design intended to be human-centered: empathy, co-creation

Empathy in HCD is the ability to immerse oneself in the user's world—understanding not just what they do, but how they feel, what they value, and what constraints shape their decisions.

The Application involves conducting ethnographic research, shadowing users, holding in-depth interviews. According to a 2023 McKinsey report, companies that apply empathy-driven design are three times more likely to outperform peers in customer satisfaction and loyalty. Empathy ensures that solutions are not based on assumptions, but on real human needs and experiences.

On the other hand Co-creation involves actively engaging users, stakeholders, and interdisciplinary experts in the design process to generate collective insight and ownership. It is used in design sprints, collaborative prototyping sessions, participatory workshops. A study by IDEO and the Design Management Institute found that co-designed solutions are 50% more likely to be adopted long-term by target communities. Encourages diverse perspectives, fosters inclusion, and leads to more contextually relevant and accepted solutions.

Iteration refers to the cyclical process of prototyping, testing, learning, and refining ideas before full-scale implementation. It is used in rapid prototyping, agile development, user feedback loops. Research from Stanford d.school shows that iterative testing improves usability scores by an average of 55% over non-iterative processes. Reduces design risk, increases functionality, and enables flexible adaptation to changing user needs.

Sustainability in HCD means designing for long-term relevance, environmental responsibility, cultural sensitivity, and equity. Lifecycle analysis, inclusive design, designing for scalability and maintenance. The UNDP reports that human-centered design in sustainability initiatives has improved community adoption rates by over 60% in low-resource settings. Ensures that solutions are not only effective in the short term but also resilient, inclusive, and scalable over time.

These four principles do not operate in isolation. Instead, they form an interlocking framework where each principle reinforces the other; empathy informs co-creation by identifying who should be involved and why. Co-creation feeds into iteration by generating diverse ideas worth testing. Iteration strengthens sustainability by refining ideas into adaptable, robust solutions. Sustainability reinforces empathy by ensuring ongoing relevance to human and ecological systems.

The Design Management Institute found that design-led

companies outperform the S&P 500 by 211% over 10 years, illustrating the business value of HCD. In government innovation labs (e.g., the U.S. Digital Service), human-centered design has reduced citizen complaints by more than 30% and improved service delivery. Human-centered design is now a core methodology used by organizations like UNICEF, WHO, and Gates Foundation for solving complex social and healthcare challenges.

**2.6.2. Framework Phases:** these are split into five phases as outlined below.

**Phase 1: Discover (Empathize & Define).** The objective is to understand user needs, challenges, and environments. The key activities involves User interviews, Ethnographic research, Journey mapping. The output is user personas, problem statements

**Phase 2: Ideate.** The objective is to generate user-informed design solutions. The Key Activities involves Brainstorming workshops, Co-creation sessions, Design sprints, The Output are Solution concepts, storyboards.

**Phase 3: Prototype.** The Objective is to develop low- to high-fidelity representations of the solution. The Key Activities involve Sketching and wireframing, Interface mockups, Physical or digital prototyping. The Output is Functional prototypes for user testing

**Phase 4: Test.** The objective is to validate the usability and desirability of solutions. The Key Activities involves usability testing, A/B testing, Feedback analysis. The Output is Iterated prototypes, validation data.

**Phase 5: Implement.** The objective is to deploy refined solution in real contexts. The **Key** Activities is Pilot programs, Training and onboarding, Monitoring and evaluation. The Output is fully integrated solution with user support systems

**2.6.3. Feedback Loops:** After every phase, insights are looped back to the previous stage. Allows for continuous learning, adaptability, and optimization.

**2.6.4. Stakeholder Integration: T**he Primary End-users directly impacted by the design. The Secondary Stakeholders are Institutions, communities, implementers. Engagement across all phases ensures inclusivity and alignment with real-world constraints.

**2.6.5. Ethical and Cultural Considerations. This involves r**especting local contexts and social norms. Ensure accessibility and equity. Address potential unintended consequences.

The visual representation of the conceptual model is shown in figure 5.

