# **Abstract**

**Introduction**

Globally, as of May 2024, 775 million COVID-19 cases and 7 million deaths were reported. Africa regional has reported 9,579,844 confirmed cases and 175,510 deaths. As of August 2023, Malawi had recorded 88,915 cases and 2,686 deaths of COVID-19. COVID-19 still pose a global threat to public health security worldwide.

During the pandemic, digital health technologies were widely used as one way of adaption and advancing human health. In Euro countries like France, Italy, and Spain used digital health technologies for telemedicine, consultation of suspected and confirmed cases, and the TreCOV2ID-19 app for surveillance-contact tracing and case detection.

In Africa, countries like South Africa in the Sub-Saharan region use digital health solutions such as SMS, mobile health applications, telemedicine and telehealth, WhatsApp-based systems, artificial intelligence, chatbot, and robotics to provide healthcare services.

Malawi also adopted some the eHealth innovations, namely the WhatsApp chatbot, District Health Information System(DHIS-2)-One Health Surveillance Platform (OHSP) and Chipatala ChaPa Foni (CCPF) to support the COVID-19 response in the Country. This study aims to assess the effectiveness of COVID-19 Chatbot during the COVID-19 pandemic. the study will use the National Workshop approach to achieve its objective.

**Study Objective**

The main objective of the national workshop is to examine the influence of WhatsApp Chatbot technology in responding to COVID-19 in Malawi.

**Methodology**

The study design is a mixed method using quantitative and qualitative techniques to collect data through a national workshop setting at Mponela. The sample size of the study is 40. strata sampling will be done to select health districts based on the COVID-19 burden using the Cumulative Attack Rate measure. and purposive sampling will be used to select participants from the Ministry of Health (MoH)(20) and the general public(20).. participants will come from 10 health districts of Blantyre, Likoma, Mzimba-South, Mzimba North, Lilongwe, Neno, Zomba, Mwanza, Ntchisi, and Rumphi. the MoH participants will come from district health Hospitals, while the participants from the general public will come from community-based Organizations (CBOs). Data will be collected using the adopted questionnaire based on the Technology Acceptance Model (TAM) and Mobile Application Rating Scale (**MARS**) tool. Quantitative data will be analysed using R-software version 4.3.3

**Results**

# Introduction and Literature Review.

## Global burden of COVID-19

The first coronavirus disease 2019 (COVID-19) cases were observed in Wuhan City, China. The investigations indicated that the disease onset was in December 2019(1). Despite COVID-19 being declared as no longer a public health emergency of international concern (PHEIC), the global community still faces the public health threat of COVID-19. In May 2024, 124,889 new cases were reported worldwide. As of May 2024, cumulative confirmed cases reported were 775 million and 7 million deaths worldwide. The European continent was heavily affected, with over 279 million cases and 2 million deaths. The least affected continent was Africa, with 9579,844 confirmed cases and 175,510 deaths(2).

## Epidemiology of COVID-19 in Africa

Despite the pandemic spectrum of COVID-19, Africa has not been spared from the global pandemic. The first case was reported in Egypt in February 2020(3), and since then, all countries in the region have been grappling with the disease. South Africa, in particular, has borne a significant burden, contributing 35% of the confirmed cases and 42% of the reported deaths. However, one of the critical challenges faced in the region has been weak surveillance and laboratory capacity, which has led to the under-reporting of COVID-19 cases. For example, the region conducted the fewest tests compared to its population size, indicating the challenges faced(3).

## Epidemiology of COVID-19 in Malawi

The first case of COVID-19 was reported in April 2020. As of August 2023, Malawi had recorded 88,915 cases and 2,686 deaths of COVID-19. All 29 health districts in Malawi were affected. The Burden of the pandemic was mostly in the City districts of Blantyre, contributing 24,895 cases and 697 deaths; Lilongwe, 20,684 cases and 618 deaths; and Mzimba North (Mzuzu City), 5,385 cases and 128 deaths. The three health districts contributed 57.3% of the total cases and 53.7% of the reported deaths(4). However, actual infection burden and fatalities are not estimated due to the limited capacity to test and surveillance, as in the case of the whole region(3,5). One initiative to strengthen COVID-19 responses in Malawi was using innovative digital health technologies(6)

## Digital Health Technologies and COVID-19

Digital health technologies were widely used globally during the COVID-19 response. These technologies helped fill in gaps for healthcare services created by public health measures that were put in place to hinder disease transmission. For example, during the first and second waves of the pandemic, many countries had to implement measures such as total lock-down, which included closing schools, restricting mass gatherings and social distancing. This setting promoted adopting digital health solutions such as telemedicine as an alternative and preferred healthcare model where physical visits were impossible (7). The introduction of digital health technologies started before the pandemic, and the adaptation of these technologies during the pandemic was accelerated (6,8)

In Europe, countries like France allowed teleconsultation of suspected and confirmed cases of COVID-19. Italy was one of the countries that used a contact tracing app (Immuni). However, most developed contact tracing apps were never used due to privacy and personal security. Digital health technology helps countries like Italy better respond to the pandemic; for instance, the TreCovid-19 app monitors 9400 patient symptoms remotely in Trento, Italy. The state captured more than 40,000 suspect COVID-19 cases via chatbot (8).

Singapore is one nation that leverages digital health technologies during the COVID-19 pandemic. One challenge faced during the epidemic is contact tracing. Manual contact tracing requires a lot of resources and is disadvantageous due to patient recall bias. Singapore developed and deployed a mobile app called trace-together. Community members used this app to support the government's effort on COVID-19 contact tracing(9).

