

Co-Designing with Users: Towards a Persuasive App to Promote the Adoption of Appropriate Malaria Prevention and Control Behaviors in Developing Nations

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Abstract. In recent years, persuasive technology research has gained traction in the Global South. Persuasive strategies have been incorporated into user-based technologies to motivate desirable behaviors in domains such as: eCommerce, sustainable environment, and in various healthcare domains. Many primary healthcare studies have shown that malaria, which is transmitted via the bites of female anopheles mosquitoes is one of the most common illnesses in sub-Saharan African nations such as Nigeria. It is one of the commonest causes of deaths amongst pregnant women and children (under five years). Although national governments and relevant healthcare stakeholders have deployed various strategies to fight this health menace, however, mortality rates resulting from malaria especially amongst pregnant women and children has continued to rise. This may be unconnected to various behavioral and social factors. In addition, there is lack of persuasive interventions that could be deployed to support users to adopt desirable prevention and control behaviors. Therefore, this research examines new ways of motivating individuals, especially pregnant and nursing mothers to adopt appropriate malaria prevention and control behaviors in developing African nations. As a first step towards contributing to research, we conducted a user-based research to uncover the factors that prevent the adoption of the measures, and the strategies that could be employed to motivate users to adopt appropriate malaria prevention and control behaviors. Mapping the results to their corresponding persuasive strategies and operationalizing them in a mobile platform, we show how persuasive technologies could be co-designed with potential users and personalized to promote the prevention and control of malaria diseases in the global south.

Keywords: Malaria Prevention and Control, Persuasive Technology, Persuasive Strategies, Behavior Change, Mobile Apps

1 Introduction

Studies have shown that persuasive apps for behavior change encourage individual and communal actions in numerous domains of human endeavors such as: water, energy,

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mobility, and sustainable waste management [1, 6, 11, 12, 19, 23]. Research also reveals an increasing application and integration of persuasive technologies in the health and wellness domain [18]. In the Global south, there is a significant increase in healthcare research amongst indigenous persuasive technology researchers [8]. Berkovsky et al. [3] opines that tailoring persuasive strategies has “huge untapped potential to maximize the impact of persuasive applications”. This is seen as persuasive strategies have been used to recommend culturally sensitive guidelines for designing persuasive apps for various domains. In the health domain, persuasive strategies have been employed to tailor important information, send notifications and reward outstanding performances. Consequently, these strategies are increasingly being incorporated into various kinds of apps to support users to adopt appropriate healthcare behaviors without coercion or the use of force [13]. Although national governments and relevant healthcare stakeholders have deployed various strategies to promote the adoption of appropriate malaria prevention and control behaviors, however, mortality rates resulting from malaria especially amongst pregnant women and children has continued to rise. This may be unconnected to various behavioral and social factors. In addition, there is lack of persuasive interventions that could be deployed to support users to adopt desirable prevention and control behaviors.

Therefore this paper seeks to uncover the factors that affect the adoption of appropriate malaria prevention and control behaviors, with a view to recommending socially responsible guidelines for co-designing a mobile persuasive technology to promote the adoption of appropriate malaria prevention and control behaviors in the local communities. In order to drive research and contribute to the body of knowledge, we conducted a user-based research to uncover the factors that prevent the adoption relevant malaria prevention and control measures put in place by government and healthcare stakeholders. Secondly, we sought to find what strategies could be employed to motivate users to adopt appropriate malaria prevention and control behaviors.

The findings of our studies show that users exhibit negative attitudes toward adopting relevant malaria prevention and control measures put in place by government and healthcare stakeholders. Specifically, we uncovered wrong perception and poor knowledge about malaria prevention and control behaviors, forgetfulness (inability to remember to perform timely malaria prevention and control activities, and lack of communal cooperation, as some of the negative attitudes of the people. In addition, we uncovered that there is dearth of personalized technology platforms, integrated with appropriate persuasive strategies which will have the capacity to encourage the adoption and utilization of those malaria prevention and control measures in the communities.