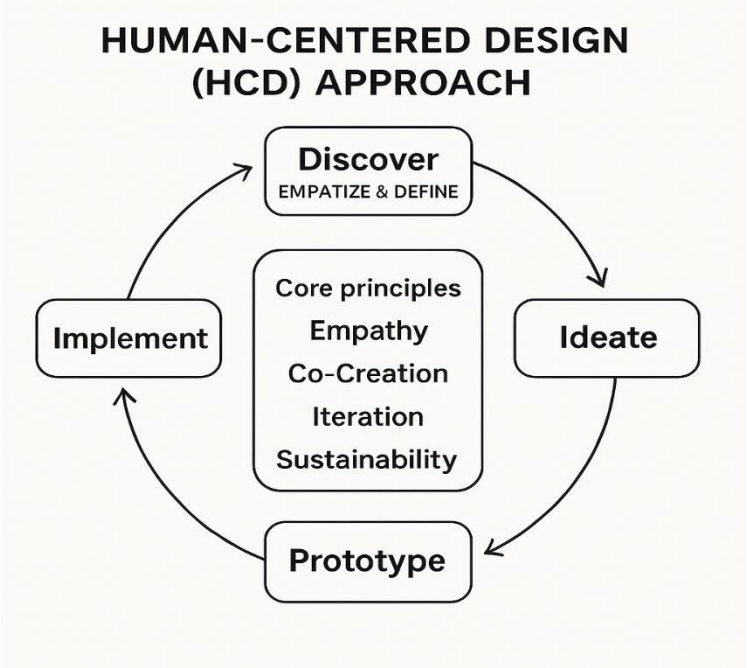


**Fig 5:** The schematic representation of the developed model

## 3. Discussion

The systematic review of Human-Centered Design (HCD) approaches within the telecommunications and public sectors illuminates the evolving significance of HCD in driving digital innovation. This review highlights various practices, outcomes, and challenges associated with employing HCD in these sectors, emphasizing its role as a strategic enabler for user-driven innovation (George, McGahan & Prabhu, 2012, Ikolo, 2013). Historically, HCD transcended its origins in creative design methodology to become a robust framework for fostering inclusive, adaptive services. Embracing HCD principles has been noted in both sectors, albeit in varying extents, providing rich lessons on embedding user-centricity in organizational practices.

The telecommunications sector has notably adopted HCD particularly to enhance customer satisfaction, loyalty, and competitiveness. Companies in this field leverage HCD tools to discern user behaviors, preferences, and pain points, subsequently translating these insights into iterative product development processes especially within mobile applications and customer support systems (Catalani *et al*., 2014; Kim *et al*., 2019). The rapid nature of telecommunications innovation, coupled with access to real-time user data, empowers firms to engage in accelerated prototyping and testing of HCD-driven products (Bazzano *et al*., 2017). Conversely, the public sector's engagement with HCD is

primarily driven by the goals of enhancing service delivery, fostering equity, and increasing trust in government systems (Iyawa, *et al*., 2020, Mannell, 2014). Initiatives within this sector focus on ensuring that technological solutions are grounded in social and cultural contexts, engaging citizens in policy design, thereby reaffirming equity and accessibility (Cao *et al*., 2015; Bazzano *et al*., 2017).

Despite contextual divergences, both sectors exhibit common barriers and facilitators when implementing HCD methodologies. Studies have identified key enablers such as supportive organizational culture, leadership commitment, and cross-functional collaboration as critical to successful HCD implementation (Chen *et al*., 2019; Bazzano *et al*., 2017). Conversely, obstacles like resistance to change, limited design capacities, and siloed operations can hinder the effective adoption of HCD approaches (Catalani *et al*., 2014; Kim *et al*., 2019). This convergence indicates a universal necessity for structural and cultural transformations to deepen the incorporation of HCD within institutional frameworks (Kiptot & Franzel, 2011, Martin & Barnard, 2013).

Furthermore, the synthesis underscores a growing trend of integrating HCD with cutting-edge technologies such as artificial intelligence (AI), big data, and the Internet of Things (IoT). This integration not only redefines the scope of service delivery (Kim *et al*., 2019; Bazzano *et al*., 2017) but also presents ethical considerations surrounding data privacy, algorithmic bias, and the digital divide underscoring HCD's role as a governance tool that shapes human-technology interactions (Bazzano *et al*., 2017: Klamroth-Marganska *et al*., 2021). Consequently, HCD evolves from a problem-solving technique to a value-driven framework crucial for ethical design practices (Catalani *et al*., 2014; ,Cao *et al*., 2015).

In terms of policy implications, embracing HCD requires a paradigm shift from perceiving it merely as a technical enhancement to recognizing it as a transformative approach to service development. For effective institutionalization of HCD, it is essential that policies enable agile procurement and flexible funding for iterative projects while formally acknowledging design expertise within organizational structures (Catalani *et al*., 2014). In the telecommunications sector, there is a pressing need to integrate HCD strategically within innovation processes, aligning performance indicators with user satisfaction (Chen *et al*., 2019; Bazzano *et al*., 2017).

In the public sector, fostering a culture of co-creation, characterized by ongoing dialogue with citizens, emerges as a vital component of successful HCD engagement. Governments that embed HCD principles through formal design standards and user testing protocols are better poised to deliver responsive and equitable public services. To maintain momentum in HCD efforts across both sectors, investment in training and capacity building, particularly for non-design employees, is essential (Milek, Stork & Gillwald, 2011, Ndemo & Weiss, 2017). This democratization of design thinking can foster a culture of empathy, iterative development, and collaboration that influences all organizational levels (Cao *et al*., 2015; Bazzano *et al*., 2017).