In Africa, countries like South Africa in the Sub-Saharan region used digital health solutions such as SMS, mobile health applications, telemedicine and telehealth, WhatsApp-based systems, artificial intelligence, chatbot, and robotics to provide healthcare services during the COVID-19 pandemic. Health services utilise digital health technology, including surveillance, contact tracking, medication, and treatment compliance (9). The use of digital health faced many implementation challenges. For example, some challenges faced in countries like South Africa, Malawi, and Guyana during the COVID-19 pandemic were infrastructural and capabilities, organisation and financial barriers, policy and regulation, cultural barriers, morals, religious background, integration of existing health information platform and COVID-19 services. (6,7,10). There is that need of investing in digital health technologies to utilize the potential of digital technologies in the modern era to quick detect and response to pandemic and epidemic.

In Malawi, the use of digital health solutions dates back to 2002, when the Ministry of Health adopted the District Health Information System (DHIS) instance, a web-based system for National health information(11). In 2009, it adopted a Child Nutrition Surveillance System as a Rapid SMS system to collect and transit Child nutrition information. In 2013 the Ministry of Health adopted the Chipatala ChaPa Foni (CCPF). This program was launched to improve maternal and child health and reproductive health services in the Country. The system uses a toll-free hotline and voice and text messages when interacting with the general public(12). Other digital health systems include Electronic Medical Record Systems, One Health Surveillance Platform, and digital health registry and component services based on the Open Health Information Exchange framework(13). Over 31 digital health projects implemented by different partners have been registered with the Ministry of Health. In 2021, the Ministry of Health launched a Digital Health Strategy. It established a dedicated government authority - the Digital Health Division (DHD), to regulate the development and implementation of digital health Innovations in Malawi(13).

During the COVID-19 pandemic, the CCPF, OHSP, Zoom Service, WhatsApp-based services, and Chatbot were digital health tools used extensively by the general public and health workers. The public used the CCPF to access information related to COVID-19, and the system offered health education services. Health workers used the OHSP to report and capture individual patient-level data on COVID-19. Health workers use WhatsApp forums to report aggregated COVID-19 from the health facility to the national level(6).A WhatsApp COVID-19 Chatbot was developed with the leadership from DHD and used by the general public to self-report if one suspected COVID-19. This study aims to assess the effectiveness of WhatsApp-based services in responding to COVID-19 as it is one of the innovative surveillance systems applied in Malawi.

# Justification of the Study

WhatsApp COVID-19 Chatbot was one of the innovative digital technologies used during the COVID-19 response in Malawi. In May 2023, WHO declared COVID-19 no longer a public health emergency of international concern(14). However, much is still being determined about how WhatsApp COVID-19 chatbots contributed towards the COVID-19 response in Malawi. The study aims to assess the effectiveness of the WhatsApp COVID-19 Chatbot and document lessons learned using this technology in Malawi. The results of this study will highlight best practices which will inform the best ways to deploy epidemic chatbots and digital health technologies for the next pandemic or epidemic.

# Main and Specific Objective

## The main objective

The main objective of the national workshop is to examine the influence of WhatsApp Chatbot technology in responding to COVID-19 in Malawi.

Specific objectives;

* Assessing the usage of the Malawian-developed WhatsApp COVID-19 Chatbot by reviewing its effectiveness during the pandemic
* Conduct a functionality assessment of the WhatsApp COVID-19 Chatbot using the Mobile App Rating Scale (MARS) Toolkit to identify strengths, weaknesses, and areas of improvement.
* Co-designing the future of WhatsApp Chatbots by identifying desired features and functionality with the MoH and general public to enhance its usage for future epidemics.

# Methodology

## Study design

This study will use a cross-sectional mixed method to collect quantitative and qualitative data from the study population through a workshop. Participants will be invited to one venue, and the research team will collect data during the workshop sessions. The qualitative data will be collected using plenary sessions, group discussions, and note-taking. The quantitative data parameters will be collected using a checklist in the form of a post-workshop survey.

## Study setting / Site.

The national workshop study will be held physically at the participants' agreed-upon venue and location, a central point for all participants. The research team will reach a consensus after asking the participants to suggest a site to ensure that the study site is convenient for all the participants**.**

## Study population/ Participants.

The study population consists of health professionals involved in the COVID-19 response and using digital health technologies and the general public. Digital health technologies were used by different departments within the Ministry of Health, namely the Public Health Institution of Malawi, the Quality Management Directorate (QMD), the Clinical Department, the Nursing Department, the Digital Health Division, the Public Health Department, and the Health Education Unit. Health workers use the DHIS2-One Health Platform Surveillance (OHSP), while the general public uses the chatbot to report any events related to COVID-19 for Surveillance purposes. MoH has established 25,755 positions within the health systems; in 2016, 17,298 were filled, representing 67.16% During the COVID-19, the Ministry of Health recruited 5,622 health workers (13). The 2016 and 2022 figures add up to 22,920.

According to the preliminary analysis result retrospective Chatbot data analysis, 8779 individuals from the general public used the Malawi-WhatsAp COVID-19 Chatbot during the COVID-19 pandemic. Since the number is small and the user information is confidential, the study aims to invite participants from community-based organisations (CBOs) that are working with the general public, with grassroots representation and members of the general public.

Members from the general public will be selected via CBOs since they constantly interact with the community and can represent the experiences and challenges faced during the COVID-19 pandemic. The MOH also uses the same approach, interacting with the Traditional Authorities, Group Village Headman, and Village Headman for community engagement. This study is anchored in health issues, so there is confidence that selecting the CBOs for the study can adequately represent the situation for the general public.

The CBOs will come from ten health districts of Blantyre, Likoma, Mzimba-South, Mzimba North, Lilongwe, Neno, Zomba, Mwanza, Ntchisi, and Rumphi; they Represent 34.5% of the 29 health districts and 37.98%(7,237,073) estimated population in Malawi.

## Study Period

The study period is from May 2024 to October 2024. The National workshop will be conducted on August 15th and 16th, 2024.

## Sample Size determination

CCPF showed that 94% of users were satisfied with their hotline experiences. With a desired precision of 0.06% and a confidence interval of 95%, the sample size was calculated at **60**. However, due to resource constraints, the sample size was reduced to 40 individuals.

