PAPER

Deconstructing Heat Stress: Communicating Bottom-Up Heat Stress Resilience for Self-build Housing in Nigeria

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In Nigeria, heat stress is responsible for significant health complications and loss of lives. Rising temperatures in the country are exacerbated by unbridled anthropogenic activities including deforestation, poor urban planning, and urbanization. Low-income households, single mother led households, and households with the elderly and/or people with disabilities, are especially vulnerable to heat stress because of their limited response to unreliable & failing energy infrastructure in the country. Consequently, to mitigate heat stress, many households heavily utilize gas-powered generators and mechanical cooling systems, which unfortunately contribute to both high energy burden amongst low-income households and increased environmental pollution. Adapting to heat stress is paramount in saving lives and reducing significant costs. It is especially important, as a large part of the populace develop and build their own homes in a widely practiced process called self-building. Fortunately, a systematic approach to literature review of over 40 ethnographic peer reviewed literature determined successful bottom-up heat stress resilience strategies used by households in tropical global south, such as in informal settlements. However, successfully disseminating these findings to self-builders in Nigeria would encounter challenges. Although some of these design solutions are local knowledge in other regions of the global south, they may be unfamiliar to self-builders in Nigeria; thereby, requiring steep learning curves for households–many with limited formal education–to effectively incorporate these bottom-up strategies in their housing. Furthermore, there is a communication barrier due to the multiple languages, nomenclature, and subcultures in the country. To address these challenges, this research study used participatory design through focus groups involving a cross section of Nigerian self-builders, to develop a step-by-step design guide using nontechnical descriptors (visuals, illustrations, jargon) to break down complex and technical architecture and engineering designs. This paper highlights findings from the participatory design sessions which will be evaluated through inductive analysis to determine themes on the 'best' design elements for the guidebook, communication methods, and effective learning techniques for self-builders in this region. The paper will also provide insight on performing participatory design sessions in countries within the global south, and the methods for promoting stakeholder engagement while navigating different subcultural, socioeconomic, and language boundaries.

INTRODUCTION

The health and well-being of households in Nigeria, especially in dense urban tropical cities such as Lagos, Abuja and Port-Harcourt are consistently affected by indoor heat stress. Heat stress affects mental health, increases susceptibility to food & vector borne diseases, & exacerbates existing cardiovascular health conditions.[1,2] In extreme cases, high temperatures over short and intense or prolonged periods of time can also be fatal.[3,4] With high temperatures lasting months at a time, the elderly and other vulnerable groups including children and pregnant women are most at risks to heat-related health illnesses and premature mortality. The elderly residents are especially vulnerable to high temperatures due to changes in their physiology and increased susceptibility to chronic health problems.[3]

Globally, there has been a total of 12,429 deaths and 761 injuries reported in the last six decades due to heat waves in the Global South (EM-DAT, accessed July 2021). Per EM-DAT, there was also approximately $400,000 in total damages from heat waves that occurred in the years 2000 and 2003 in Morocco and India, respectively. Over 99% of the total damage came from Andhra Pradesh, Orissa, Tamil Nadu, Vidarbha, Chhattisgarh, Jharkland, Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar provinces in India. The temperature reportedly reached 120.2°F (49°C), temperatures hot enough to melt asphalt and pavement.[5,6] With climate change amplifying these conditions, heat related fatalities is expected to increase. Nigeria especially, has seen a significant and steady rise in temperatures since the 1980s (0.2-0.3°C per decade).[7]

Mitigating the impacts of heat stress on well-being and improving occupant comfort is primarily achieved through mechanical cooling systems. However, unreliable energy supply limits the use of artificial cooling systems within homes, increasing occupants' sensitivity and exposure to heat stress.[4] More than half of the population do not have access to grid-connected electricity, and those connected are resigned to unreliable power supply, leading to frequent power outages.[8] Unfortunately, the burden of these inefficient institutional systems is carried by the residents, especially self-builders whose funds and resources are being stretched but often results in less than substantial work and low utility (satisfaction).

Furthermore, the low electrification rate increases a household's indoor thermal burden as they will be unable to use mechanical cooling systems such as fans and air conditioners. In these instances, passive design strategies such as opening windows could work to improve households' thermal comforts, but they are often unable to effectively use these strategies due to their housing environments and poor housing structures. Many lower income homes may not have operable windows or have any windows at all. Municipal services are also decentralized, which may leave many households without water to cool themselves or stay hydrated.