Mapping the results to their corresponding persuasive strategies and operationalizing them in a mobile platform, we recommend specific guidelines that could be used to co-design a Malaria Prevention and Control Support System (MPCSS) with users; a persuasive technology that has the capacity to help users adopt appropriate malaria prevention and control healthcare behaviors in developing African nations.

2 Background of Study

Persuasive technologies are interactive systems (mobile, desktops and games) that help users to perform target behaviors [4][5]. They are integrated with persuasive strategies,

which are the structural pillars that allow it to motivate and assist users to perform target behaviors [14, 15, 18, 19]. In the past, many researchers developed various design steps [4], and strategies [22] which could be employed to design and evaluate persuasive systems. Specifically, Oinas-kukkonen and Harjumaa (2009) came up with twenty-eight persuasive strategies (persuasive system design (PSD) framework) which are categorized into four groups based on the type of support that they provide to users of a system: the primary task, dialogue, system credibility, and social support [15][22]. (See Figure 1 below).

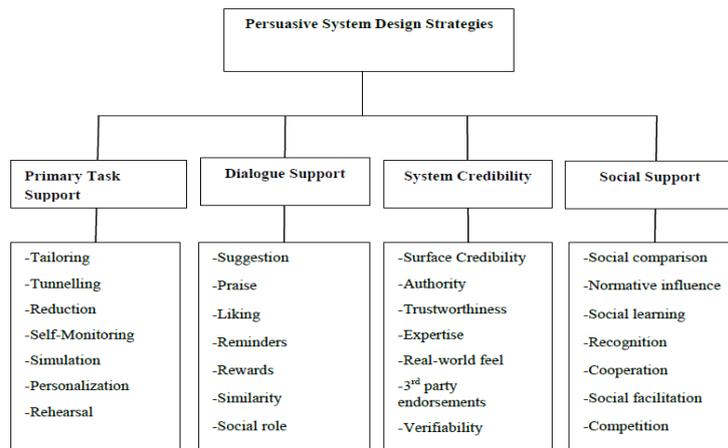


Fig. 1. Persuasive strategies of the persuasive system design framework

Many of these strategies have been employed and have proven to be effective in developing and evaluating persuasive technologies in various domains [1, 6, 11, 12, 19, 23]. In this study, therefore, we employ relevant persuasive strategies present our design guidelines for co-designing a mobile Malaria Prevention and Control Support System (MPCSS) with users that has the capability to help users adopt appropriate malaria prevention and control healthcare behaviors.

In related healthcare studies, malaria, which is transmitted via the bites of female anopheles mosquitoes is one of the most common illnesses in sub-Saharan African nations such as Burkina Faso, Nigeria, etc [21]. It is one of the commonest causes of deaths amongst pregnant women and children (under five years) [9][2]. National governments and relevant healthcare stakeholders have deployed various strategies and initiated a number of social programmes to fight the health menace of malaria. Some of these social health initiatives include: Rollback Malaria Programme, free and subsidized distributions of insecticide-treated nets (ITN), free distribution of malaria drugs, introduction of genetically modified mosquitoes (GMM), environmental fumigation and release of mosquitocidal fungi into the mosquito habitats [7, 9]. However, mortality rates resulting from malaria infection, especially amongst pregnant women and children has continued to rise [9]. This may be unconnected to certain behavioral and social factors. In addition, there is lack of persuasive interventions that could be deployed to

support users to adopt desirable prevention and control behaviors. Therefore, an approach to motivate these group of people to adopt appropriate malaria prevention and control measures and behaviors without coercion is desirable, since it could help to promote sustainable health amongst them. This new approach could be achieved via the combined powers of persuasion and digital technologies [8]. In addition, smartphones are becoming more popular as people conduct all kinds of activities such as banking, shopping, gaming in their smart phones [16]. This provides the avenue for mobile apps to drive changes that can positively impact our health.