The following formula was used to determine the sample size.

: n= Za/22 \*µ(1-µ)/σ2(15)

Where Za/22 = 1.96, µ= 0.94, σ= 0.06

## Sampling methods.

The sampling techniques to select the study subjects will be non-probability sampling methods. Participants will be chosen using purposive sampling methods because of the nature of the study, which seeks experts' insight into using digital health methods towards COVID-19 response (16)

Of the 40 individuals, 20 will come from MoH and 20 from the general public represented by the CBOs. The research team will invite the study population and pick the first 20 to be approached or recruited for the National workshop.

### List of expertise technicality from MoH

The workshop participants will be invited based on their experience in digital health solutions and their level of involvement in the COVID-19 response. During the workshop, the group discussion will be based on the COVID-19 response pillars adopted from the second edition of the Emergency Response Framework (17). The Participants will involve National (10) and district-level (10) team staff and two individuals from the following pillars.

1. Surveillance
2. Laboratory
3. EPI
4. Emergency Operation Centre
5. Risk Communication and Community Engagement,
6. Infection Prevention and Disease Control.
7. Point of Entry.
8. Operation Supply and Logistics (OSL)
9. Digital Health Division
10. CMED/ Coordination and Resource Mobilization
11. Coordination and Resource Mobilization

### Selection of District

The district will be selected based on the COVID-19 disease burden from 2020 to 2023(four years) (18). The attack rate was used to estimate the disease burden over the four years. The population at risk was calculated as the average population of the same period (four Years). The table below highlights the estimated four-year disease burden.

Table 1: Cumulative Distribution of COVID-19 Disease Burden in Malawi

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **District** | **Cases** | **AR** | **District** | **Cases** | **AR** |
| Blantyre | 24895 | 18.54 | Chitipa | 720 | 2.88 |
| Likoma | 148 | 9.52 | Chiradzulu | 1078 | 2.83 |
| Mzimba South | 2437 | 9.51 | Kasungu | 2432 | 2.65 |
| Lilongwe | 20684 | 7.34 | Mulanje | 1764 | 2.38 |
| Neno | 1042 | 7.01 | Mangochi | 2952 | 2.3 |
| Mzimba North | 5385 | 5.42 | Dowa | 1848 | 2.18 |
| Zomba | 4157 | 4.52 | Balaka | 1014 | 2.09 |
| Mwanza | 647 | 4.44 | Phalombe | 825 | 1.75 |
| Ntchisi | 1489 | 4.24 | Nsanje | 530 | 1.66 |
| Rumphi | 1038 | 4.21 | Dedza | 1372 | 1.53 |
| Karonga | 1563 | 3.98 | Chikwawa | 919 | 1.51 |
| Nkhatabay | 1110 | 3.67 | Ntcheu | 1043 | 1.44 |
| Mchinji | 2370 | 3.64 | Thyolo | 1085 | 1.41 |
| Salima | 1909 | 3.61 | Machinga | 1020 | 1.23 |
| Nkhotakota | 1439 | 3.39 |

District staff from the health districts of Blantyre, Likoma, Mzimba-South, Mzimba North, Lilongwe, Neno, Zomba, Mwanza, Ntchisi, and Rumphi will be selected to participate in the National Workshop.

### List of community participant technicality

In Addition to the list, some participants will come from the general public. These participants will be included to have insight from the general public from a layman's point of view towards the COVID-19 chatbot.

Community members will be selected randomly from a community-based organisation (CBO). Members of the CBO frequently interact with community leaders such as traditional authorities, group village heads, and village heads; hence, it is assumed that this community group represents the general public.

The CBO will be selected into strata; the first strata will divide the 29 health districts into five health zones. North Zone (Rumphi, Mzimba North and Mzimba South, Nkhatabay, Likoma, Chitipa, Karonga), Central East Zone (Dowa, Kasungu, Nkhotakota, Ntchisi, Salima), and Central West Zone ( Dedza, Lilongwe, Mchinji, Ntcheu) and South East Zone ( Balaka, Machinga, Mangochi, Mulanje, Phalombe, and Zomba) and South West Zone ( Blantyre, Chikwawa, Chiradzulu, Mwanza, Neno, Nsanje, and Thyolo.

Each health zone will randomly select four districts, and one CBO will be chosen from each district selected. One member will be selected from each CBO.

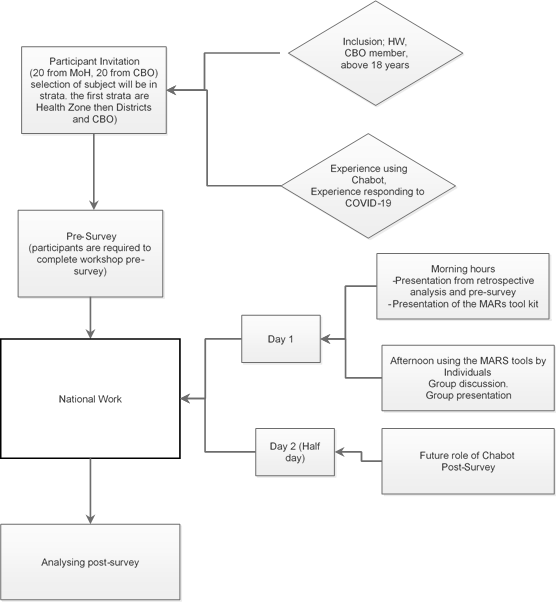


FIGURE 1 The flowchart of the workshop study protocol

Figure 1 is a flow diagram of the participant recruitment stages and an overview of the National Workshop program. The first stage is purposively selecting participants based on the health district's COVID-19 burden. Participants over 18 who have previously interacted with the COVID-19 chatbot will be chosen. The second stage is a pre-survey, which a link will be sent to the participants to complete. The third stage is the national workshop, which is one and a half days long. The following activities will accompany the first day: [1] Presentation of Retrospective results, Pre-survey results, and the Mobile App Rating Scale (MARS) toolkit. [2] fill out the MARS toolkit by individuals [3] group discussion of the chatbot using the MARS toolkit and group work presentation. The second day will be a half-day, accompanied by a panel discussion of future enhancements, roles, and possible usage of the chatbot and Workshop Post-Survey.