In cases where households do have access to air conditioning, the significant costs of utilizing alternative energy supply methods such as gas-powered and portable generators is overwhelming and contributes to high energy burden, especially amongst low-income households.[3,9,10] Per reference,[10] "Nigeria has one of the highest rates of energy poverty in the world ". Furthermore, in 2015 Nigeria contributed 506m tonnes of CO2 equivalent (MtCO2e) in greenhouse gas emissions, an amount equivalent to the UK's total emissions that year.[10] Furthermore, reference[3] explains that due to the significant increase in heat stress and high population density, the greatest increases in cooling demand in Africa will occur in Nigeria.

State governments provide top-down, reactive approaches such as cooling centers and emergency communication, however, they often fail to meet the daily needs of urban dwellers. Furthermore, infrastructural approaches alone are not enough to cope with climate uncertainty.[11] Governmental decision-makers are now left with questions on how to provide comprehensive and long-term resiliency solutions for their constituents. However, due to the complex and uncertain environment of housing resiliency construction, decision making needs to consider the input of all stakeholders, especially the beneficiaries of these decisions. Furthermore, efforts from decision makers at the household level are necessary to build adaptive capacity, therefore, allowing individuals to respond to disruptions as they occur and evolve to meet new conditions.

Considering these issues, the research through a systematic approach to literature review (SALR) process, investigated the solutions that are used by households in both Nigeria and other tropical global south regions to improve thermal comfort, and promote minimal reliance on the grid and gas-powered generators. These findings culminated into a list of over 60 heat stress design solutions. These are primarily vegetative and passive such as tree planting, operable windows, DIY insulation, and double walling. Some solutions are based on indigenous knowledge such as the use of *golpata* leaves and palm fronds for roofing and building outdoor living areas.

However, per findings from the SALR, many of these solutions are not well known by self-builders in Nigeria. Hence, to promote the effective adoption of these strategies in mainstream housing, the research focused on how to communicate the implementation of these solutions to self-builders more effectively than traditional building plans. This is important because self-build which is the mainstream housing delivery method in Nigeria,[12,13] is performed by a variety of people, many who do not have formal education or technical backgrounds,[14] and so traditional building plans with high level details, structural components, and technical jargon will need to be deconstructed to increase user comprehension.

Consequently, this research employed human-centered design techniques involving participatory design (PD) elements and evaluation methods to address this need and effectively explain the implementation of available design solutions to self-builders to improve their decision making. However, designing solutions "*for*" rather than "*with*" the target community (stakeholders) does not effectively capture and address the different unique features of stakeholders' wants/needs, especially for households with higher vulnerabilities. Per reference,[15] user-centered approaches recognize that designers need to capture emotional responses of users, as that drives interests in products. Reference[15] further explains that by employing techniques that include working with potential users, designers expand their horizon, and may also address any bias that may limit the effectiveness of any product designed.

The Field Guide to Human-Centered Design,[16] also explains that human centered design means "believing that the people who face those problems every day are the ones who hold the key to their answer." Hence the guidebook design process was collaborative and included two iterative participatory design phases through focus group discussions (FGD). Designing solutions by involving members of the case study community in the process of planning, designing, and testing the guidebook as a solution to filling the simplified communication gap, allowed for a deeper understanding of stakeholders needs and wants (both direct and indirect), and directed the design process to address their diverse cultural, social, institutional, and economic needs.

METHODOLOGY

Two phases of unstructured FGDs were used as the PD technique to elicit feedback from stakeholders on communication modes, terminology, and design elements that improve the quality of the guidebook and enhance comprehension by diverse group of decision makers. Phase one included three sessions with twenty-two participants, and phase two included two sessions with twelve participants. Phase one occurred between June and

July 2021, and phase two occurred in October 2021. An ethics protocol by the institutional review board (IRB) at CMU was followed and approval was granted for the focus groups.

RECRUITMENT AND SCREENING

Phase one was primarily a co-creation session for a communication method, and phase two was primarily an evaluation session of the step-by-step guidebook. Both phases of the FGD's were conducted online through *Zoom*.

1. A random sample of adults who fit one of the following criteria were recruited.
2. A person who currently self-builds housing in Nigeria
3. A person who self-built housing in Nigeria within the past five years
4. A person currently residing in Nigeria and is interested in self-building their housing now or in the future
5. A Nigerian citizen residing in another country (except EU and EEA countries),[17] who is interested in self-building their housing in Nigeria (now or in future).
6. A built environment professional living in Nigeria (including architects, engineers, construction managers, labor).

