# Design Science Research: Applying Integrated Fogg Persuasive Frameworks to Validate Rural ICT Design Requirements

## Design for Digital Equality in Rural Areas

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***Abstract*—Designing for digital equality is critical in the modern world. Digital inequality is more pronounced in rural areas, where the majority are illiterate and poor. As a result of this, individuals are not motivated, enabled and triggered enough to access and use Information and Communication Technologies. Additionally, existing rural ICT artifacts or applications are not usable by these demographics. Therefore, this paper understood and validated rural ICT design requirements. It achieved this by developing a community learning system, applying design science research methodology and integrated Fogg persuasive frameworks. Results shows that use of local language, local content, videos, audio, touch-based input, proper content categorization, accessibility (location) and peer participation and collaboration fosters user engagement with the ICT artifact. These approaches had a significant impact in the achievement of user self-efficacy. This is explained by the task findings, 71%, 83%, 70% and 78% successfully, within the stipulated time and on their own, accomplished tasks 1, 2,3 and 4 respectively. Users found the content to be practical and applicable to their day-to-day activities. Users appreciated the system's potential for learning indicating that it could significantly enhance their knowledge and skills. The significance of Design Science Research and integrated Fogg persuasive frameworks in creating usable and accessible ICT solutions tailored to the needs of the target population cannot be underrated. It was concluded that design solutions targeting vulnerable demographics are key to the success of designs for digital equality. In other words, usable solutions for the aged, women illiterate, uneducated and the poor, are more usable for the young, men, literate, educated, and the rich (financially stable). Thus, enhancing inclusivity in access and use of rural ICTs.**

***Keywords*—*Digital equality; rural areas; design requirements; rural ICT; artifacts; validate; Fogg frameworks; design science research***

## I. Introduction

Digital inequalities have emerged as a growing concern in modern societies [1]. The disparities pertain to differences in access and use of ICTs such as internet connectivity, internet-enabled devices and digital literacy skills among individuals living in rural areas [2, 3]. According to study [2], these three factors are essential for communities to create a sustainable access to the digital world, specifically as critical aspects of society such as education, workforce development and innovation transition to online platforms [2]. Therefore, the absence of robust, and all-encompassing applications or information access makes it difficult for people to participate in the digital community and access digital services, which remains exclusive on a systemic level. Thus, there is a need for targeted ICT solutions which will enhance inclusivity in access and use among various demographics in the community.

Even if people have equal access to digital technologies, such as the presence of rural ICT centers, disparities in skills, motivation, and literacy levels can result in digital inequality. Consequently, marginalized groups (such as the illiterate and uneducated) of all ages tend to avoid adopting modern technologies, leading them to miss out on important information. Encouraging these groups, who have little to no exposure to technology, to integrate ICTs into their daily lives is a significant challenge. This underscores the necessity for a thoughtful design approach. According to researcher [Rogers], technology can be utilized to influence people's behavior. Hence, we applied Fogg frameworks to validate ICT design requirements for rural areas and to identify additional requirements unique to rural areas.

The term persuasive technology pertains to interactive information technology that is specifically created to change users' attitudes or behavior or both within the realm of human-computer interaction [4]. Given its manipulative nature and ability to exert influence in a subtle manner [5], particularly on individuals who may lack literacy or motivation, it has the potential to significantly impact the design of digital solutions for rural areas. This helps to achieve equality in access and use of ICTs.

This research is part of a larger study aiming to establish a framework for creating rural ICTs that promote inclusivity. This paper specifically focuses on validating the requirements to achieve this broader objective. It starts by providing the study's background and related work in before delving into the requirements for designing for illiterate and semi-illiterate individuals, as the primary aim is to validate these requirements. The validation process enhances the comprehension of the design requirements for rural areas, ultimately leading to the development of a robust, practical, and applicable framework. Requirements were sourced from existing research, incorporated into the Fogg persuasive framework, and used to design persuasive features in a community learning system. The conclusion discusses the persuasive features identified through evaluation that promote inclusivity in accessing and using rural ICTs. Lastly, future work is recommended.

## II. Background and Related Work

### A. Fogg Persuasive Frameworks

According to study [6], users perceive computers as tools, media and social actors. This is known as captology (computer as a persuasive technology) triad.

The Fogg Behavioral Model (FBM) is a conceptual framework used to understand human behavior. This framework is particularly important for those involved in studying and creating persuasive technology. Persuasive technology focuses on automating behavior change. To effectively incorporate experiences that promote behavior change, designers need a thorough understanding of human psychology, especially the factors that drive human behavior. The FBM provides designers and researchers with a systematic way to consider the underlying factors of behavior change. It highlights that motivation, ability, and triggers must all align at the same time for the behavior to occur; otherwise, it will not happen. The inclusion of FBM in the UX design process assists designers in creating user-centered designs and encourages meaningful and impactful interaction with the product [7].

Fogg's persuasive integrated framework merges the triad elements of captology with the components of FBM. Captology focuses on the characteristics of ICT, while FBM emphasizes human factors. Fig. 1 demonstrates, using computer as a tool, how these components will be integrated to create a robust framework that will assist in defining the design requirements for rural ICT. MF is motivation features, AF is ability features and TF is triggers features, all to the computer as a tool.