## Data Collection and Instruments

This study will use two data collection techniques. The first technique is taking notes during a plenary session and group discussion, and the second technique is using an online evaluation checklist, which will be deployed on the Kobo Collect v2024.1.3**. Observation and note-taking, group discussion, and survey and questionnaire are all suitable methods of collecting data during the workshop**(19)**.**

The study will collect qualitative data from the National workshop and the MARS tool kit (20). In addition, rapporteurs will receive a notepad and pencils to record the participants' comments, remarks, and statements. The MARS tool kit will be deployed on Kobo Collect.

The study will use Kobo Collect to collect quantitative data. It will administer a pre-post-workshop survey questionnaire deployed on Kobo Collect. The participants will receive a link to access the pre-post-survey questionnaire at the workshop. A paper version of the pre and post-survey will be available for backup during the workshop. The questionnaire for the pre-survey and post-survey has been adopted from A QUESTIONNAIRE-BASED APPROACH ON TECHNOLOGY ACCEPTANCE MODEL FOR MOBILE DIGITAL GAME-BASED LEARNING by Ghani et al.(21).

The Chatbot Retrospective Analysis Results will be presented on the first day of the National Workshop. The participants' comments and suggestions on the results will be part of this study's qualitative data, which will be collected using note-taking.

# Data Management

## Qualitative data management:

Rapporteurs will be taking notes during this national workshop. All notes from the rapporteurs will be submitted to research assistants for consolidation. All documentation related to this project will be stored online using Google Drive. Access to this Google Drive will not be granted to any third party.

## Content Quality Check.

The content quality of the notes (comments or statements) will be checked against the respondents. This step will be done soon after the workshop to avoid introducing a recall bias. Spell errors within the notes will be checked against the rapporteurs.

## Quantitative data management

Quantitative data were be collected electronically using a Kobo collector in the form of a post-workshop survey. The survey will focus on rating the workshop content, delivery model, and setting. Thorn, Mueller and Badke-Schaub(19) summarised the principles of a workshop study into five: focus definition, role allocation, triangulation, Transparency, and Reflection. This study will use the first three principles, focus definition, role allocation and triangulation, which can be grouped into workshop content, delivery and setting.

All Fields within the survey will be required. This means that one will only proceed to answer the following question after answering the previous one; hence, all fields will be filed by the end of the survey. This is done to ensure all data is present.

All data submitted from the survey will be synced to a server that the research team will set up. To ensure that all participants have completed the study, the team will monitor the number of submitted forms against the number of participants in the workshop. Participants will be encouraged to complete and sync their forms before leaving the workshop. The research assistants at the seminar will assist participants who are having challenges opening, filling out, and synching the form to the server.

## Data Analysis.

Qualitative data was analysed using the MARS toolkit to assess Chabot's functionality, usability, security, data quality, and individual perspective.

Quantitative data was analysed using R-studio version 4.3.3, using the following packages: *tidyverse* for data management manipulation and graphics and *Rio* for data cleaning, importation, and exportation of files in and from the R environment. *Summary tools were* be used to conduct descriptive analysis.

## Ethics consideration

We will conduct the study once the Mzuzu University Research Ethical Committee on has approved it.

During the data collection period, the researcher assistants will seek and obtain written consent from participants.

Data collected from this study will not be shared with any third partner. And will be used for the purpose stated in the objective section.

Participants will receive a unique series ID generated randomly to ensure anonymity.

The researchers will ensure that all questions outlined in the questionnaire align with the study objectives and do not distress participants.

**Results**

Using the TAMA tool, we conducted pre- and post-surveys during the workshop. 24 (38.1%) were post-surveys, and 39 (61.9%) were pre-surveys. Completeness on the pre-survey was 97.5% (39/40), while for post survey it was 60% (24/40). Analysis on data collected by TAMA tool focus on the pre-survey.

The median age was 45(IQR: 34, 49); of the respondents who completed the pre-survey, 76.9% were male, and 17.9% were female. 53.85% were from the general public, while 46.15% were from participants from the Ministry of Health. Among the participants at the National Workshop, the median number of years of experience responding to COVID-19 was 4(IQR; 3 4).

Among the 45% from MoH, 8 were within Surveillance,2 each with Laboratory, EOC, and Digital Health Division, and 1 each from Coordination and Resource Mobilization, EPI, and RCCE.

Regarding occupation, 49% were health workers, 13.15% were farmers, 10.53% were Business personnel, 7.9% were fishermen and social workers,2% were CSO leaders, housewives, and Retired others.

Regarding the distribution of participants per district, 15% of the participants were from Lilongwe and Ntchisi, 13% from each Neno and Mzimba South, 10% from Blantyre, 7.7% each from Zomba, Rumphi, Mwanza, Likoma, and 5.1% from Mzimba North. Table x shows the frequency of demographic variables of the national workshop participants.