There was no ceiling for income, age, education, or expertise for expected participants. This is because literature suggests that self-builders have a range of socioeconomic characteristics from low income to high income and utilize a range of network relationships including serving as labor and serving as financier. Majority of participants were conversant and/or fluent in at least one additional language spoken in Nigeria beyond English, including *Yoruba, Ijaw, Pidgin, Igbo, and Hausa* languages, and a large portion of the participants spoke Pidgin–another common language spoken within the country. However, non-English speakers were excluded from the sample due to the additional requirements of getting a translator to engage in the sessions.

DEMOGRAPHIC PROFILE OF PARTICIPANTS

For phase one, seven participants attended the first session (session I), seven participants attended session II, and eight participants attended session III. In total, 32% of participants reported their sex as female, and were between 19 and 29 years old; and 68% of participants reported as male between 21 and 38 years old. As it was a random sample and based on participants availability, there was no external influence and/or control of the age of participants that signed up, however efforts were made to create sessions that represented the sample of age groups available. The sessions in this phase were grouped into three activities, i.e., *instructions, terminology,* and *prototypes review*.

The feedback from phase one indicated common factors and themes that are important for learning, comprehension, and desirability across a group of experts and non-experts. The themes were used to prepare the second iteration of the guidebook which was further evaluated by participants in phase two. Using 10 questions administered via a poll, the participants also validated that the guidebook was effective in improving their decision making on the implementation of heat stress resilience design solutions. In phase two, 58% of participants reported their sex as female and were between the ages of 22 and 30; and 42% reported as male between the ages of 19 and 35. Screening was done to select a more comprehensive group of people with broader age group and diverse educational attainment, because of the smaller sample (n=12) compared to phase one.

THEMATIC AND DESCRIPTIVE ANALYSIS OF FEEDBACK

The researcher served as a *design partner*, and neutral participant that focused on moderating the session, summarizing key points, and probing into participants discussions in order to generate further conversations. This research study uses the term design partner in lieu of moderator, to emphasize collaboration and co-creation.

A combined coding approach of inductive and deductive coding was used for the thematic analysis of the transcripts from each session. The deductive coding was used because there were established broad codes which framed the three "activities" within the first phase. Inductive coding was exploratory and used to determine the themes and patterns from the FGD's. Within these two approaches, in vivo, and values coding were used interchangeably throughout the thematic analysis. Specifically, in vivo coding was used for the first round of coding to determine the broader categories before re-categorization of themes and codes.

Coding was done manually on the transcriptions; however, the transcription of recordings was performed using the *Otter.ai* program and manually reviewed and edited where applicable, for accuracy. The codes were developed to represent the themes that supported designing instructions and improving the guidebook during both iterations, this included codes for terms that explain characteristics of efficient communication guide, and elements that will improve comprehension. Re-categorization was further done through an iterative and inductive process which included matching themes that were similar or had the same meaning to existing codes or creating new codes to better capture themes and phrases.

All sessions were reviewed for each activity thoroughly, and codes were combined and re-assigned to address the aim of preparing directions and instructions for enhanced comprehension and learning. The number of "hits" (times) a term, phrase, or theme was mentioned uniquely was included in the analysis and represented by a color scheme in the thematic diagrams. This was done to ensure that the thematic diagram illustrated the common beliefs, attitudes, and values of the participants.

Lastly, relevant, and significant statements were highlighted within the transcriptions and incorporated as direct quotes in this chapter. All tangential contexts were also explained in detail within the respective subsections. Descriptive statistics were completed in Excel and utilized to determine the frequency of responses to the polling questions. It was also used to evaluate the change in confidence implementing design solutions during the polling activity in phase two.

FINDINGS FROM PHASE 1

Thematic analysis of the data determined four main themes to design instructions. The analysis also determined guidelines for selecting and using terminology to improve communication, and six main themes for designing a simplified communication tool for self-build housing decision support.

INSTRUCTIONS ACTIVITY

Participants were split into two groups and sent into separate break-out rooms in *Zoom* to discuss preparing instructions to perform tasks they were assigned. The two tasks included,

- **Team A**: Transplant a full-grown coconut tree from a farm to a site 5 km away
- **Team B**: Build a concrete wall (fence) around a small site

Participants had to prepare instructions that would be detailed and clear enough for the other team to perform the task easily. Also, the team had to prepare the tasks without revealing the title of the task to the opposing team. Furthermore, participants were given no specific direction on the medium to use in preparing the instructions and were assigned ten minutes to prepare the instructions before coming back into the main room to present it to the opposing team. There were no wrong or right answers, and the research was interested in understanding the level of detail that would be included in the instructions, and the mode used for explaining it. Presenting the team with a blank slate on how to pursue the creation of instructions for their tasks, was used as a tactic to get insights on their values and preferred mode (s) of communication. It was also used to get insights on how the other team would respond to medium/ media of communication and if they would easily and clearly comprehend the instructions presented to them.