In summary, the findings from the systematic review affirm that HCD, when effectively applied and supported by organizational cultures, has the potential to fundamentally reshape both how services are conceived and how organizations operate. The insights derived from the review provide a solid foundation for future inquiry and policy formulations aimed at embedding HCD as a cornerstone of innovation in the digital age (Paunov, 2013, Rivera-Santos, *et al*., 2015)

## 4. Conclusion and Future Research

This systematic review has explored the implementation and impact of Human-Centered Design (HCD) across the telecommunications and public sectors, revealing a shared aspiration toward more user-responsive, inclusive, and effective service innovation. Despite the differences in sectoral goals commercial growth and competitiveness in telecommunications, versus equity and public value in the public sector the findings show a growing convergence in how both sectors adopt and adapt HCD methodologies. Key insights include the increasing institutionalization of HCD practices, the integration of HCD with emerging technologies such as AI and big data, and a shift from isolated user experiences toward systems-thinking and ecosystem-wide innovation. The review also found that successful HCD outcomes are strongly correlated with cross-functional collaboration, leadership support, and ethical commitment, while structural constraints such as organizational silos, rigid procurement models, and capacity deficits remain significant challenges.

The review contributes meaningfully to the broader discourse on design and innovation by offering a conceptual framework for cross-sectoral HCD implementation. This model emphasizes iterative development, ethical governance, and systems-level integration as foundational elements for sustainable human-centered innovation. Additionally, the review outlines guidelines for institutionalizing HCD through leadership alignment, capacity building, operational integration, performance measurement, and culture change. These recommendations are supported by empirical evidence from diverse geographies and contexts, making them adaptable to both global and local applications.

However, the review is not without limitations. First, while it synthesized literature and case studies from 2013 to 2021, there remains a degree of publication bias toward high-profile or well-documented initiatives, potentially underrepresenting grassroots or informal HCD practices, especially in low- and middle-income regions. Second, the scope of the review, though comprehensive, was limited by language and access restrictions, with a majority of sources published in English and within specific databases. Third, the comparative nature of the analysis, while insightful, may overlook deeper sectoral nuances that a more targeted, domain-specific review could uncover. Lastly, the evaluation of impact in many cases remains qualitative or anecdotal, underscoring the need for more robust, quantifiable metrics to assess the effectiveness of HCD across varying contexts.

Looking forward, future research should address these limitations by expanding geographic and linguistic inclusivity, incorporating longitudinal studies, and developing rigorous evaluation tools that capture both short-term user satisfaction and long-term systemic impact. There is also a need to explore the intersection of HCD with regulatory design, organizational transformation, and emergent digital ethics frameworks. Comparative case studies that analyze how different governance models or corporate structures enable or hinder HCD would provide further insight into institutional dynamics. Additionally, interdisciplinary research that bridges design, public policy, computer science, and sociology can offer a more holistic understanding of how HCD can evolve to meet the demands of increasingly complex digital ecosystems.

For practitioners, the findings suggest a clear imperative to

move beyond surface-level user engagement toward embedding HCD as a core strategic capability. This means shifting from project-based applications to organization-wide integration, supported by leadership, training, and design-oriented performance indicators. Telecom firms and government agencies alike are encouraged to adopt inclusive design practices that reflect the diversity of their user base and to institutionalize feedback mechanisms that promote ongoing refinement and responsiveness.

In conclusion, Human-Centered Design continues to demonstrate significant potential as a unifying framework for innovation in both telecommunications and public services. Its emphasis on empathy, inclusivity, and adaptability aligns with the core needs of twenty-first-century institutions namely, the ability to serve diverse populations effectively while remaining flexible and future-ready. As digital transformation accelerates and societal challenges grow more complex, HCD offers a valuable compass for navigating innovation that is not only efficient but also ethical, equitable, and human-focused. The future of HCD lies in its capacity to evolve, adapt, and scale across sectors and systems fueling a new era of design-led transformation.