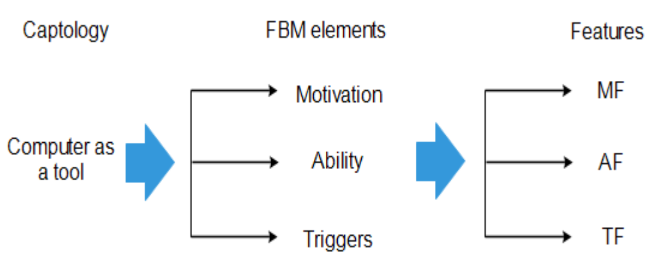


Fig. 1. Illustration of integrated Fogg persuasive frameworks.

The Chomoka Mobile Application, developed by [8], is a relevant persuasive technology for this study. It was designed specifically for Village Savings and Loan Associations (VSLAs) in seven rural African countries. Their goal in utilizing FBM was to build a more user-friendly and intuitive application, focusing on creating triggers that promote consistent usage. Furthermore, this approach improved the overall user experience and impact of the Chomoka app. It is evident that incorporating the Fogg Behavior Modeling framework could have further enhanced the success of the Chomoka app.

In their content analysis study, [9] systematically assessing the prevalence of persuasive design elements in popular early childhood apps [9] found out that a majority of them displayed a high prevalence of passive motivation features such as vibrant colors and music, as well as ability features like in-game help suggestions and repetitive tasks. In their conclusion, the researchers emphasized the importance of considering the developmental consequences of persuasive design features in apps and investigating how they might influence problematic screen behaviors in early childhood.

In their study, [10], demonstrated how the mobile app Sedentaware can prevent sedentary behavior by encouraging users to engage in physical activities. They illustrated how their model can complement a mathematical model to develop more effective persuasive technologies. Their research highlighted a key drawback of persuasive technology theory: it lacks the necessary level of detail for designers to systematically create persuasive technologies. This led us to combine Fogg frameworks with DSRM.

Researchers, [11] combined Fogg Behavioral Model and the Hook model to design features for an app as a component of a larger persuasive system to help improve three key areas of study habits: study scheduling, class preparation and group study. The proposed mobile companion app formed the overall persuasive system which was used to influence student study habits to improve their learning outcomes.

### B. Design Science Research Methodology

Researcher, [12] conducted a study with the goal of reducing the digital divide between literate and illiterate populations in Iraq. They achieved this by creating a mobile app focused on educating about traffic signs. The app was developed using the Design Science Research (DSR) method. Upon development and evaluation, it was found that the illiterate participants demonstrated highly competent performance in completing tasks. The study confirmed that the app, which incorporated design principles such as voice instructions, symbols, and the local language, was effective, efficient, and garnered high user satisfaction. This study demonstrates that developing mobile apps for illiterate individuals can enhance their technological knowledge and bridge the gap between them and those with access to modern technology.

In their study, [13] created a mobile app to help illiterate individuals in Bangladesh find jobs, aiming to bridge the digital gap in developing nations. They used the DSRM to develop and assess the IT tool. They discovered that incorporating minimal text and voice prompts was crucial for designing mobile apps for illiterate users, and that using voice instead of text for information input was another essential design principle for this demographic. They also emphasized the importance of using images and culturally relevant symbols in User Interfaces (UI) to improve user understanding of the app's functions. In their future work, they suggested conducting a study to address the issues identified in their research, such as using methods like observation and on-site visits in addition to semi-structured interviews for requirement gathering, and considering a longitudinal study for broader insights. They also highlighted the need to recruit a larger number of participants for future studies.

### C. Existing Gap

Numerous research efforts have aimed to narrow the digital divide for people who are illiterate by concentrating on the design of user interfaces and interaction methods for providing digital services in different global settings. Nonetheless, it is clear that no prior research in Kenya has investigated and validated these requirements for creating a practical design solution, which contributes to digital inequality among different population groups in rural areas. Furthermore, our study combines a persuasive framework with the DSRM process, demonstrating a theoretical aspect that is not commonly found in other studies that strive to promote equality through designing for individuals with limited literacy skills, particularly, rural areas.

### D. ICT Design Requirements for Rural Areas

Illiteracy is a significant challenge in rural areas [14]. Moreover, as outlined by study [15], the increase in computer illiteracy among individuals is significantly contributing to the expansion of the digital divide. According to [16], literacy is defined as "the capacity to securely and effectively access, manage, comprehend, integrate, communicate, evaluate, and generate information using digital technologies. It could be for the purpose of gaining knowledge, employment, securing decent jobs, and entrepreneurship." This literacy encompasses a continuous process of learning and mastery in reading, writing, and numerical skills throughout one's lifespan, forming part of a broader range of competencies that encompass digital literacy, media literacy, education for sustainable development, global citizenship, and specific skills required for various professions [16].

Despite the educational deficiencies prevalent among a substantial portion of the population, numerous existing applications and their interfaces cater primarily to individuals with higher levels of education. These interfaces tend to be text based thus making them unsuitable for individuals who are illiterate, semi-literate, or lack digital literacy, thereby limiting their ability to effectively engage with software systems. Consequently, these sizable demographics are unable to derive the advantages offered by ICT services if they are unable to access them, ultimately giving rise to digital inequality, the divergence between individuals who possess unrestricted access to information and communication technologies and those who either lack access entirely or have limited access to such technologies. Hence, the task of bridging the digital gap would be unattainable in the absence of implementing ICTs for this extensive population of disadvantaged (illiterate and semi-literate) cohorts [17].