One of the main insights from this activity was that time constraints governed the selection of communication media. Many reported that based on time constraints they used verbal medium to explain the instructions and would have utilized visual (pictures and illustrations), audio-visual, or visual with texts to improve comprehension. Furthermore, personal learning styles influenced comprehension of instructions, more than complexity of the instruction.

Participants from each team were also asked to provide feedback on their own instructions and their opposing teams instructions. Overall, each team understood the instructions to a certain degree, however, no team understood the instructions effectively and always required more detail to understand the task. Majority of the feedback provided to improve the instructions involved using terminology specific to the task and using terms that were necessary and straightforward. These comments were coded as represented in Figure 1.

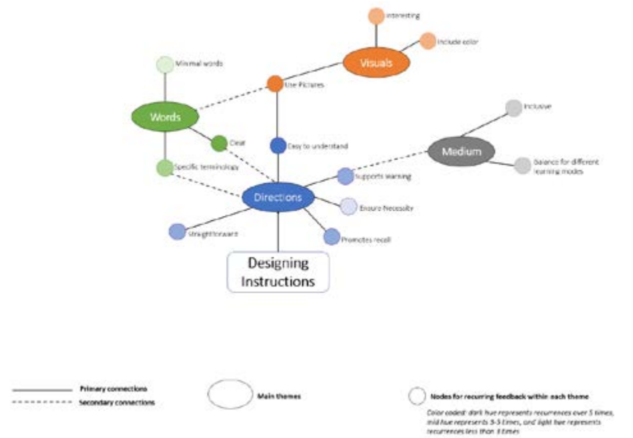

Figure 1. Thematic Diagram illustrating participants feedback for effectively designing instructions

TERMINOLOGY ACTIVITY

A poll of twelve terms ranging from green infrastructure to fenestration was used to highlight housing related terms that were well-known, somewhat known, and unknown to the group of participants. Participants were given the opportunity to discuss alternative terminology for these terms after description and/ or images were shown to understand these terms. The terms frequently selected as unknown included plinth, stilts, soffit, laterite soil, bioswale; and the frequently known terms included trowel, scaffold, waterproofing – which was mainly associated with damp proofing, fenestration, gutter, rebar, and studs.

It was a mixed bag of known and unknown terms, and the degree of knowledge varied by personal exposure to the term or item in daily life, as opposed to education or technical background. When queried on the use of native languages or Pidgin in lieu of some of the terminology, especially the frequently unknown terms, participants were of the consensus that it would be counterintuitive to communication or learning.

As an alternative, participants from all three sessions reached the same consensus to use the industry standard jargon in English because it is the official language in Nigeria and include alternate and/or simpler terminology where applicable. Industry standard was stated as especially important method to address the multiple languages and diversity of potential users. It would prevent any bias in selecting terms that may enhance comprehension for one tribe or group over another. The second consensus was to include a relatable visual such as an illustration, icons, or image that represents the term and can effectively communicate to members of the target audience.