## 5. Reference


1. Abisoye A, Akerele JI. High-Impact Data-Driven Decision-Making Model for Integrating Cutting-Edge Cybersecurity Strategies into Public Policy, Governance, and Organizational Frameworks. 2021.
2. Adebusayo AC, Adepoju HA, Austin B, Oladimeji H. A conceptual model for centralized data platforms to enhance decision-making and optimize cross-functional collaboration. Open Access Res J Sci Technol. 2021;2(1):23-40.
3. Adepoju PA, Akinade AO, Ige AB, Afolabi AI. A conceptual model for network security automation: Leveraging AI-driven frameworks to enhance multi-vendor infrastructure resilience. Int J Sci Technol Res Arch. 2021;1(1):39-59. doi:10.53771/ijstra.2021.1.1.0034.
4. Ajayi A, Akerele JI. A high-impact data-driven decision-making model for integrating cutting-edge cybersecurity strategies into public policy, governance, and organizational frameworks. Int J Multidiscip Res Growth Eval. 2021;2(1):623-37.
5. Akinade AO, Adepoju PA, Ige AB, Afolabi AI, Amoo OO. A conceptual model for network security automation: Leveraging ai-driven frameworks to enhance multi-vendor infrastructure resilience. 2021.
6. Altman M, Huang T, Breland J. Design thinking in health care. Prev Chronic Dis. 2018;15:E117. doi:10.5888/pcd15.180128.
7. Amankwah-Amoah J, Boso N, Debrah YA. Africa rising in an emerging world: an international marketing perspective. Int Mark Rev. 2018;35(4):550-9. doi:10.1108/IMR-02-2017-0030.
8. Ampaire EL, Acosta M, Huyer S, *et al*. Gender in climate change, agriculture, and natural resource policies: insights from east africa. Clim Change. 2019;158(1):43-60. doi:10.1007/s10584-019-02447-0.
9. Antonio A, Tuffley D. The gender digital divide in developing countries. Future Internet. 2014;6(4):673-87. doi:10.3390/fi6040673.
10. Arnold T, Fuller H, Wood S. Mapping usability heuristics to medical ethical principles in clinical decision support design. Proc Int Symp Hum Factors Ergon Health Care. 2021;10(1):54-8. doi:10.1177/2327857921101024.
11. Asongu SA. How has mobile phone penetration stimulated financial development in africa? SSRN Electron J. 2012. doi:10.2139/ssrn.2493265.
12. Asongu SA, Odhiambo NM. How enhancing gender inclusion affects inequality: thresholds of complementary policies for sustainable development. Sustain Dev. 2019;28(1):132-42. doi:10.1002/sd.1977.
13. Austin-Gabriel B, Hussain NY, Ige AB, Adepoju PA, Amoo OO, Afolabi AI. Advancing zero trust architecture with AI and data science for enterprise cybersecurity frameworks. Open Access Res J Eng Technol. 2021;1(1):47-55.
14. Babalola FI, Kokogho E, Odio PE, Adeyanju MO, Sikhakhane-Nwokediegwu Z. The evolution of corporate governance frameworks: Conceptual models for enhancing financial performance. Int J Multidiscip Res Growth Eval. 2021;1(1):589-96. doi:10.54660/.IJMRGE.2021.2.1-589-596.
15. Balogun ED, Ogunsola KO, Ogunmokun AS. A risk intelligence framework for detecting and preventing financial fraud in digital marketplaces. IRE J. 2021;4(8):134-40. Available from: https://irejournals.com/paper-details/1702600.
16. Bayat P, Lesage D, Cole R. Low-energy collision-induced dissociation (low-energy cid), collision-induced dissociation (cid), and higher energy collision dissociation (hcd) mass spectrometry for structural elucidation of saccharides and clarification of their dissolution mechanism in dmac/licl. J Mass Spectrom. 2018;53(8):705-16. doi:10.1002/jms.4205.
17. Bazzano AN, Martin J, Hicks E, Faughnan M, Murphy L. Human-centred design in global health: a scoping review of applications and contexts. PLoS One. 2017;12(11):e0186744. doi:10.1371/journal.pone.0186744.
18. Beck T, Cull R. Banking in africa. In: Oxford Handbook of Banking. 2015:913-37. doi:10.1093/oxfordhb/9780199688500.013.0037.
19. Beck T, Senbet L, Simbanegavi W. Financial inclusion and innovation in africa: an overview. J Afr Econ. 2014;24(Suppl 1):i3-i11. doi:10.1093/jae/eju031.
20. Bender D, Sartipi K. HL7 FHIR: an agile and restful approach to healthcare information exchange. Proc CBMS. 2013:326-31. doi:10.1109/CBMS.2013.6627810.
21. Blackden CM, Canagarajah S, Klasen S, Lawson D. Gender and growth in sub-saharan africa: issues and evidence. In: Gender Inequality and Growth. 2007:349-70. doi:10.1057/9780230801462_19.
22. Blomkamp E. The promise of co-design for public policy. Aust J Public Adm. 2018;77(4):729-43. doi:10.1111/1467-8500.12310.
23. Bruns C. Using human-centered design to develop a program to engage south african men living with hiv in care and treatment. Glob Health Sci Pract. 2021;9(Suppl 2):S234-S243. doi:10.9745/GHSP-D-21-00239.
24. Buchanan R. Systems thinking and design thinking: the search for principles in the world we are making. She Ji. 2019;5(2):85-104. doi:10.1016/j.sheji.2019.04.001.
25. Burns S. M-Pesa and the 'market-led' approach to financial inclusion. Econ Aff. 2018;38(3):406-21. doi:10.1111/ecaf.12321.
26. Burton J, Patel D, Landry G, Anderson SM, Rary E. Failure of the "Gold Standard": the role of a mixed methods research toolkit and human-centered design in