Table 1: Frequency of demographic variables

| **Characteristic** | **Frequency(n%)** |
| --- | --- |
| **Institution belonging** |  |
| General Public | 21 (53.9) |
| MoH | 18 (46.2) |
| **Age** | 45 (34, 49) |
| **Sex** |  |
| female | 7 (18) |
| male | 30 (76.9) |
| Unknown | 2(5.1) |
| **District** |  |
| Blantyre | 4 (10) |
| Likoma | 3 (7.7) |
| Lilongwe | 6 (15) |
| Mwanza | 3 (7.7) |
| Mzimba North | 2 (5.1) |
| Mzimba South | 5 (13) |
| Neno | 5 (13) |
| Ntchisi | 6 (15) |
| Rumphi | 3 (7.7) |
| Zomba | 2 (5.1) |
| **COVID-19 Response Pillar** |  |
| CMED/ Coordination and Resource Mobilization | 1 (5.6) |
| Digital Health Division | 2 (11) |
| Emergency Operation Centre | 2 (11) |
| EPI | 1 (5.6) |
| Laboratory | 2 (11) |
| Risk Communication and Community Engagement, | 1 (5.6) |
| Surveillance | 9 (50) |
| **Years of experience in COVID-19 response** | 4(3,4) |
| **Occupation designation** |  |
| Business | 4 (11) |
| CSO Leader | 1 (2.7) |
| Farmer | 5 (14) |
| Fisherman | 3 (8.1) |
| Health worker | 18 (49) |
| Housewife | 1 (2.7) |
| other | 1 (2.7) |
| Retired | 1 (2.7) |
| social worker | 3 (8.1) |

**Perceived Usefulness of the COVID-19 chatbot**  
The section had seven questions, using a Likert scale from strongly agree to strongly disagree .

| **Perceived Usefulness of the COVID-19 Chatbot** | **Agree** n(%) | **Disagree** n(%) | **Neutral** n(%) | **Strongly Agree** n(%) | **Strongly disagree** n(%) |
| --- | --- | --- | --- | --- | --- |
| COVID-19 chatbot enhances COVID-19 surveillance health information and vaccination services | 18(46) | 4 (10) | 9 (23) | 8 (20) | 0 (0) |
| COVID-19 chatbot increased awareness of COVID-19 information vaccination services | 14 (36) | 3 (7.7) | 12 (31) | 10 (26) | 0 (0) |
| Covid 19 chatbot increased surveillance activities, especially case detection and reporting | 10 (56) | 0 (0) | 2 (11) | 6 (33) | 0 (0) |
| The COVID-19 chatbot improved awareness of COVID-19 information vaccination services | 22 (56) | 2 (5.1) | 9 (23) | 6 (15) | 0 (0) |
| The COVID-19 chatbot improved covid 19 Surveillance | 11 (61) | 0 (0) | 1 (5.6) | 6 (33) | 0 (0) |
| The COVID-19 chatbot made it easier to find information on COVID-19 vaccination | 13 (33) | 4 (10) | 8 (21) | 14 (36) | 0 (0) |
| The COVID-19 chatbot makes detecting and reporting cases from the community easier | 21(54) | 2 (5.1) | 8 (21) | 7 (18) | 1 (2.6) |

Table x shows the scaling of the statements on the perceived usefulness of the COVID-19 chatbot 46% agreed with statement COVID-19 chatbot enhances COVID-19 surveillance health information and vaccination services 20% strongly agree, 23% were neutral and 10% disagree with the statement.

Regarding rating the statement of COVID-19 chatbot increased awareness of COVID-19 information vaccination services, 26% strongly agree with it, 36% agree with it, 31% were neutral and 7.7% disagree with it.

Regarding rate the statement Covid 19 chatbot increased surveillance activities, especially case detection and reporting 56% agree with the statement, 33% strongly agree with it and 11% were neutral with the statement.

Regarding rate the statement COVID-19 chatbot improved awareness of COVID-19 information vaccination services 56% agree with it, 15% strongly agree with it, 23% were neutral and 5.1% disagree with the statement.

Regarding rating the statement COVID-19 chatbot improved covid 19 surveillance 61% agreed with the statement, 33% strongly agreed and 5.6% were neutral.

Regarding rating the statement COVID-19 chatbot made it easier to find information on covid 19 vaccination 36% strongly agreed with the statement, and 33% agreed with it 21% were neutral, and 10% disagree with it

Regarding the statement the covid 19 chatbot makes detecting and reporting cases from the community easier 54% agree with the statement, 18% strongly agreed with it, 21% were neutral, 5.1% disagreed with it and 2.6% strongly disagreed the statement .

Perceived Ease of Use of the COVID-19 Chatbot

| Perceived Ease of use of COVID-19 chatbot | **Agree**, n(%) | **Disagree**, n(%) | **Neutral**, n(%) | **Strongly Agree**, n(%) | **Strongly disagree**, n(%) |
| --- | --- | --- | --- | --- | --- |
| I find the COVID-19 chatbot easy to use | 14 (35) | 4 (10) | 11 (28) | 11 (28) | 0 (0) |
| It is easy to become skilful in using the covid 19 chatbot | 16 (41) | 1 (2.6) | 9 (23) | 13 (33) | 0 (0) |
| It will be easy for me to find information through the covid 19 chatbot | 19 (48) | 2 (5.0) | 8 (20) | 11 (28) | 0 (0) |
| learning how to use the COVID-19 chatbot is easy for me | 8 (20) | 3 (7.5) | 10 (25) | 18 (45) | 1 (2.5) |
| my interaction with the COVID-19 chatbot was clear | 16 (40) | 5 (13) | 11 (28) | 8 (20) | 0 (0) |
| my interaction with the COVID-19 chatbot was understandable | 13 (33) | 3 (7.5) | 13 (33) | 11 (28) | 0 (0) |
| The COVID-19 chatbot features are easy to use and follow through | 14 (35) | 4 (10) | 13 (33) | 9 (23) | 0 (0) |

Table x shows Perceived Ease of Use of the COVID-19 Chatbot; there were seven questions asked to assess the ease of using the COVID-19 chatbot. 36% agreed with the statement COVID-19 chatbot easy to use, 28% strongly agree with it, 26% were neutral and 10% disagreed with it.

Regarding easy to become skillful in using the COVID-19 chatbot 42% agreed with the statement, 34% strongly agree with it, 21% were neutral and 2.6% disagree with it.