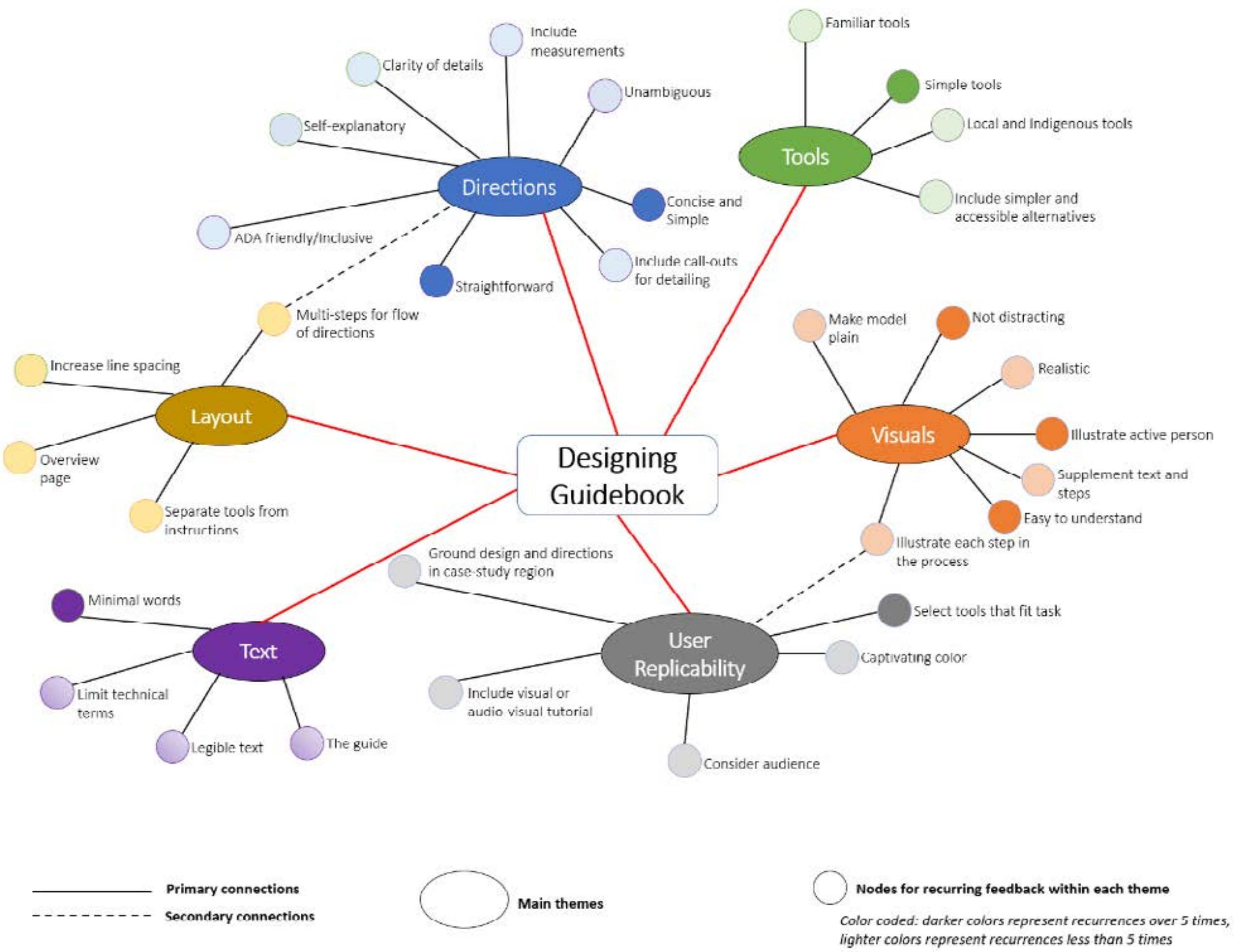

Figure 2. Thematic Diagram illustrating participants feedback for improving the guidebook

PROTOTYPE REVIEW ACTIVITY

Participants were asked to review three prototype designs in three formats, Type A, Type B, and Type C, and provide both first thoughts and in-depth feedback that would be used to design the final guide. Type A, a single sheet layout, emphasized the use of visuals to depict the construction of stilts for flood avoidance in new construction on a single sheet. Type B a single-sheet layout primarily in black and white, emphasized minimality and directional flow elements to depict the installation of insulation for a heat barrier in existing construction. Lastly, type C utilized multi-sheets, visuals, and minimality to show the different steps involved in building a pergola for minimizing heat exposure in both new and existing construction.

The main themes from the in-depth evaluation of the three prototypes include improving directions, layout, text, visuals, and user replicability elements. The feedback also emphasized the careful selection of tools and materials that reflect the stakeholders needs in the case-study region include in the guidebook. Figure 2 highlights the cumulative feedback from the review of all three prototypes.

No consensus was reached on preference of displaying the instructions in multi-sheet or single sheet format. However, from the participants that commented on the format (n=11), majority expressed content with multi-sheets than single sheets. The main pros of the multi-sheet reported by participants include.

- Helps improve low-attention span
- The stage-by-stage format increases passion to read the guide
- Each sheet has a particular mission to capture
- Aesthetically pleasing when separated on different sheets
- Less chances to be confused about the directions
- Helps track progress

Overall, *easy, seamless, clear,* and *simple* were largely associated with the multi-sheet format. Some participants reported that the single sheets were cluttered, not seamless and lacked directional flow–a user would not know where to first look in the sheet. Participants did appreciate the arrows in Type B that showed the directional flow, however, stated that it missed the balance between directional flow and effective visualizations.

Figure 3. Updated diagram illustrating the stools on individual sheet, and local/simpler alternatives suggested

Furthermore, participants reported that a single-sheet would not help a user determine errors in their process, while a multi-sheet will help you "back-track" the process.