transformative WASH. Environ Health Insights. 2021;15:11786302211018391.
27. Cao M, Theus S, Straub K, *et al*. AAV2/8-humanFOXP3 gene therapy shows robust anti-atherosclerosis efficacy in LDLR-KO mice on high cholesterol diet. J Transl Med. 2015;13(1):1-13. doi:10.1186/s12967-015-0597-7.
28. Catalani C, Green E, Owiti P, *et al*. A clinical decision support system for integrating tuberculosis and hiv care in kenya: a human-centered design approach. PLoS One. 2014;9(8):e103205. doi:10.1371/journal.pone.0103205.
29. Chataway J, Hanlin R, Kaplinsky R. Inclusive innovation: an architecture for policy development. Innov Dev. 2014;4(1):33-54. doi:10.1080/2157930X.2013.876800.
30. Chatzoglou P, Chatzoudes D, Kipraios N. The impact of ISO 9000 certification on firms' financial performance. Int J Oper Prod Manag. 2015;35(1):145-74. doi:10.1108/IJOPM-07-2012-0387.
31. Chavula HK, Chekol A. ICT policy development process in africa. In: Digital Literacy. 2013:257-83. doi:10.4018/978-1-4666-3607-1.ch017.
32. Chen A, Huang H. Analysis approach of user centered innovation for call center services in telecommunication. Int J Innov Educ Res. 2016;4(12):190-6. doi:10.31686/ijier.vol4.iss12.74.
33. Chen E, Leos C, Kowitt S, Moracco K. Enhancing community-based participatory research through human-centered design strategies. Health Promot Pract. 2019;21(1):37-48. doi:10.1177/1524839919850557.
34. Cleeve E, Yiheyis Z. Mobile telephony and economic growth in africa. Thunderbird Int Bus Rev. 2014;56(6):547-62. doi:10.1002/tie.21643.
35. Costa J, Diehl J, Snelders D. A framework for a systems design approach to complex societal problems. Des Sci. 2019;5:e8. doi:10.1017/dsj.2018.16.
36. Craig T, Zhao Y. Organizational redesign through digital transformation: a case study in the life science industry. INCOSE Int Symp. 2021;31(1):1229-40. doi:10.1002/j.2334-5837.2021.00897.x.
37. Crossan A, McKelvey N, Curran K. Mobile technologies impact on economic development in sub-saharan africa. In: Encyclopedia of Information Science and Technology. 2018:6216-22. doi:10.4018/978-1-5225-2255-3.ch540.
38. Dehmolaee S, Rashnavadi Y. Strategic agility in telecom industry: the effective factors on competitive advantages. Middle East J Manag. 2019;6(1):1-18. doi:10.1504/MEJM.2019.10016558.
39. Edo S, Okodua H, Odebiyi J. Internet adoption and financial development in sub-saharan africa: evidence from nigeria and kenya. Afr Dev Rev. 2019;31(1):144-60. doi:10.1111/1467-8268.12370.
40. Egbuhuzor NS, Ajayi AJ, Akhigbe EE, Agbede OO, Ewim CP, Ajiga DI. Cloud-based CRM systems: Revolutionizing customer engagement in the financial sector with artificial intelligence. Int J Sci Res Arch. 2021;3(1):215-34. doi:10.30574/ijsra.2021.3.1.0111.
41. Elu JU. Gender and science education in sub-saharan africa. J Afr Dev. 2018;20(2):105-10. doi:10.5325/jafrideve.20.2.0105.
42. Ezeife E, Kokogho E, Odio PE, Adeyanju MO. The future of tax technology in the United States: A conceptual framework for AI-driven tax transformation. Int J Multidiscip Res Growth Eval. 2021;2(1):542-51. doi:10.54660/.IJMRGE.2021.2.1.542-551.