Regarding rate the statement easy to find information through the COVID-19 chatbot, 46% agree with the statement, 28% strongly agree with it, 21% were neutral and 5.1% disagreed with it.

Regarding rating the statement learning how to use the covid 19 chatbot is easy 46% strongly agree with the statement, 21% agree with it, 23% were neutral on it, 7.7% disagree with it and 2.6% strongly disagree with the statement.

On the statement Interaction with COVID-19 chatbot was clear 38% agreed with the statement, 21% strongly agree 28% were neutral, and 13% disagree with it.

Regarding rating the statement Interation with the COVID-19 chatbot was understandable 31% agree with the statement, 28% strongly agree with it, 33% were neutral and 7.7% disagree with it.

Regarding rating the statement COVID-19 chatbot features easy to use and follow through 33% agreed with the statement, 23% strongly agreed with it, 33% were neutral and 10% disagreed with the statement

Attitude towards using the COVID-19 chatbot

| **Attitude of COVID-19 chatbot** | **Agree**, n(%) | **Disagree**, n(%) | **Neutral**, n(%) | **Strongly Agree**, n(%) | **Strongly disagree**, n(%) |
| --- | --- | --- | --- | --- | --- |
| Conducting surveillance using the covid 19 chatbot was an excellent idea | 17 (43) | 2 (5.0) | 12 (30) | 9 (23) | 0 (0) |
| I am confident about using the COVID-19 chatbot for COVID-19 surveillance and covid 19 vaccination services | 17 (43) | 2 (5.0) | 13 (33) | 8 (20) | 0 (0) |
| I believe it is a good idea to use a COVID-19 chatbot for future covid COVID-19 surveillance | 13 (33) | 2 (5.0) | 9 (23) | 16 (40) | 0 (0) |
| I prefer using a covid 19 chatbot for COVID-19 surveillance and covid 19 vaccination services | 17 (43) | 1 (2.5) | 13 (33) | 8 (20) | 1 (2.5) |
| Sharing COVID-19 information about vaccination services was a good idea | 18 (45) | 2 (5.0) | 8 (20) | 12 (30) | 0 (0) |
| The COVID-19 chatbot helps to increase engagement in covid 19 surveillance and vaccination services | 20 (50) | 1 (2.5) | 10 (25) | 8 (20) | 1 (2.5) |

Table x shows Attitude towards using the COVID-19 chatbot; to assess attitude towards COVID-19 chatbot six statements were asked

On conducting surveillance using the COVID-19 chatbot was an excellent idea 41% agreed with the statement 23% strongly agreed with it, 31% were neutral, and 5.1% disagreed with the statement.

41% agreed with the statement that they were confident about using the COVID-19 chatbot for COVID-19 surveillance and COVID-19 vaccination services.

Regarding rating a statement preference on using a covid 19 chatbot for covid 19 surveillance and covid 19 vaccination services 41% agreed with the statement, 21% strongly agree, 33% were neutral, 2.6% disagree and 2.6% strongly disagree.

Regarding a statement on sharing COVID-19 information vaccination services was a good idea 44% agreed with the statement, 31% strongly agree with it, 21% were neutral and 5.1% disagree with it.

Regarding rating the statement COVID-19 chatbot helps to increase engagement in the COVD-19 surveillance and vaccination services 49% agree with the statements, 21% strongly agree, 2.6% disagree and 2.6% strongly disagree.

**Behavior Internation to use the chatbot Technology for any pandemic and epidemic**

| **Behavior Internation to use the chatbot Technology for any pandemic and epidemic** | **Agree**, n(%) | **Disagree**, n(%) | **Neutral**, n(%) | **Strongly Agree**, n(%) | **Strongly disagree**, n(%) |
| --- | --- | --- | --- | --- | --- |
| I intend to use the chatbot technology for epidemic-heavily | 18 (45) | 1 (2.5) | 9 (23) | 11 (28) | 1 (2.5) |
| I intend to use the chatbot technology for future outbreaks | 14 (35) | 2 (5.0) | 7 (18) | 17 (43) | 0 (0) |
| I intend to use the mobile chatbot for surveillance frequently | 15 (38) | 3 (7.5) | 10 (25) | 12 (30) | 0 (0) |
| I intend to use the repetitive chatbot technology for epidemics as often as possible | 19 (48) | 1 (2.5) | 7 (18) | 12 (30) | 1 (2.5) |

Table x shows Behavior Internation to use the COVID-19 chatbot, 44% agree with the statement Intention to use the chatbot technology for epidemic heavily, 28% strongly agree with the statement, 23% were neutral, 2.6% disagree with the statement, and 2.6% strongly disagree with the statement.

Regarding rating the statement intention to use the chatbot technology for future outbreaks 44% strongly agree with the statement, 33% agree with the statement, 18% were neutral, 5.1% disagree with the statement.

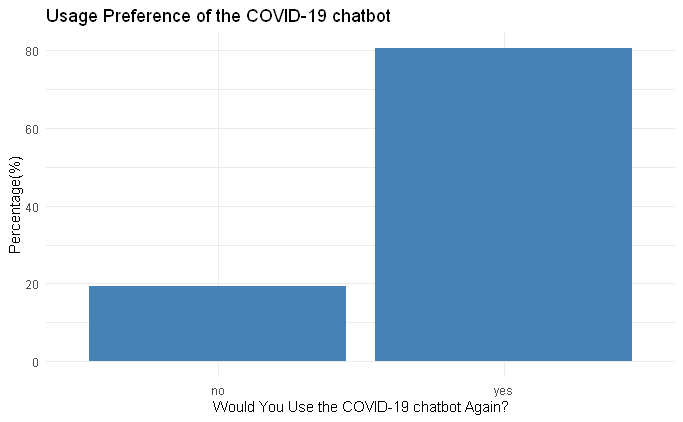
Regarding rating the statement intention to use the mobile chatbot for surveillance frequently 36% agree with the statement, 31% strongly agree with it, 26% were neutral, and 7.7% disagree with the statement.