However, three participants argued that a single sheet had all the information needed on a single page. They explained that "flipping" through multiple pages is exhausting and a single sheet is comforting because the work did not look daunting, and they would know that they were done with the tasks once they completed the single sheet. Single-sheet proponents also recommended that to address the lack of directional flow on single sheets, "steps" or "phases" should be boldly stated for the different tasks, hence, users are aware of where to begin, the next steps, and where to end the work.

Moreover, proponents of multi-sheet laid stronger points than single sheet supporters, hence leading to the decision to proceed with multi-sheets in the second iteration. Nonetheless, the second iteration utilized suggestions from both single sheet and multi-sheets, by aiming to strike a balance between providing enough detail and limiting the number of sheets to prevent fatigue from "flipping a lot".

FINDINGS FROM PHASE 2

ITERATION OF PROTOTYPE

All participants were sent the complete set of sheets of the updated prototype, through the *Zoom* chat to review during the

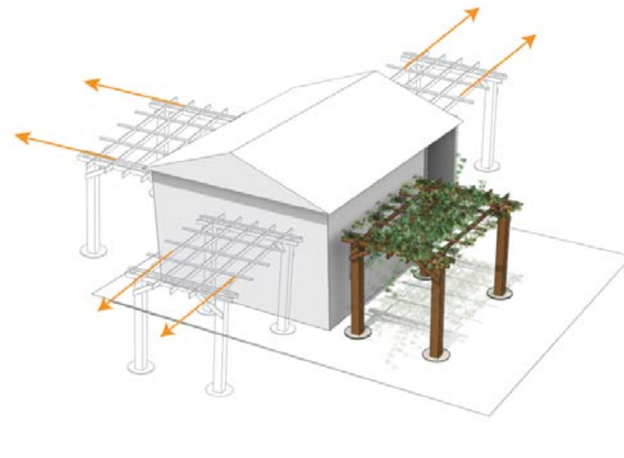

Figure 4. Updated diagram illustrating the massing of heat stress design action "build pergola" for overview sheet

evaluation activity. Overall, participants reported that the guide was simple and straightforward, and the steps assure users that the process is not as labor-intensive as initially thought. Many participants explained that they would have confidence in implementing the design properly while using the guidebook, and one participant specifically called it a "low-tech blueprint". Further providing feedback, the participant explained that the guidebook properly provides a balance between primary and secondary information. The primary information is detailed, and the secondary information such as *measurements*, complements the primary information without overwhelming the user.

Many of the positive comments were reflections of prior sessions and confirmed the design captured participants feedback and emphasized the benefits of designing with stakeholders. The consensus was the step-by-step guidebook improved understanding of how to implement a design solution and was a valuable decision-making tool. However, participants suggested five main points that would improve the overall layout of the guide and further position the guidebook as a planning tool. The suggested improvements include.

- Including only tools and materials locally used in the region
- Separating materials and tools into different sheets (Figure 3)
- Providing simpler and more accessible alternatives to tools and materials (Figure 3)
- Using arrows to indicate flexibility in the placement of the pergola based on its massing (Figure 4)
- Include a sheet prior to the overview sheet that explains the expected duration of the process, and suggested weather conditions (if applicable) to do the task.

Figures 3 and 4 show some of the changes in the final version of the guide.

VALIDATION OF GUIDEBOOK

The effectiveness of the second iteration of the guide was evaluated in both sessions during phase two through the real-time polling questions via the zoom teleconference platform. Participants were given the 13-page step-by-step instructions to build a pergola to review. They were asked to rate their understanding of the step-by-step instructions for building a pergola, on a 5-point Likert scale from *very easy to understand* to *very difficult to understand*. Participants were also asked three questions prior to receiving the guidebook and four questions afterwards. They were expected to rate their confidence in implementing the guidebook successfully on a 4-point Likert scale from *very successfully* to *unsure*.

When given the guide, all participants responded that they understood the instructions, with the majority reporting that the instructions were easy to understand (n =6), four responding it was very easy to understand, and two responding it was somewhat easy to understand. Further verbal feedback indicated that the guidebook was straightforward, and the step-by-step format broke up the work into phases, allowing users to digest the information for each phase.

Regarding successfully building the pergola, the majority of participants (n=11) reported being able to build a pergola *somewhat successfully* when given instructions. The change is considered significant as many participants initially responded *not successfully* and cited labor intensiveness. This indicates that the instructions provide a perception of lower labor requirements. Figure 5 illustrates participants' change in confidence in successfully implementing heat stress design solutions before and after reviewing the guide.