Researchers, [18] revealed various aspects that need to be recognized when designing persuasive systems include responsiveness, error-freeness, ease of access, ease of use, convenience, information quality, positive user experience, attractiveness, user loyalty, and simplicity, to name a few; however, they indicate that more precise requirements for software qualities will have to be defined to be able to communicate the ideas from idea generators and/or management to software engineers. Additionally, [18] suggested four principles of persuasive design: (1) primary task (applying reduction, tunneling, tailoring, personalization, self-monitoring, simulation, and rehearsal). (2) dialogue (include, praise, rewards, reminders, suggestion, similarity, liking, and social role). (3) system credibility (include, trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability). (4) social support (social facilitation, social comparison, normative influence, social learning, cooperation, competition, and recognition).

On the other hand, [6] indicated that changing peoples' attitudes and behavior require;

- tailored information.
- computer simulations.
- application of animate characteristics (like, physical features, emotions, voice communication),
- play animate roles (like, coach, pet, assistant, opponent), or
- social rules or dynamics (like greetings, apologies, taking turns)

Numerous studies were undertaken to pioneer innovative ICT-based solutions aimed at delivering information to illiterate and semi-illiterate residents of rural areas in developing countries [12, 15, 17, 18, 19]. They indicated the following requirements;

- Applying minimized hierarchical navigation
- Uses of text-free UI in local language;
- speech/voice and touch based interactions
- apply intuitive icons, symbols, images, and photographs
- use audio, video, and animated instruction/guide;
- include context sensitive suggestions
- proactive briefing
- local content (useful application)

### E. Validating Rural ICT Design Requirements

Validating the rural ICT design needs, entail designing an intervention (artifact) for solving the problem [20]. There are various design methodoogies and frameworks that can be applied in the development of ICTs for inclusivity. [21], revealed that appropritate design techniques for ICT inventions encourage participartory design. Utilizing a participatory action research approach in ICT design and development is essential for not only preserving local culture and identity but also fostering the local creation of ICT [22]. This design has been found to be appropriate for the development of innovations for rural areas and especially systems where usability is a critical factor [23, 24, 25].

Persuasive design employs participatory design (PD) method, which involves potential users as active participants in the design process for creating computer systems and computer-based activities [26]. In addition to providing the venerable with the opportunity to design ICT products and services, PD fosters a positive relationship between users and designers, allowing designers to leverage the users' creativity and knowledge about the context of use, thereby fostering a sense of ownership of the resulting ICT product. Additionally, it is a design technique which helps in creating successful human-computer-interactions where designers are required to play a big role as agents of influence [6].

DSR is another approach that involves creating a new practical object to tackle a broad category of issues and then assessing its effectiveness in solving problems within that category [27]. It utilizes a participatory approach. Researchers, [12, 13] applied DSRM in the design and validation of design requirements for illiterate and semi-illiterate users.

## III. METHODOLOGY

This study employed Design Science Research methodology (DSRM). The selection of DSRM was based on its rigor, flexibility and cost effectiveness [28]. DSRM has six steps; problem identification, objectives for the solution, design and development, demonstration, evaluation, and communication [29]. This methodology is systemic and flexible, with a focus on improvement through iterative processes that involve empathetic observation, understanding user needs, and devising innovative approaches to meet those needs. The objective is to transition from explaining phenomena to creating interventions to solve problems. Therefore, design science is especially valuable for identifying and implementing practical solutions within complex situations [20] like the case of rural areas.

As a result of DSR's flexibility and support for participatory design, this study was able to integrate persuasive theory into its process. The urban informatics design model [30] was adapted, see Fig. 2. Their model was designed specifically for a socio-cultural context, hence shared similarities with rural informatics.

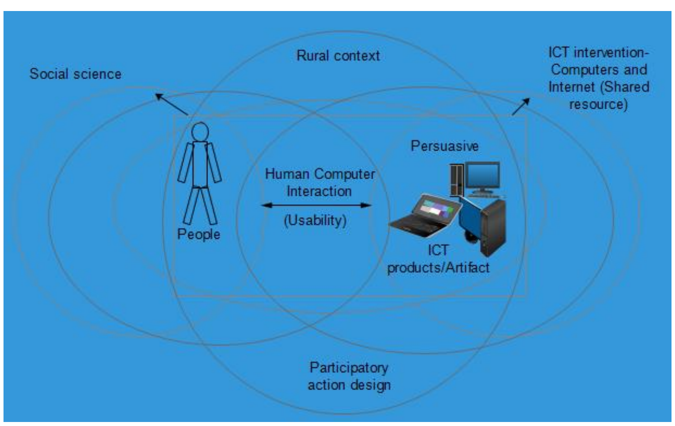


Fig. 2. Adapted PADR for rural Informatics.

For ease of integrating participatory action design research (PADR) with DSR, we simplified it and the resultant model is shown in Fig. 3.

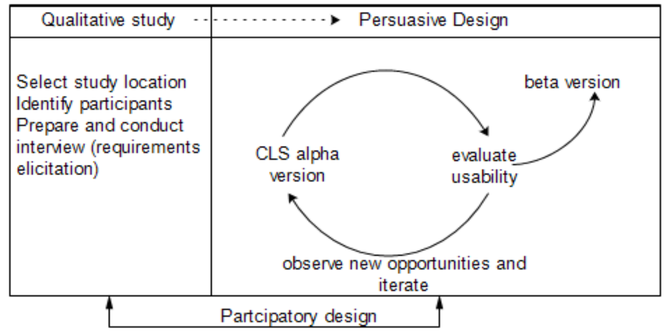


Fig. 3. Rural ICT design and development model.

### A. Persuasive Design

Studies [33, 34] have revealed that as a result of affordability and illiteracy issues, individuals in rural areas are not persuaded into accessing and utilizing ICTs. Hence, the need for persuasive design methodology. Furthermore, persuasive design approaches have been applied by other information systems researchers [8, 9, 11, 18, 35, 36, 37].