43. Fakoya I, Cole C, Larkin C, *et al*. Enhancing human-centered design with youth-led participatory action research approaches for adolescent sexual and reproductive health programming. Health Promot Pract. 2021;23(1):25-31. doi:10.1177/15248399211003544.
44. Foster C, Heeks R. Analyzing policy for inclusive innovation: the mobile sector and base-of-the-pyramid markets in kenya. Innov Dev. 2013;3(1):103-19. doi:10.1080/2157930X.2013.764628.
45. Foster C, Heeks R. Conceptualising inclusive innovation: modifying systems of innovation frameworks to understand diffusion of new technology to low-income consumers. Eur J Dev Res. 2013;25(3):333-55. doi:10.1057/ejdr.2013.7.
46. Foster C, Heeks R. Nurturing user-producer interaction: inclusive innovation flows in a low-income mobile phone market. Innov Dev. 2014;4(2):221-37. doi:10.1080/2157930X.2014.921353.
47. Fredson G, Adebisi B, Ayorinde OB, *et al*. Driving Organizational Transformation: Leadership in ERP Implementation and Lessons from the Oil and Gas Sector. Int J Multidiscip Res Growth Eval. 2021. doi:10.54660/IJMRGE.2021.2.1.508-520.
48. Fredson G, Adebisi B, Ayorinde OB, *et al*. Revolutionizing Procurement Management in the Oil and Gas Industry: Innovative Strategies and Insights from High-Value Projects. Int J Multidiscip Res Growth Eval. 2021. doi:10.54660/IJMRGE.2021.2.1.521-533.
49. Friederici N, Wahome M, Graham M. Digital entrepreneurship in africa. MIT Press; 2020. doi:10.7551/mitpress/12453.001.0001.
50. Fuglie K, Rada N. Resources, policies, and agricultural productivity in sub-saharan africa. SSRN Electron J. 2013. doi:10.2139/ssrn.2266459.
51. Gachie W, Govender D. Innovation policy and governance in the african region. Int Bus Econ Res J. 2017;16(2):119-30. doi:10.19030/iber.v16i2.9926.
52. Ganle JK, Otupiri E, Obeng B, *et al*. Challenges women with disability face in accessing and using maternal healthcare services in ghana: a qualitative study. PLoS One. 2016;11(6):e0158361. doi:10.1371/journal.pone.0158361.
53. Gapsiso N, Jibrin R. Women and nigerian ict policy. In: Gender and Diversity. 2016:260-72. doi:10.4018/978-1-4666-9773-7.ch014.
54. George G, McGahan AM, Prabhu J. Innovation for inclusive growth: towards a theoretical framework and a research agenda. J Manag Stud. 2012;49(4):661-83. doi:10.1111/j.1467-6486.2012.01048.x.
55. Giacomin J. What is human centred design? Des J. 2014;17(4):606-23. doi:10.2752/175630614X14056185480186.
56. González C, García-Holgado A, García-Peñalvo F. Strategies to introduce gender perspective in engineering studies: a proposal based on self-diagnosis. Proc EDUCON. 2020:1884-90. doi:10.1109/EDUCON45650.2020.9125289.
57. Göttgens I, Oertelt-Prigione S. The application of human-centered design approaches in health research and innovation: a narrative review of current practices. JMIR Mhealth Uhealth. 2021;9(12):e28102. doi:10.2196/28102.
58. Hammerschlag Z, Bick G, Luiz J. The internationalization of african fintech firms: marketing strategies for successful intra-africa expansion. Int Mark Rev. 2020;37(2):299-317. doi:10.1108/IMR-05-2019-0130.