One of the participants expressed that the instructions make the work easier to do, especially with the list of materials and tools that can be easily accessed. The singular participant that reported *very successfully* explained the instructions were self-explanatory and with the aid of someone, they would be able to build it. Participants that responded *somewhat successfully* in session I, also expressed concern that they would not be able to do it properly without a partner, or it would not be properly built without a professional but noted that the instructions were clear enough to give them confidence to attempt it. Others in both sessions explained that with repeated attempts over time, they would be able to build the pergola very successfully.

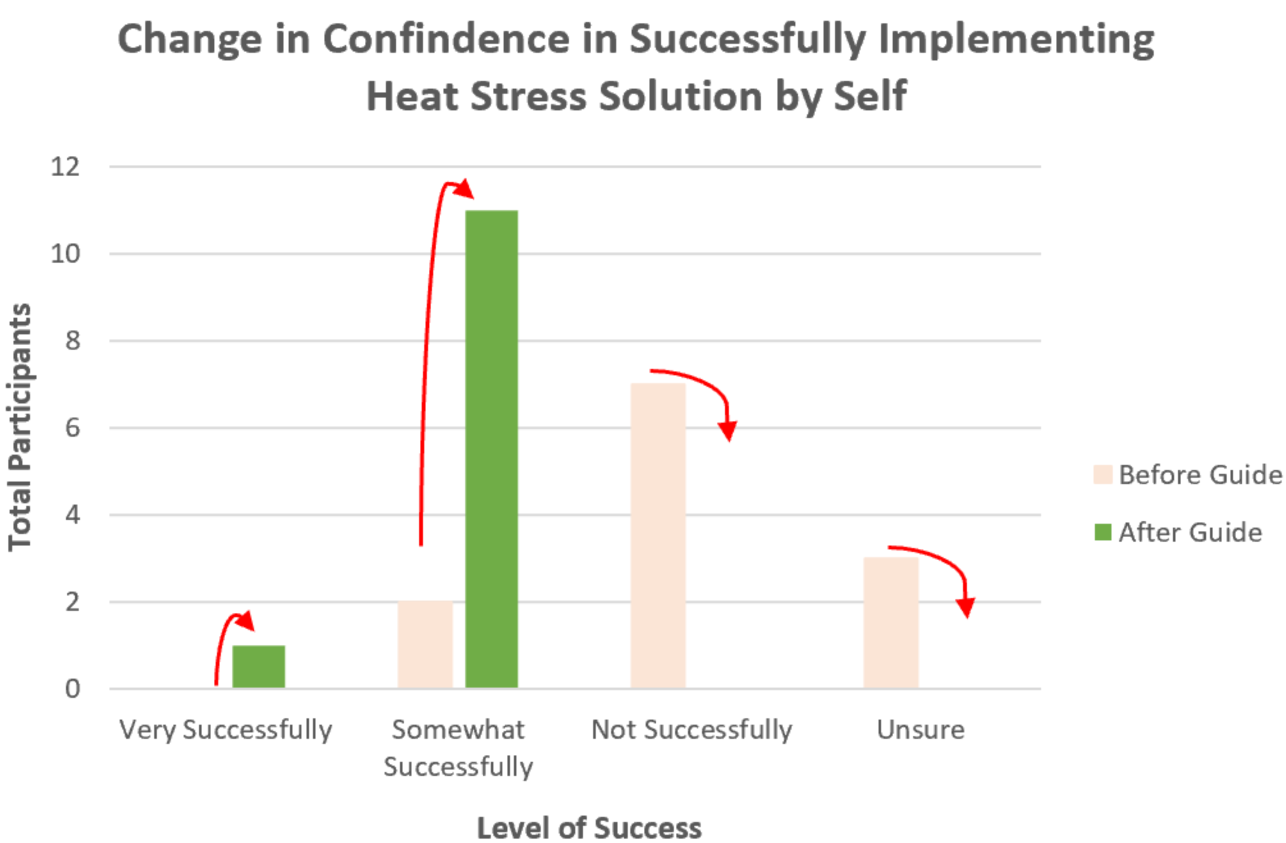

Figure 5. Change in confidence in successfully implementing heat stress design solution before and after the guide

DISCUSSION

Overall, participants expressed greater interest in heat stress resilience in housing, self-build, and taking control of their decision-making. Per one participant, the challenge in promoting heat stress resilience in housing is the limited knowledge and lack of expertise of the people implementing the solutions. However, he believes that with instructions, it will be much easier to implement it either alone or under supervision by someone experienced, stating that the instructions "definitely make a difference". The findings from the evaluation of the guide indicate that the guidebook will have a positive effect on adoption of heat stress resilience design solutions in self-build housing. The findings also highlight the benefits of using a combination of design elements including text, visuals, directions, and layout of the instructional resource/material to effectively communicate technical information to stakeholders with varying levels of education and technical knowledge, and different backgrounds and learning styles.