The use of persuasive systems can involve either persuading humans through computers or using computers to mediate persuasion. It is true that the idea of a persuader is quite intricate because computers themselves do not have intentions; it is the people who develop, disseminate, or use the technology that have the intention to influence someone's attitudes or actions. [38]. Additionally, [38], stated that Fogg's framework and principles offer valuable ways to comprehend persuasive technology. According to these statements, we applied a persuasive framework that leverages both Fogg Behavior Model (FBM) and his Captology (Computer as a persuasive technology) Triad framework. This was also based on the understanding that designing Information and Communication Technology solutions for illiterate users requires a thoughtful approach. The FBM emphasizes Motivation (desire to participate in access and use of RICTs), Ability (the ease of accessing and using RICTs), and Triggers or prompts (cues that prompt users to access and use RICTs). On the other hand, the functional captology triad outlines how computers can act as tools (enhances users' abilities to perform tasks), mediums (conveys or simulates experiences), and social actors (engages users in social interaction). As seen in Table VI the integrated Fogg persuasive frameworks incorporate the design requirements for illiterate found in the existing literature.

### B. Application of Design Science Research

*1) Problem-centered approach:* The study is problem centered which was necessitated by the need to identify and validate rural ICT design requirements. On the quest of how to design rural ICT solutions for inclusivity, this study obtained good information but barely none was from Kenyan setup, it was mostly based in other countries like Asian and developed nations. Fig. 4 illustrates this approach.

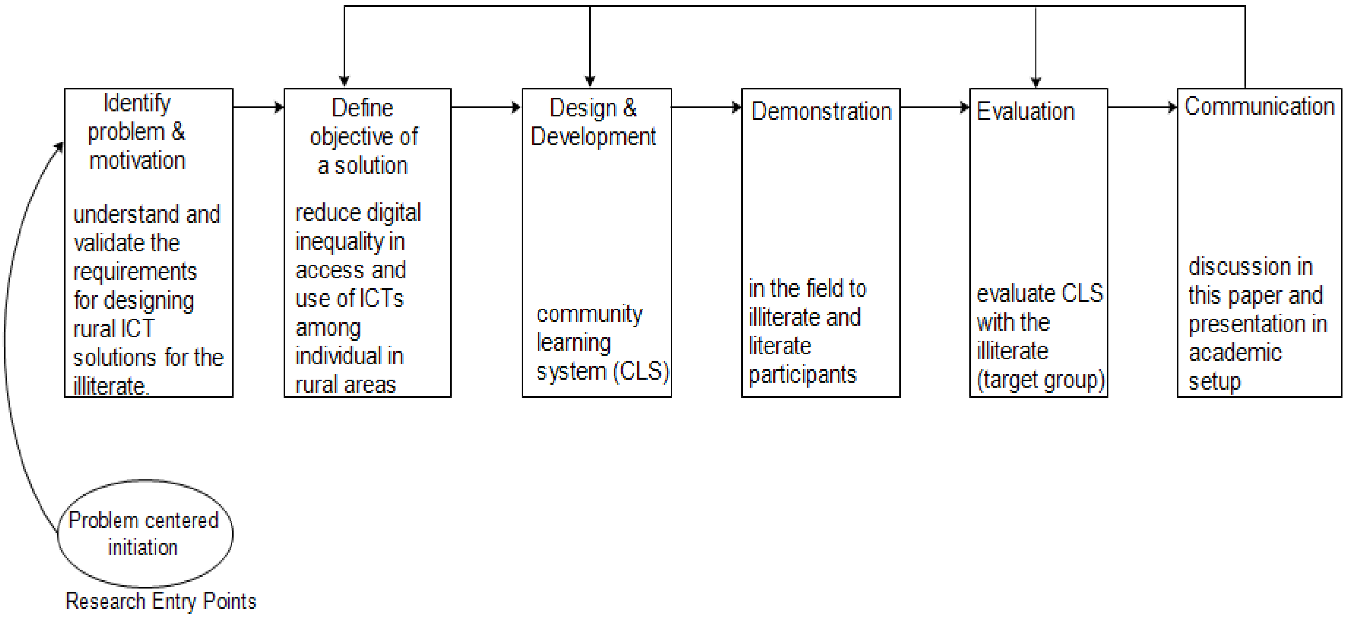


Fig. 4. DSR problem centered approach.

*2) Problem identification and motivation:* The existing ICT solutions in rural Kenya (for example websites or web applications or ICTs for information dissemination) are exclusively English and text-based in their user interfaces. Therefore, rendering it challenging for individuals with low literacy levels to access and utilize them. As a result, ICTs for relaying information to and in rural areas mainly target the educated and literate, excluding the illiterate and the semi-illiterate. Therefore, there is a need to understand and validate the requirements for designing rural ICT solutions which consider the illiterate people, allowing them to fully, on their own, participate in their access and use.

*3) Objectives of the solution:* The objective of this study is to validate the identified design needs for rural areas so as to inform solutions for enhancing ICT inclusivity in access and use among individuals. To achieve this, we developed an artifact which helped in identifying other special needs tailored to Kenyan rural areas. The results from artifact evaluation were used to develop a comprehensive and practical solution for designing rural ICTs in Kenya.

*4) Design and development:* Determining the intended functionality and architecture of the artifact is part of this activity, followed by the creation of the actual artifact [29]. Hence, prior to CLS creation, data was collected from the identified location of study, in accordance with [29] recommendations. Additionally, the existing practical approaches (in literature) for designing systems for the illiterate were considered. Study, [29] noted that the problems that have been identified may not directly correspond to the objectives for the artifact which was supported by our case, the artifact was disseminating information to the users but to us (the researchers), we were only using it to validate considerations for designing ICTs for the rural individuals especially the illiterate.