On intention to use the repetitive chatbot technology for epidemic as often as possible 46% agree with the statement, 31% strongly agree with it, 18% were neutral, and 2.6% disagree with it and 2.6% strongly disagree with the statement.

**Experiences using the COVID-19 chatbot.**

The average years of experience using COVID-19 among the participants who attended the national workshop were 2.58(1.41).

Regarding usage of preference for the COVID-19 chatbot, 80% of the respondents preferred to use the chatbot again, and only 20% did not like to use it again. Figure x shows the usage preference of the COVID-19 chatbot



All items in the MARS tool were rate 5-points scale from “1 =inadequate/ strongly disagree” to 5=Excellent/ strongly agree”,

| **Engagement** | **N = 37(n %)** |
| --- | --- |
| **Covid-19 WhatsApp Chabot is fun and entertaining to use** |  |
| Mostly boring | 3 (8.) |
| OK, fun enough to entertain the user for a brief time (< 5 minutes) | 13 (35) |
| Moderately fun and entertaining, would entertain user for some time (5-10 minutes total) | 12 (32) |
| Highly entertaining and fun, would stimulate repeat use | 9 (24) |
| **COVID-19 WhatsApp Chabot enjoyable to use** |  |
| Mostly uninteresting | 1 (2.7) |
| OK, neither exciting nor uninteresting; would engage the user for a brief time (< 5 minutes) | 13 (35) |
| Moderately interesting; would engage the user for some time (5-10 minutes total) | 14 (38) |
| Very interesting, would engage the user in repeat use | 9 (24) |
| **COVID-19 What’s App Chabot retains all necessary preferences features** |  |
| Does not allow any customization or requires setting to be input every time | 2 (5.4) |
| Allows insufficient customization limiting functions | 8 (22) |
| Allows basic customization to function adequately | 13 (35) |
| Allows numerous options for customization | 12 (32) |
| Allows complete tailoring to the individual’s characteristics/preferences retains all settings | 2 (5.4) |
| **COVID-19 WhatsApp Chabot allow users inputs provide feedback and contain prompts** |  |
| No interactive features and/or no response to user interaction | 1 (2.7) |
| Insufficient interactivity, or feedback, or user input options, limiting functions | 1 (2.7) |
| Basic interactive features to function adequately | 12 (32) |
| Offers a variety of interactive features/feedback/user input options | 15 (41) |
| Very high level of responsiveness through interactive features/feedback/user input options | 8 (22) |
| **COVID-19 WhatsApp Chabot content visual information language and design** |  |
| Completely inappropriate/unclear/confusing | 1 (2.9) |
| Acceptable but not targeted. It may be inappropriate/unclear/confusing | 15 (43) |
| Well-targeted, with negligible issues | 13 (37) |
| Perfectly targeted, no issues found | 6 (17) |
| Unknown | 2 |
|  | |

Table 1 shows the engagement frequencies of Malawi MoH COVID-19 Chabot: The engagement section had five questions with a total score of 25. The mean total engagement score of Malawi MoH COVID-19 WhatsApp Chabot was 17.89. 35% find Malawi MoH COVID-19 Okay and fun enough to entertain the users briefly. 38% of the participants found the Malawi MoH COVID-19 Chabot Moderately interesting, engaging the user for some time. 35% were okay, neither fascinating nor uninteresting.

Under The necessary preference features in the Malawi MoH COVID-19 Chabot, 35% agree that it allows basic customisation to function adequately, and 32% agree that it provides numerous options for customization.

Under COVID-19, WhatsApp Chabot allows users to provide input, provide feedback, and contain prompts. 41% agree that the COVID-19 Chabot offers a variety of interactive features/feedback/ user input options. And 32% agree that the Chabot provides basic interactive features to function adequately.

Under the COVID-19 Chabot content, visual information, and Language design, 43% agreed that the Chabot was acceptable and not targeted. It may be inappropriate and unclear. And 37% agreed that it was well-targeted, with negligible issues.

| **Information** | **N = 37(n%)** |
| --- | --- |
| **The COVID-19 WhatsApp Chabot profile contains its purpose.** |  |
| Inaccurate. The profile contains very few of the described components/functions | 1 (2.7) |
| OK, the COVID-19 WhatsApp Chabot profile contains some of the described components/ functions | 8 (22) |
| Accurate. The COVID-19 WhatsApp Chabot profile contains most of the described components/functions | 20 (54) |
| Highly accurate description of the COVID-19 WhatsApp Chabot components/functions on the profile. | 8 (22) |
| **Covid-19 WhatsApp Chabot content is correct, well written, and relevant.** |  |
| Moderately relevant/appropriate/coherent/and appears correct | 9 (24) |
| Relevant/appropriate/coherent/correct | 21 (57) |
| Highly relevant, appropriate, coherent, and correct | 7 (19) |
| **COVID-19 WhatsApp Chabot scope is comprehensive and concise** |  |
| Insufficient or possibly overwhelming | 1 (2.9) |
| OK, but not comprehensive or concise | 9 (26) |
| Offers a broad range of information that has some gaps or unnecessary detail or has no links to more information and resources | 14 (40) |
| Comprehensive and concise; contains links to more information and resources | 11 (31) |
| Unknown | 2 |

Table 2 shows the frequency of information content and the relevance of the COVID-19 Chabot. The section of information had 3 questions, and the total score was 15. The mean score of information was 11.68(2.22).

Under the COVID-19 WhatsApp Chabot Profile and Contain variable, 53% of the participants agreed that the Malawi MoH COVID-19 Chabot was Accurate (the profile contains most of the described components/Functions). 22% agreed that the content was Highly Accurate, and another 22% were OK with the content. 1% described the Malawi MoH COVID-19 Chabot as Inaccurate. The profile contains very few of the described components/functions.