One of the significant aspects of the PD sessions was to develop the guidebook to serve as a recommendation and decision-support tool rather than to mandate or force the implementation of the design solution. By striking that balance, the guidebook supports adaptive capacity at the household level, and leaves the power of decision-making in the hands of the self-builder and provides them with the resources to improve their own resilience. This is especially important because of the cultural, economic, and societal barriers that limit stakeholders' access to resilience information in many cities in Nigeria, thereby restricting the widespread adoption of resilience solutions, especially in underserved communities.

Overall, literature has highlighted participants' limited understanding of the design process, variations in socio-economic levels, participant motivation, and strong social hierarchies as challenges that limit widespread adoption of PD in projects involving underserved communities. Reference[18] call for research to address the need of effectively performing PD research in the Global South, and this research contributes to the growing body of research that addresses this gap.

PERSPECTIVES FROM THE FOCUS GROUP SESSIONS

Interactions of participants during the sessions were insightful, reassuring, relaxed, and participants were generally forthcoming with comments and answers. However, there were instances where most of the participants were not forthcoming and required encouragement from the design partner. These instances mainly happened during first questions that asked for first thoughts on the prototypes. However, these instances were seemingly contained with first questions, as participants were very forthcoming during probing questions and in-depth discussions. There may have been apprehension sharing their perspectives during questions directed at their critique/opinion of a new concept, but comfort creeped in once the conversations flowed.

Furthermore, participants were less receptive to expressing their comments via markup than speaking about their changes. Only a small number of participants opted to use the markup tool on zoom to describe their comments and changes, yet many other participants did not despite continuous suggestions. Overall, participants, specifically from session III in phase 1, engaged deeply with the instruction's activity, providing intensive critique to both their own team and the alternative teams instructions. They recognized that effectively preparing instructions that can be understood widely was a "difficult task" due to possible misinterpretations and oversight of details. Additional key takeaways from participants' behavioral responses include.

- Deep understanding of the culture, subcultures, and societal governances/influences
- Participants reported appreciation of being involved in the design process
- Participants expressed improved understanding of heat stress resilience by engaging in the PD session (capacity building)
- Participants reported being hopeful of future change in heat stress resilience within their communities

Other significant perspectives from the sessions came from the participation of the design partner. The design partner was instrumental in enhancing discussions amongst participants and diving further into shared perspectives on the main area of conversations, as well as other tangential areas that provided further insight into the research.

LIMITATIONS OF THE STUDY

The main limitation of the study is the small sample size common with FGDs. Generalizations to the population cannot be made, however the exploratory format of FGDs allows for insights that provide an outlook of the population and provides broad findings on lessons learned that may be transferable to other regions. Another limitation from the study is non-verbal data could not be captured for the majority of participants because many participants had their video cameras switched off. However, expressive tones and use of expressions and colloquial exclamations such as "Chai" and "Vibes" during the conversation indicated certain behavioral responses that contributed to the insights.

CONCLUSION

This guidebook is freely accessible to self-builders online. This paper discusses the lessons learned from the design of a step-by-step guidebook to guide self-builders' decisions to implement flooding and/or heat stress design solutions, by illustrating how the solution may be designed and applied in their context. The paper also provides insight on performing PD sessions in Nigeria, with techniques that can be transferred to other countries within the Global South, and the methods for promoting stakeholder engagement while navigating different subcultural, socioeconomic, and language boundaries.

The in-depth feedback from two phases of FGD were extremely valuable in designing the easy to use, step-by-step guidebook as a communication tool. The process determined important elements required for developing an effective communication guide for the research scope. The process also highlighted the importance of observation of behavior and participant responses in human centered design. The comments from the iterative design process in addition to the evaluation by phase 2 participants lends to the case of utilizing illustrations and texts when developing communication and learning tools for groups with varied socio-economic characteristics.

To conclude, this guidebook will improve decision making in diverse groups of people with varying socioeconomic stances. The guidebook will help alleviate the financial constraints of many households and has the potential to improve & foster resilience education. Lastly, this guidebook may influence policy on climate resilience and adaptation, specifically in housing & energy sectors. For example, Nigeria's 2020 framework report for its National Adaptation Plan outlines guiding principles for adaptation which include involving youth in decision making, focusing adaptation on communities, and incorporating indigenous knowledge.

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