3 Method

The goal of this research is to uncover the factors that affect the adoption of appropriate malaria prevention and control behaviors. In addition, we want to map these factors to their corresponding persuasive strategies which can be employed to co-design and evaluate a prototype Malaria Prevention and Control Support System (MPCSS) for the local communities. To achieve these aims, we addressed the following research questions: 1) What factors affects the adoption of appropriate malaria prevention and control behaviors? 2) What persuasive strategies can be used to remedy the factors identified above? 3) How can we adapt and operationalize these strategies in a mobile MPCSS to promote the adoption of appropriate malaria prevention and control behaviors?

3.1 3.1 Study Participants, Data Collection and Analysis

We are using a mixed method for this study and it includes: 1) Survey, 2) Persuasive System Design (PSD) model and 3) Object-oriented Analysis and Design Methodology. This hybridized method were chosen to optimize the benefits of each component methods in analyzing an existing system to discover problem areas, and design an enhanced system for the future.

To achieve our research goals and address research question one and two, we surveyed residents Ebonyi State in the South-eastern region of Nigeria. It consists of 13 local government areas (LGAs) classified under three senatorial zones. This study was conducted between January 2021 and December 2021, in multiple locations such as in homes, village squares, schools, and healthcare centers. The age ranges of the subjects were between 18 to 69 years. We present the demography of the subjects in Table 1.

Table 1. Participants Demography

Total = 196	
Gender	Female (100%).
Age	18-29 (80)41%, 30-40 (102)52%, over 40 (14)7%
Level of Education	Uneducated = (4) 2%, Primary School = (48) 25%, Secondary School = (144) 73%,
Marital Status	Married (160)82% and Single (36) 18%

Using the survey method, we conducted a user-based study of the residents of the community. The instrument used for data collection was the questionnaire which was structured using four points 4-Likert scale ranging from “1 = Strongly Disagree” to “4 = Strongly Agree”. The questionnaire was based on a pre-existing tool developed by Venkatesh [20] and has been validated by Nkwo et al [10]. It was modified for the domain of this research; primary health. We employed random sampling to select and administer our questionnaires to the subjects on different days. We used the basic statistical method to analyze data collected quantitatively via a questionnaire.

The findings from this initial user study will be employed to design a novel mobile malaria prevention and control support system (MPCSS), using Object-oriented Analysis and Design Methodology. In addition, we will map the identified factors to their corresponding persuasive strategies as described in the Persuasive System Design (PSD) model [17]. The persuasive strategies will be operationalized on the MPCSS. Specifically, the support system personalized to the individual users, integrated with text notification/reminder features, as well as relevant social supports such as audiovisuals in both English and local dialects. All of these will give the system the capacity to motivate users to adopt positive malaria preventive attitudes. The overall idea is to co-design the system with potential users, starting with the initial prototype, which will be iterated based on user responses.

4 Results and Discussions

1. In this section, we describe the factors that affect the adoption of appropriate malaria prevention and control behaviors. These answer research question one. The results of our research uncover that people exhibit various attitudes which negatively affects the adoption appropriate of malaria prevention and control measure. In specific terms, we found:
2. “Wrong perception” and “poor knowledge” is one of the major factors that affect the adoption of appropriate malaria prevention and control behaviors in the community. Our respondents believes that malaria is a natural sickness and cannot not be prevented. Many others feel that prevention and control items such as malaria drugs and insecticide-treated nets were developed by Europeans for population control and to reduce the rate of child births in the community. These reasons dissuade the local people.
3. Forgetfulness. This is the inability to remember to adopt timely and appropriate malaria prevention and control behaviors. Even when some of them knows the implications of mosquito bites and malaria sicknesses, many of our respondents confessed that they rarely remember to use spray the insecticides or fix the treated nets for themselves and their children. This may be connected to the time-consuming local businesses and farming activities which they must do to survive.
4. Lack of communal cooperation is another factor that negatively affects the adoption of appropriate malaria prevention and control behaviors. It seems that the residents of the community are careless about the implication of open and non-flowing drain-

ages, as well as poor waste disposal and open defecation, which are veritable breeding environments for the mosquito vectors. A community which understands these facts will work together to maintain a clean and healthy environment which has the capacity to reduce the breeding of female anopheles mosquitos.