Now, to be explicit on CLS design and development process, the rural ICT design and development model was integrated with DSRM process, see Fig. 5.

*a) Selection of location:* The selection was guided by Fogg's argument that computers can be used to persuade people to change their behavior (doing something differently from the usual) as well as design ICT products which persuade people towards a behavior (adoption). The two villages (Cheleget and Kipgegei) were secretely practicing female genital mutilation and at the same time maize farming was no longer viable because of change in weather patterns. We assumed that applying Fogg frameworks in design of the artifacts was going to persuade them change their attitudes on certain vices and appreciate other farming innovations as advised by the agricultural extension officers like embracing drought resistant crops. With this, we were careful not to defiate from the objective of the study (validation). At thesame time, this formed part of our local content among those suggested by the participants.

*b) Familiarizing with the community:* On the first day, we went round the villages doing observations and familiarizing ourselves with the community's way of life where we interacted with thirthy one (31) individuals. We utilized the opportunity to share information about our study and the idea of creating CLS with them and or them. This was a way of creating awareness for the to-be designed ICT product. We explained to them the benefits which come with ICT interventions; including access to information which can help them improve their farming skills, business skills, health among others. We did not forget the fact that they could also get an opportunity to market their products through ICT solutions.

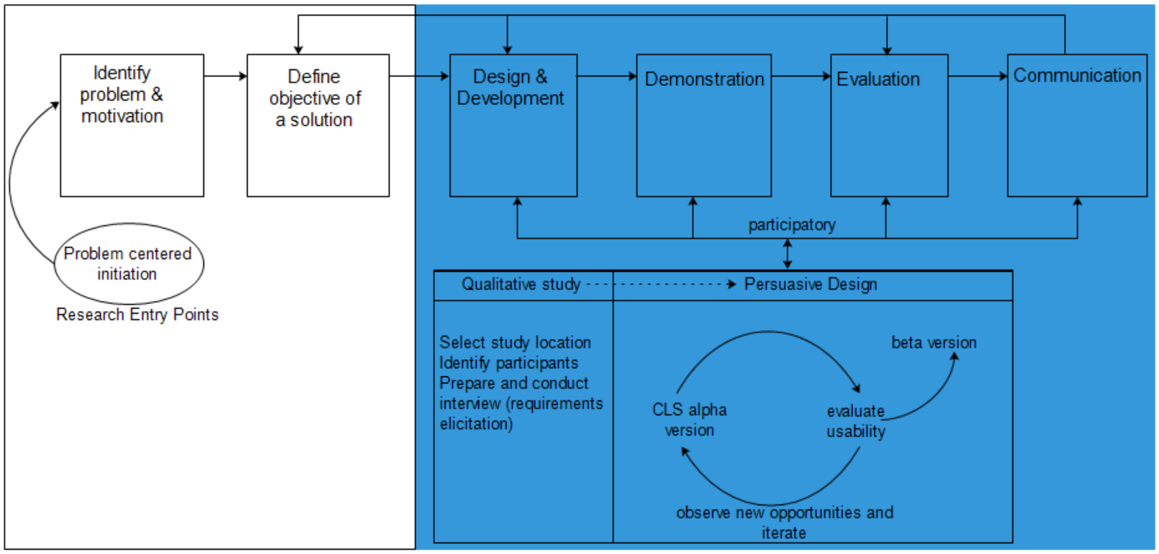


Fig. 5. DSRM-RICT integrated design and development model.

*c) Selection of participants:* Nine (9) participants were identified. They were willing to participate and support the study until the end. Four of them were promising content creators. They were doing well in agriculture and interventions for food security in the village. For example, the farmer in Fig. 6 created content demonstrating how to build a beehive. This also took care of local content.

Fig. 6. Beehive construction demonstration at Cheleget village.

*d) Preparing and conducting the interview (requirements elicitation):* After we had familiarised ourselves and won the villagers for support, we conducted an interview. The survey asked the participants about their personal information such as age, familiarity with computers and the internet, educational background, and other relevant details. Then we sought to understand the things that would motivate them to access and use rural ICTs (computers and internet or community learning systems/portals), their abilities to use ICTs including literacy level, and the triggers that would prompt them to access and use the products. Another theme that we incorporated was the ICT product's / artifact's attributes as per resource and appropriation model [39]. We noticed that the question on attributes was too technical for the respondents, as they had not experienced these technologies before. In fact, one participant responded that he did not know how a computer looks like, and that if he had seen and used it then he could be having something to say about it. So, we decided at that point to embrace the saying that "seeing is believing." Therefore, we create a prototype and used it to probe their ICT design needs.

Overall, we interviewed twenty-seven (27) participants of whom, seventeen (17) were female and ten (10) were male. We stopped the interview at twenty-seventh individual because the interview was getting saturated. That is, response was being replicated and the only part that was changing was the demographics such as age, gender among other.

*5) CLS development:* After we had analyzed the requirements, including the local content, we immediately embarked on CLS development. All the requirements which had been recommended [12, 13, 15, 17, 19, 40, 41, 42, 43,] and indicated in integrated Fogg persuasive framework, Table VI, for example multisensory strategies [44] including audio, video were applied were implemented, following DSRM process. Fig. 7 is part of CLS's UI. Consistency was another consideration in CLS development. This is demonstrated in screenshots A, B, and C.