59. Hankivsky O, Grace D, Hunting G, *et al*. An intersectionality-based policy analysis framework: critical reflections on a methodology for advancing equity. Int J Equity Health. 2014;13(1):1-16. doi:10.1186/s12939-014-0119-x.
60. Hart T, Booyens I, Sinyolo S. Innovation for development in south africa: experiences with basic service technologies in distressed municipalities. Forum Dev Stud. 2019;47(1):23-47. doi:10.1080/08039410.2019.1654543.
61. Harte R, Glynn L, Rodríguez-Molinero A, *et al*. A human-centered design methodology to enhance the usability, human factors, and user experience of connected health systems: a three-phase methodology. JMIR Hum Factors. 2017;4(1):e8. doi:10.2196/humanfactors.5443.
62. Hassan YG, Collins A, Babatunde GO, Alabi AA, Mustapha SD. AI-driven intrusion detection and threat modeling to prevent unauthorized access in smart manufacturing networks. Artif Intell. 2021;16.
63. Heeks R, Amalia M, Kintu R, Shah N. Inclusive innovation: definition, conceptualisation and future research priorities. SSRN Electron J. 2013. doi:10.2139/ssrn.3438439.
64. Heeks R, Foster C, Nugroho Y. New models of inclusive innovation for development. Innov Dev. 2014;4(2):175-85. doi:10.1080/2157930X.2014.928982.
65. Heeks R, Foster C, Nugroho Y. New models of inclusive innovation for development. Routledge; 2017. doi:10.4324/9781315673479.
66. Holeman I, Kane D. Human-centered design for global health equity. Inf Technol Dev. 2019;26(3):477-505. doi:10.1080/02681102.2019.1667289.
67. Hussain NY, Austin-Gabriel B, Ige AB, Adepoju PA, Amoo OO, Afolabi AI. AI-driven predictive analytics for proactive security and optimization in critical infrastructure systems. Open Access Res J Sci Technol. 2021;2(2):6-15. doi:10.53022/oarjst.2021.2.2.0059.
68. Ibitoye BA, AbdulWahab R, Mustapha SD. Estimation of Drivers' Critical Gap Acceptance and Follow-up Time at Four-Legged Unsignalized Intersection. 2017.
69. Igun S. Gender and national information and communication technology (ict) policies in africa. Int J ICT Res Dev Afr. 2010;1(4):46-58. doi:10.4018/978-1-61520-847-0.ch013.
70. Ihirwe F, Ruscio D, Mazzini S, Pierini P, Pierantonio A. Low-code engineering for internet of things. Proc MODELS. 2020. doi:10.1145/3417990.3420208.
71. Iio J, Hasegawa A, Iizuka S, Hayakawa S, Tsujioka H. Ethics in human-centered design. In: Human-Centered Design. 2021:161-70. doi:10.1007/978-3-030-78462-1_12.
72. Ike CC, Ige AB, Oladosu SA, Adepoju PA, Amoo OO, Afolabi AI. Redefining zero trust architecture in cloud networks: A conceptual shift towards granular, dynamic access control and policy enforcement. Magna Sci Adv Res Rev. 2021;2(1):74-86. doi:10.30574/msarr.2021.2.1.0032.
73. Ikolo V. Gender digital divide and national ict policies in africa. In: Gender and Diversity. 2013:812-32. doi:10.4018/978-1-4666-1852-7.ch042.
74. Ismyrlis V, Moschidis O. The effects of ISO 9001 certification on the performance of greek companies. TQM J. 2015;27(1):150-62. doi:10.1108/TQM-07-2013-0091.
75. Iyawa GE, Hamunyela S, Peters A, *et al*. Digital transformation and global health in africa. In: Digital Transformation in Healthcare. 2020:1-32. doi:10.1007/978-3-030-05325-3_6-1.
76. Kaur M. Systemic design in the australian taxation office – current practice and opportunities. Aust J Public Adm. 2021;80(4):1017-31. doi:10.1111/1467-8500.12516.
77. Khan A, Majeed S, Shabbir R. Designing a customer retention framework for telecommunication sector. Inf Manag Bus Rev. 2016;8(5):48-60. doi:10.22610/IMBR.v8i5.1459.
78. Khorram F, Mottu JM, Sunyé G. Challenges & opportunities in low-code testing. Proc MODELS. 2020. doi:10.1145/3417990.3420204.
79. Kim D, Kumar V, Kumar U. A performance realization framework for implementing ISO 9000. Int J Qual Reliab Manag. 2011;28(4):383-404. doi:10.1108/02656711111121807.
80. Kim S, Piccinini D, Mensah E, Lynch M. Using a human-centered design approach to determine consumer preferences for long-lasting insecticidal nets in ghana. Glob Health Sci Pract. 2019;7(2):160-70. doi:10.9745/GHSP-D-18-00284.
81. Kim Y. Digital transformation types for product-service systems. Proc Des Soc. 2021;1:1283-92. doi:10.1017/pds.2021.128.
82. Kiptot E, Franzel S. Gender and agroforestry in Africa: a review of women's participation. Agrofor Syst. 2011;84(1):35-58. doi:10.1007/s10457-011-9419-y.
83. Klamroth-Marganska V, Gemperle M, Ballmer T, *et al*. Does therapy always need touch? A cross-sectional study among Switzerland-based occupational therapists and midwives regarding their experience with health care at a distance during the COVID-19 pandemic in spring 2020. BMC Health Serv Res. 2021;21(1). doi:10.1186/s12913-021-06527-9.
84. Kratzke N, Peinl R. Clouns - a cloud-native application reference model for enterprise architects. Proc EDOCW. 2016. doi:10.1109/edocw.2016.7584353.
85. Langham J, Paulsen N. Applying the experience effectiveness (xe) framework in the Canadian public sector. Des Manag J. 2018;13(1):53-69. doi:10.1111/dmj.12042.
86. Lauff C, Collopy A, Swee A, *et al*. Design innovation in complex systems design: integrating design thinking and systems thinking. J Mech Des. 2021. doi:10.1115/1.0002251v.
87. Lynch M, Andersson G, Johansen FR, Lindgren P. Entangling corporate innovation, systems thinking and design thinking. Proc Eur Conf Innov Entrep. 2021:518-XXVII.
88. Ma Q, Schmit S, Glodt C, Kelsen P. Combining models with code: a tale of two languages. Proc ICGSEW. 2014:27-32. doi:10.1109/icgsew.2014.9.
89. Mackey A, Petrucka P. Technology as the key to women's empowerment: a scoping review. Res Sq. 2019. doi:10.21203/rs.2.18788/v1.
90. Mandl K, Gottlieb D, Mandel J, *et al*. Push button population health: the SMART/HL7 FHIR Bulk Data Access Application Programming Interface. NPJ Digit Med. 2020;3(1). doi:10.1038/s41746-020-00358-4.
91. Mannell J. Conflicting policy narratives: moving beyond culture in identifying barriers to gender policy in South Africa. Crit Soc Policy. 2014;34(4):454-74. doi:10.1177/0261018314538794.
92. Martin P, Barnard A. The experience of women in male-