In addition, we found that a significant number of our respondents owns internet enabled mobile devices which can be used for web surfing, social media, listening to music and watching videos. This result is important because findings from recent studies shows that increased penetration of mobile and internet technologies in developing nations have expanded opportunities and influenced how users connect and socialize with one another, learn new behaviors and perform desired activities [16]. These developments inspire the design and implementation of new digital health applications that will promote support social engagement, collaboration and feedback amongst various group of users of digital interventions.

5 Mapping Results to Persuasive Strategies

In this section, we identify some social strategies that could be employed to motivate the people to adopt appropriate malaria prevention and control behaviors. Subsequently, we mapped them to their corresponding persuasive strategies of the Persuasive System Design (PSD) model [17] which could be employed to motivate appropriate malaria prevention and control behaviors. The following answers research question two.

5. The factors “Wrong perception” and “poor knowledge” could be remedied by offering the people with tailored correct information about the causes and health implications of malaria. Personalized messages about available and cost-effective malaria prevention and control behaviors could also be provided to the people who reside in different communities. Simulation of the pictures and videos of showing the benefits and otherwise of adopting proper prevention and control measures could also be effective in changing people’s perception and wrong knowledge. Through these avenues, the people will be adequately informed about the causes of malaria and available prevention and control behaviors. They will ultimately become motivated to adopt appropriate malaria prevention and control behaviors and live a cleaner and healthier lifestyle. **We map this to the tailoring, personalization and simulation strategies**, which are two of the persuasive strategies in the primary task support category of the PSD model. The tailoring strategy opines that “information provided in the system will be more persuasive if it is tailored to the potential needs, interests and other factors relevant to the users”. The personalization strategy opines that “a system which offers personalized content or services has a greater capability to persuade”. Simulation strategy opines that systems that provide simulations can motivate by enabling users to observe the link between cause and effects.
6. This factor “Forgetfulness” could be remedied by the provision of regular reminders for the people to adopt and carry out timely and appropriate malaria prevention and control behaviors. Measured and thought-out notifications is necessary which will

remind people to spray the insecticides or fix the treated nets for themselves and their children. Such reminders motivate the people and help them to remember to adopt appropriate malaria prevention and control behaviors and live a cleaner and healthier lifestyle. **We map this to the reminder strategy**, which is one of the persuasive strategies in the dialogue support category of the PSD model. The reminder strategy opines that “a system that reminds users of their target behaviors will more likely help them to achieve their goals”.

7. This factor “Lack of communal cooperation” could be resolved by providing ways through which the people can learn and get the right information about the causes and implication of malaria, as well as available prevention and control behaviors. Public recognition and activities that promote cooperation could be employed to encourage citizens to contribute their quota to maintain a cleaner and healthier environment that is a deterrent to mosquitoes. Providing such learning and public recognition opportunities would help to keep the people informed and motivated, respectively, to live a cleaner and healthier lifestyle. **We map these strategies to the social influence strategies such as social learning, cooperation, and recognition**, which are some of the persuasive strategies in the social support category of the PSD model. Social learning opines that “one will be more motivated to perform a target behavior if one can use a system to observe others performing the behavior”. Cooperation opines that “a system can motivate users to perform a target behavior by leveraging people’s natural drive to cooperate”. Recognition opines that “by offering public recognition for an individual or group, a system can increase its likelihood that an individual or group will adopt a target behavior”.

These persuasive strategies will be operationalized in the new mobile malaria prevention and control support system (MPCSS), which we are co-designing with potential users to support them to adopt appropriate malaria prevention and control behaviors and live a cleaner and healthier lifestyle.

6 Design Recommendations

In this section, we provided answers to research question three. We describe how to operationalize these persuasive strategies in a mobile MPCSS to promote the adoption of appropriate malaria prevention and control behaviors.