Fig. 7. CLS user interface.

Fig. 8 illustrates the CLS minimalistic approach [45] involving navigation (two-step process to accomplish a task). First step, a user clicks on a category of interest (button), for example, agriculture then a screen showing different items (content) on this category appears. Second step, user selects content to read or watch/listen to the video. We presented information in local language, achieving user experience (UX) localization [46].


Fig. 8. Features of CLS.

Every button and icon was linked to an audio message. Anytime the mouse hovers on it, the message explained its purpose and the action to be accomplished if the user was to select it. For example, click on it if they were interested in that particular information. It enabled users to select the right information according to their preferences, minimizing errors at the same time enhancing self-efficacy.

*6) CLS demonstration:* The nine (9) participants were engaged in the usability evaluation of the prototype. This phase was crucial in understanding the user's design needs. Other three (3) educated and literate participants were approached and they agreed to give their feedback on the system. Since we had adhered to the developed framework in Table VI, the finding showed that the participants were satisfied, and were in agreement that the product was usable, particularly by the illiterate. Majority requested for additional content. Apart from the participants' responses, our observation was that those users who were unable to read or slow in reading, were unable to perceive the application's launching icon on their own. This was going against our goal of achieving users' self-efficacy (ability to complete a task without help). This feedback was then utilized for further refinements. Fig. 9 shows CLS modified launching icon which was more pronounced and visible.


Fig. 9. CLS launching icon.

*7) CLS evaluation:* The beta version of CLS was evaluated for usability. On our initial visit, 31 people who expressed interest and were willing to take part in the study were specifically asked to participate in the evaluation. Among them is the group of nine people who participated in the design of CLS (community co-designers). Thirty-seven participants attended the session but only twenty-three (23) evaluated CLS. Though in attendance, the nine participants and five other literate people were excluded. At this stage the literate participants assisted in setting-up the room for evaluation and during participants' training session. We started the session by first training the participants on how to use CLS. Among the participants, 12 were male and the rest (11) were female. Fig. 10 shows the trainer projecting the steps (photo 1) and assisting the participants (photo 2). Majority of the participants were between the age of 25 and 60.


Fig. 10. CLS training session.

*8) Communication:* We discussed the findings of CLS evaluation in this paper and presented in an academic forum.

## IV. Results

We conducted a usability test to evaluate illiterate design needs, focusing on their ability to independently launch the system (self-efficacy). The timing period was determined during demonstration sessions where an average of the time taken by the literate and the illiterate participants was computed. During the evaluation, participants were asked to close (exit) CLS window, then locate and launch it within 180 seconds. Results in Table I revealed that 16 participants (70%) successfully located and launched the system on their first attempt, 3 participants (13%) succeeded after several attempts without assistance, and four participants (17%) required help after multiple unsuccessful trials.

TABLE I. Task One- Launching CLS

| ***Number of attempts*** | ***Frequency (number of participants)*** | ***Percentage (%)*** | ***Average time (seconds)*** |
|---|---|---|---|
| succeed on 1st attempt | 16 | 70 | 48 |
| succeeded after several attempts | 3 | 13 | 123 |
| failed after several trials | 4 | 17 | not successful |

Task 2 evaluates users' self-efficacy by assessing their ability to independently complete a familiar task which involved opening a beehive making video. This task also provided insights into their learnability and memory retention, as they had previously accessed the video multiple times. Allocating a duration of 120 seconds for this particular assignment, a total of 19 participants, which accounts for 83%, effectively managed to finalize it with an average completion time of 68 seconds. However, from Table II, four participants were unable to finish within the allotted time, mainly due to difficulties with mouse handling and positioning. Upon requesting a second attempt, half of these participants completed the task in an average of 63 seconds, while the remaining two still required assistance.

TABLE II. TASK TWO- FAMILIA TASK

| *Number of attempts* | *Frequency (number of participants)* | *Percentage (%)* | *Average time (seconds)* |
|---|---|---|---|
| succeeded | 19 | 83 | 68 |
| failed after several attempts | 4 | 17 | elapsed time |
| 2nd chance | | | |
| succeeded | 2 | 50 | 63 |
| failed after several attempts | 2 | 50 | not successful |

In Task 3, participants were instructed to access a video on "Kalenjin Proverbs" which was uncommon task. However, our observations revealed that most participants typically viewed videos related to agriculture and health. As a result, the "Kalenjin Proverbs" video was not frequently accessed. During the training session, participants were informed that any information not related to agriculture or health was categorized under "general information." They were allocated 120 seconds to complete this task. Based on the data presented in Table III, it was observed that 16 individuals, constituting 70% of the total participants, effectively accomplished the task during their initial try, demonstrating an average duration of 69 seconds. Of the eight participants who failed initially, five succeeded on their second attempt, with an average time of 66 seconds. Despite multiple attempts, three participants were unable to complete the task.

TABLE III. TASK 3- UNCOMMON TASK

| *Number of attempts* | *Frequency (number of participants)* | *Percentage (%)* | *Average time (seconds)* |
|---|---|---|---|
| succeeded | 16 | 70 | 69 |
| failed after several attempts | 8 | 30 | elapsed time |
| 2nd chance | | | |
| succeeded | 5 | 63 | 66 |
| failed after several attempts | 3 | 37 | not successful |

In Task 4, participants were instructed to close the CLS application, relaunch it, and then open content related to female genital mutilation (FGM). They were allocated 240 seconds to complete this task. As indicated in Table IV, despite the complexity of the task, 78% of participants successfully completed it. Upon a subsequent trial, 80% of the individuals successfully finished the assignment within an average duration of 128 seconds.