dominated occupations: a constructivist grounded theory inquiry. SA J Ind Psychol. 2013;39(2). doi:10.4102/sajip.v39i2.1099.
93. McGann M, Blomkamp E, Lewis J. The rise of public sector innovation labs: experiments in design thinking for policy. Policy Sci. 2018;51(3):249-67. doi:10.1007/s11077-018-9315-7.
94. Melles M, Albayrak A, Goossens R. Innovating health care: key characteristics of human-centered design. Int J Qual Health Care. 2020;33(Suppl 1):37-44. doi:10.1093/intqhc/mzaa127.
95. Milek A, Stork C, Gillwald A. Engendering communication: a perspective on ICT access and usage in Africa. Info. 2011;13(3):125-41. doi:10.1108/14636691111131493.
96. Mustapha SD, Ibitoye BA, AbdulWahab R. Estimation of drivers' critical gap acceptance and follow-up time at four-legged unsignalized intersection. CARD Int J Sci Adv Innov Res. 2017;1(1):98-107.
97. Ndemo B, Weiss T. Making sense of Africa's emerging digital transformation and its many futures. Afr J Manag. 2017;3(3-4):328-47. doi:10.1080/23322373.2017.1400260.
98. Odio PE, Kokogho E, Olorunfemi TA, *et al*. Innovative financial solutions: A conceptual framework for expanding SME portfolios in Nigeria's banking sector. Int J Multidiscip Res Growth Eval. 2021;2(1):495-507.
99. Ogunnowo E, Ogu E, Egbumokei P, Dienagha I, Digitemie W. Theoretical framework for dynamic mechanical analysis in material selection for high-performance engineering applications. Open Access Res J Multidiscip Stud. 2021;1(2):117-31.
100. Okolie CI, Hamza O, Eweje A, Collins A, Babatunde GO. Leveraging Digital Transformation and Business Analysis to Improve Healthcare Provider Portal. IRE J. 2021;4(10):253-4. doi:10.54660/IJMRGE.2021.4.10.253-254.
101. Oladosu SA, Ike CC, Adepoju PA, Afolabi AI, Ige AB, Amoo OO. Advancing cloud networking security models: Conceptualizing a unified framework for hybrid cloud and on-premise integrations. 2021.
102. Oladosu SA, Ike CC, Adepoju PA, *et al*. The future of SD-WAN: A conceptual evolution from traditional WAN to autonomous, self-healing network systems. Magna Sci Adv Res Rev. 2021. doi:10.30574/msarr.2021.3.2.0086.
103. Oladosu SA, Ike CC, Adepoju PA, *et al*. Advancing cloud networking security models: Conceptualizing a unified framework for hybrid cloud and on-premises integrations. Magna Sci Adv Res Rev. 2021. doi:10.30574/msarr.2021.3.1.0076.
104. Olutimehin DO, Falaiye TO, Ewim CPM, Ibeh AI. Developing a Framework for Digital Transformation in Retail Banking Operations. 2021.
105. Onukwulu EC, Agho MO, Eyo-Udo NL. Advances in smart warehousing solutions for optimizing energy sector supply chains. Open Access Res J Multidiscip Stud. 2021;2(1):139-57. doi:10.53022/oarjms.2021.2.1.0045.
106. Onukwulu EC, Dienagha IN, Digitemie WN, Egbumokei PI. Predictive analytics for mitigating supply chain disruptions in energy operations. IRE J. 2021 Sep 30. Available from: https://www.irejournals.com/index.php/paper-details/1702929.
107. Oyedokun OO. Green human resource management practices and its effect on the sustainable competitive edge in the Nigerian manufacturing industry (Dangote) [Doctoral dissertation]. Dublin Business School; 2019.
108. Pahl C, Jamshidi P, Zimmermann O. Architectural principles for cloud software. ACM Trans Internet Technol. 2018;18(2):1-23. doi:10.1145/3104028.
109. Paunov C. Innovation and inclusive development. OECD; 2013. doi:10.1787/5k4dd1rvsnjj-en.
110. Paunov C, Planes-Satorra S, Ravelli G. Review of national policy initiatives in support of digital and AI-driven innovation. OECD; 2019. doi:10.1787/15491174-en.
111. Rivera-Santos M, Holt D, Littlewood D, Kolk A. Social entrepreneurship in sub-Saharan Africa. Acad Manag Perspect. 2015;29(1):72-91. doi:10.5465/amp.2013.0128.
112. Sahay A, Indamutsa A, Ruscio D, Pierantonio A. Supporting the understanding and comparison of low-code development platforms. Proc SEAA. 2020:171-8. doi:10.1109/seaa51224.2020.00036.
113. Sanchís R, García-Perales Ó, Fraile F, Poler R. Low-code as enabler of digital transformation in manufacturing industry. Appl Sci. 2019;10(1):12. doi:10.3390/app10010012.
114. Santos G, Costa B, Millán A. The estimation of the return on firms' investments - as to ISO 9001. Int J Eng Sci Technol. 2018;4(2):46-57. doi:10.4314/ijest.v4i2.4.
115. Sobowale A, Odio PE, Kokogho E, *et al*. Innovative financial solutions: A conceptual framework for expanding SME portfolios in Nigeria's banking sector. Int J Multidiscip Res Growth Eval. 2021;2(1):495-507.
116. Steen M. Tensions in human-centred design. CoDesign. 2011;7(1):45-60. doi:10.1080/15710882.2011.563314.
117. Tasleem N. Human-centered design is essential for successful technology adoption in telecom and public sector innovations, as it prioritizes user needs to enhance engagement, usability, and sustainable outcomes. 2021.
118. Van der Bijl-Brouwe M. The Challenges of Human-Centred Design in a Public Sector Innovation Context. 2016.
119. Varianytsia L. The category of design thinking: a systemic analysis. Bull Luhansk Taras Shevchenko Natl Univ. 2020;1(2 (333)):54-62. doi:10.12958/2227-2844-2020-2(333)-1-54-62.
120. Vetterli C, Brenner W, Uebernickel F, Petrie C. From palaces to yurts: why requirements engineering needs design thinking. IEEE Internet Comput. 2013;17(2):91-4. doi:10.1109/mic.2013.32.
121. Wang X, Wu H, Lu L. A novel service provision mode for sustainable development of the telecom industry. Sustainability. 2021;13(9):5164. doi:10.3390/su13095164.
122. Wu W, Shi K, Wu C, Liu J. Research on the impact of information security certification and concealment on financial performance. J Glob Inf Manag. 2021;30(3):1-16. doi:10.4018/jgim.20220701.oa2.