8. **Automated and Expert Healthcare Information:** Provision of auto-expert information is one of the ways to tackle the issue “wrong perception” and “poor knowledge”. The tailoring and personalization strategies could be implemented on smart devices as apps such that users will be able to receive customized information about mosquito vectors and enabling environmental factors, as well as the health implications malaria bites. User is provided with personalized access to this information. The user will be able to receive timely health education, suggestions, and supports from the comfort of their homes. In addition, Ignorance and negative perceptions can be tackled via the implementation of the simulation strategy. Simulation of the pictures and videos of people whose adoption of proper prevention and control

measures such as malaria drugs and insecticide-treated nets etc, led to a state of good health, and those who were not knowledgeable and careless with the environment and health led to breeding of mosquitoes, malaria and other sicknesses, and even deaths.

- 9. Provision of System Reminders and Notifications:** Incorporating the dialogue support strategies such as reminder strategy is one of the ways to tackle the issue of forgetfulness. It notifies users about their target behaviors. It can be implemented such that apps can send text/audio/video messages and notifications to users as daily/weekly reminders to take on appropriate malaria prevention and control behaviors, and protect themselves. Such notifications will help to remind people to keep their environment clean, clean up nearby drainages, spray the insecticides or fix the treated nets for themselves and their children. Adopting these measures will certainly reduce mosquito breeding and help the people to live a cleaner and healthier lifestyle.
- 10. Social Support and Cooperation:** Social influence strategies could help to motivate individuals and groups to interact with peers on shared concerns and behaviors about mosquitoes and malaria. People have the opportunity to view, feel norm and learn proper malaria prevention and control behaviors, and healthy lifestyles from similar others in the same community, from their mobile devices. For example, an instant messaging component of the mobile MPCSS could be developed to offer users the opportunity to share and interact with one another about the mosquito vectors and enabling environmental factors, as well as the health implications malaria bites. This forum will also allow users to share how to adopt appropriate malaria prevention and control measures such as: keeping their environment clean, clean up nearby drainages, spray the insecticides or fix the treated nets for themselves and their children. Users will be able to set up environmental cleanup cooperative measures, interact and receive real-time feedback and testimonies from peers, who will help them dissipate away with the fears and wrong perceptions created by age-long held misconception about malaria and prevention and control measures. In addition, users of the forum who adopted appropriate malaria prevention and control behaviors such as: consistent use of net, environmental cleanliness, least malaria treatment (LMT) and makes valuable contributions to discussions in the forum are publicly recognized and displayed on the *wall of fame* in the forum. Operationalizing these social support strategies will motivate users to live a cleaner and healthier lifestyle.

7 Conclusion and What Next

This study sought to uncover the factors that affect the adoption of appropriate malaria prevention and control behaviors, with a view to presenting guidelines that could be employed to co-design new persuasive technology that will have the capacity to support users to adopt appropriate malaria prevention and control behaviors in the local communities. The results of our studies uncovered that “Wrong perception” and “poor knowledge”, about causes of malaria and genuineness of the available prevention and control measures is one of the major factors that affect the adoption of appropriate ma-

alaria prevention and control behaviors in the community. Others includes: forgetfulness, and Lack of communal cooperation amongst the members of community, especially as it concerns incessant open and non-flowing drainages, poor waste disposal and open defecation, which are veritable breeding environments for the mosquito vectors. We identified some social strategies that could be employed to motivate the people to adopt appropriate malaria prevention and control behaviors and successively mapped them to their corresponding persuasive strategies of the Persuasive System Design (PSD) model [17]. Finally, we describe how designers could co-design with potential users and operationalize these persuasive strategies in a new mobile malaria prevention and control support system (MPCSS) to promote the adoption of appropriate malaria prevention and control behaviors.

The co-design exercise with potential users is currently underway as we are utilizing the Object-oriented Analysis and Design OOAD approach which allow designers to use objects and classes to represent essential components and related objects of the system. The OOAD approach involves the following: object-oriented analysis of the processes and procedures of the new system, object-oriented design which is carried out using tools such as flow diagrams and CASE tools, and object-oriented programming which involves actual coding

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