TABLE IV. TASK 4- LENGTHY TASK

| *Number of attempts* | *Frequency (number of participants)* | *Percentage (%)* | *Average time (seconds)* |
|---|---|---|---|
| succeeded | 18 | 78 | 186 |
| failed after several attempts | 5 | 22 | elapsed time |
| 2nd chance | | | |
| succeeded | 4 | 80 | 128 |
| failed after several attempts | 1 | 20 | not successful |

We concluded the CLS evaluation session by asking the participants to verbally give their views on the system, as applied by [13]. This gauged their satisfaction and experience with CLS. All participants were using the computer and digital application for the first time. The system had employed the guidelines in Table VI, like use of video, audio cues, local language, and local language. Collected information included their engagement with CLS, its relevance (usefulness), their learning experience, their willingness to recommend it to the others and finally, challenges experienced while using CLS.

Finally, the study sought to understand rural users' willingness and ability to pay for the internet services. It started with a proposal to install CLS in their nearest market's cybercafé, located 8 kilometers from the village. The cybercafé was charging one shilling per minute for access and use of the internet. Results indicate that users were dissatisfied with the proposal, given the distance involved and monetary issue.

## V. DISCUSSION

Similar to study [42] our study findings show that user self-efficacy was attained. This is explained by the task findings, 71%, 83%, 70% and 78% successfully, within the stipulated time and on their own, accomplished tasks 1, 2, 3 and 4 respectively.

Comparable to [12, 13], participants reported their overwhelming satisfaction with the CLS. They were satisfied with the use of local language and local content, noting that the language made it easy for them to learn and use the system while the local content matched with their information quest and needs. They found the content to be practical, and applicable to their day to day activities. They enjoyed using it and found it relevant (helpful/useful). Users appreciated the system's potential for learning, indicating that it could significantly enhance their knowledge and skills. Table V summarizes the impact of CLS on user experience, highlighting both positive aspects and challenges.

TABLE V. INTEGRATED FOGG PERSUASIVE FRAMEWORKS (FBM AND CAPTOLOGY)

| ***Captology*** | ***FBM Element*** | ***Design requirements/features*** | ***Guidelines*** |
|---|---|---|---|
| Computer as a tool | | | |
| | Enhancing Ability | Increase self-efficacy (reduction of tasks)<br>provide tailored information<br>simplify/guide people through process (integrate training modules and audio aids)<br>{minimalistic approach and UX localization} | Make navigation simple (few clicks)<br>Design UI using less text (video and audio)<br>present local content in local (mother) language<br>Use intuitive images, symbols, and pictures<br>Offering guidance through audio, video, and animated tutorials. |
| | Boosting Motivation | Provide immediate feedback | Information to reinforce positive behavior for example congratulates the user for listening to the video |
| | Effective Prompts | trigger decision making | use visual and audio cues like bright colors, icons, and sounds to guide users through tasks (uses visual/audio cues to prompt actions) |
| Computer as a medium | | | |
| | Enhancing Ability | Simulate cause and action | create interactive simulation that allow users to practice tasks or create a video of peers/expert simulating a task |
| | Boosting Motivation | Create engaging content<br>Include demonstration | Incorporate stories of successful person for example in farming or business to motivate users or Show real-life scenarios where similar users successfully use the technology, enhancing the perceived relevance and usefulness. |
| | Effective Prompts | Provide interactive guides provide prompts during the simulation. | Use animated characters or avatars to provide step-by-step instructions and encouragement and Trigger actions within the simulation to guide users towards desired behaviors. |
| computer as a Social Actor | | | |
| | Enhancing Ability | Provide social support<br>Incorporate mentorship roles | During training, allow users to practice on their own (peer learning)<br>The application should allow interested community members for example farmers to share their experiences.<br>Incorporate virtual mentors or coaches that provide guidance and support. |
| | Boosting Motivation | Provide social proof<br>Include recognition | Design with the community and let them be content creators<br>Shows successful peer examples and their achievements<br>Show that others in the community are using the technology, leveraging the influence of social norms.<br>Publicly recognize achievements within the application, such as leaderboards or community shout-outs. |
| | Effective Prompts | Apply social prompt<br>Consider community engagement | Sends reminders from community social workers, agriculture extension officer, community leaders among others.<br>Use social challenges or group tasks to motivate users through collective action. |

Due to the cost and location, rural users expressed their unwillingness to participate in its access and use. The participants expressed their dissatisfaction with the proposed location terming it as far away, requiring additional time, cost and effort to travel. Largely, the economic constrain among individuals in rural areas significantly impacted their willingness to pay for internet services. Data and observations showed that the majority of users had limited financial resources. Majority struggled to afford basic necessities, including school fees for their children and daily living expenses. Given their low income levels, the users were not willing to allocate funds for accessing the internet services. The idea of paying for information was deemed impractical and unaffordable. Similar to study [13], all the participants positively articulated their willingness to recommend CLS to the other members of the community.

TABLE VI. RATING CLS SATISFACTION

| ***Positive aspects*** | ***views*** |
|---|---|
| Engagement | Participants enjoyed the interactive elements provided by the video and audio cues. These features made the system engaging and easy to navigate. |
| Relevance | The use of local language and content resonated well with the users thus made the information more accessible and meaningful. |
| Learning Potential | Users felt that the system was a valuable educational tool with a very high potential of facilitating significant learning and personal development. |
| challenges | |
| Mouse Handling | participant's difficulty in handling the mouse was the primary and most notable challenge to be reported. Many found it challenging to use. This indicated a steep learning curve which was experienced as a result of this input device. |
| Learning Time | Participants felt they needed more time to become proficient with the system especially in relation to mouse handling. They suggested that if alternative input methods were provided then their experience could improve. |
| Content | Participants felt CLS needed to be populated with more content particularly on how to grow and manage various crops. |

## VI. CONCLUSION

This study validated design requirements for rural areas, focusing on the illiterate. It followed DSRM process and applied Fogg integrated frameworks. The artifact that was used for validation, applied the specified design features and guidelines indicated in the framework. In 2022, [32] proposed the same requirements for creating systems designed to address gender inequality. Furthermore, this approach is capable of generating intuitive artifacts, closing the digital gap not only between illiterate and literate individuals, but addresses the gender and age divide as well. We found out that user experience localization enhances user's engagement with the ICT artifacts or products. This was achieved with the use of local language and local content. It was ascertained [46] that adaptation of UX enables an application to bridge divides among various demographics. Content was development in local language, meaning that there was no need for interpreters or difficulty in comprehension. At the same time, tailored information was provided through CLS as the community members were fully involved in the design and development of CLS. This means that the information was relevant to users' needs and their context. Furthermore, the local content was based on users' demand. Localization strategy showed full potential of encouraging ICT inclusivity, fostering user engagement with the ICTs.

Application of videos and audio cues significantly impacted participant's UX with CLS. It made CLS intuitive and easy to learn. According to study [44] combining various techniques for information dissemination or learning is known as multisensory approach. Our study revealed that multisensory approach is applicable in the design of rural ICTs (artifacts). Furthermore, CLS applied minimalistic design principles [46] which included few clicks and intuitive navigation, enhancing user's self-efficacy. This finding agrees with [6], where they revealed that the act changes users' attitude and behavior by exposing them to information which may have not been readily available at their disposal, hence they may be persuaded to apply the learned information in their daily lives.

This study maximized on content categorization. This strategy involved putting together related information helping the users to locate information with ease, and minimizing the time taken to search for information. The results highlight the varying levels of self-efficacy among participants and the need to carefully craft solutions for special groups like those with low cognitive levels, low technical skills and low confidence. In their study [47] found this to be the case as they concluded that ICT user interface and content designed for individuals with low literacy skills should consider factors beyond just illiteracy, including additional cognitive differences among these users.

This study reveals the positive significance of peer participation in the design and acceptability of ICTs by rural people. Peers were involved in the design, evaluation and content creation. Also, during training, peer learning was encouraged. They patronized the content created by their own village mates than others. This enhanced learning speed and made the participants engaged with the system. Additionally, other input devices need to be explored for the users with low technical skills like dragging and positioning the mouse.

DSRM provided significant benefits for our research endeavor. Its structured approach ensured thorough investigation and validation of the specific needs of our target demographic, while its iterative nature allowed for continual refinement based on real world feedback. This adaptability was crucial for addressing the diverse challenges faced by illiterate users in rural areas. Furthermore, the focus of the methodology on practical implementation harmonized effectively with our objective of establishing a community learning system that was accessible and user-friendly. Additionally, DSR's efficient use of resources made it a time effective and economical choice, allowing us to maximize our impact within the constraints of our research budget. Thus DSR provided the ideal framework for developing inclusive ICT solutions that meet the specific needs of rural populations.

Additionally, this study revealed that combination of DSR and Fogg's persuasive frameworks helps in creating usable and accessible ICT solutions customized to the needs of the target population. It enhanced the effectiveness of ICT solutions for illiterate individuals. These approaches had a significant impact in the achievement of user self-efficacy.

Despite the diffusion of mobile phones, majority of the individuals in rural areas have not switched to internet enabled phones (smartphones), [31, 48]. According to study [49,50] featured phones are still common in rural areas because of prevalence in illiteracy, affordability concerns, long battery life and weak network connections Therefore similar to [19], CLS was a computer based system.

Hence, our investigation and validation showed that critical ICT design needs for rural users include the use of local language, local content, videos, audio, few clicks, touch screen, noise-proof devices, content categorization, peer collaboration, public RICTs and low cost or subsidized ICT resources.

Additionally, location is also important in access and use of RICTs. The design process should be participatory.

We conclude this study by noting that design solutions targeting vulnerable demographics is key to the success of designing for equality. In other words, that which works or usable by the aged, illiterate, uneducated and the poor works best or more usable for the young, literate, educated, and the rich (financially stable). Thus enhancing access and use of rural ICTs.

## VII. Recommendation and Future Work

This study recommends the application of DSRM-RICT integrated design and development model and the Fogg frameworks. These methodologies are critical in the design and development of ICT artifacts with enhanced user experience.

CLS was computer based system. Therefore, following the DSRM-RICT integrated design and development model, together with integrated Fogg persuasive frameworks, future researchers are recommended to design and evaluate rural artifacts for mobile phones.

Also, future studies on rural informatics can look at various multisensory methodologies which can foster user engagement with the ICTs, for example apart from auditory (audio) and visual (video), they can consider haptic (tactile feedback).

Additionally, rural informatics researchers are encouraged to create interactive simulations which will enable users to practice a task as of real world.

Finally, this study observation is, however usable the artifact is, users may decline to access it if the location is not favorable. FBM [4] asserts that ability is comprised by anything that makes it difficult to perform a task. This in turn influences motivation in a negative manner, rendering the triggers (awareness) meaningless. Therefore, for accessibility purposes, this paper recommends strategic placement of rural ICTs.

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