Regarding the COVID-19 Chabot’s relevance and how the content was written, 57% of the participants agreed with the statement that the content was relevant, appropriate, coherent, and correct. 24% agreed that the content was Moderately relevant/Appropriate/Coherent/Appeared correct. 19% agree that it is Highly relevant, appropriate, coherent, and correct

Regarding the Malawi MoH COVID-19 Chabot’s scope, 40% of the participants agreed that it offers a broad range of information and has some gaps or unnecessary details. 31% agreed that the Chabot was comprehensive and concise and contained links to more information and resources. 26% were OK with it, but it was not extensive or concise. 2.9% described it as Insufficient or possibly overwhelming.

| **Performance** | **N = 37(n%)** |
| --- | --- |
| Accurate and fastest of the COVID-19 WhatsApp Chabot features, functions, and components. |  |
| 2. Some functions work but lag or contain major technical problems | 1 (2.7%) |
| 3. works overall. Some technical problems need fixing/Slow at times | 14 (38%) |
| 4. Mostly functional with minor/negligible problems | 13 (35%) |
| 5. Perfect/timely response; no technical bugs found/contains a ‘loading time left’ indicator | 9 (24%) |
| Ease of use of COVID-19 whats app chatbot |  |
| 3. Useable after some time/effort | 5 (14%) |
| 4. Easy to learn how to use the COVID-19 WhatsApp Chatbot | 20 (54%) |
| 5. Able to use the COVID-19 WhatsApp Chatbot immediately; intuitive; simple | 12 (32%) |
| The chatbot is interactive, consistent and intuitive across all components |  |
| 2. Often inconsistent/confusing | 1 (2.7%) |
| 3. OK with some inconsistencies/confusing elements | 12 (32%) |
| 4. Mostly consistent/intuitive with negligible problems | 12 (32%) |
| 5. Perfectly consistent and intuitive | 12 (32%) |

Table 3 shows the frequency of rating the Malawi MoH COVID-19 Chabot’s performance regarding features, functions, and components. The performance section had 3 questions, with a total score of 15. The mean Chabot performance score was 11.95(1.96).

Regarding rating the performance of the Chabot’s features, functions, and components, 38% agreed that the Chabot features, functions, and components work Overall, with some technical problems that need fixing. 35% agreed that the features, functions, and components were mainly functional with minor/negligible problems, and 24% agreed that the features, functions, and Components were Perfect/Timely Responses with no technical bugs. 2.7% agree that the Malawi MoH COVID-19 had some functions that worked but lagged or contained major technical problems.

Regarding rating the Ease of use of the Malawi MoH COVID-19 Chatbot, 54% agreed that it was easy to learn how to use, 32% agreed that they were able to use the COVID-19 Chatbot immediately and intuitively, and 14% agreed that they found it usable after some time/effort.

Regarding the Interactive, it was Consistent and Intuitive across all components. 32% of participants agreed that the Chabot was OK with some inconsistency or confusing elements, 32% said it was mostly consistent and intuitive with negligible problems, and 32% said it was perfectly consistent and Intuitive. 2.7 % agreed that Malawi COVID-19 was often inconsistent and confusing.

| **Aesthetics** | **N = 37(n%)** |
| --- | --- |
| **Chatbot graphics are of quality resolution for used icons, menus, and content.** |  |
| Moderate-quality graphics and visual design (generally consistent in style) | 12 (32%) |
| High-quality/resolution graphics and visual design – mostly proportionate, stylistically consistent | 13 (35%) |
| Very high quality/resolution graphics and visual design - proportionate, stylistically consistent throughout | 12 (32%) |
| **The chatbot content is visually appealing in terms of font colour and size.** |  |
| Little visual appeal – poorly designed, bad use of colour/font/Size, visually boring | 3 (8.3%) |
| Some visual appeal – average, neither pleasant nor unpleasant | 12 (33%) |
| High level of visual appeal – seamless graphics – consistent and professionally designed | 12 (33%) |
| As above + very attractive, memorable, stands out; use of colour enhances app features/menus | 9 (25%) |
| Unknown | 1 |

Table 4 shows the frequency rating of the Malawi MoH COVID-19 Chabot’s aesthetic. The section had two questions, and the total score was 10. The mean score rating was 7.54.

Regarding rating the quality resolutions used for icons, menus, and content, 35% agreed that the COVID-19 Chabot had high-quality graphics and visual design that was proportionately and stylistically consistent throughout. 32% of the participants agreed that the COVID-19 Chabot had very high-quality resolution graphic and visual design. And 32% agreed that the Chabot had moderate-quality graphic and visual design.

Regarding rating the Content's Visual Appeal font, Color, and Size, 33% of the participants agreed that the COVID-19 font, Color, and Size were highly visually appealing, seamless, graphic, consistent, and professional. 33% also agreed that the Malawi MoH COVID-19 Chabot had some visual appeal, was average, and was neither pleasant nor unpleasant. 25% of the participants agreed that the Malawi MoH COVID-19 colour, font, and size were beautiful, memorable, and stand out. 8.3% agree that the Malawi MoH COVID-19 had Little visual appeal – poorly designed, bad use of colour/font/Size, and visually boring.

| Quality score | Mean scores |
| --- | --- |
| Engagement Score | 17.89 |
| Performance Score | 11.95 |
| Graphic Score | 7.54 |
| Information Score | 11.67 |
| Quality Score | 11.49 |
| **App quality overall mean Score** | 12.11 |

Table 5 shows the scores of the Malawi MoH COVID-19 rating based on Engagement, Performance, Graphics, Information, and quality. The quality overall mean of Malawi MoH COVID-19 Chabot score was 12.11.

| **Subjective Quality-Recommendation** | **N = 37(n%)** |
| --- | --- |
| **Recommend COVID-19 WhatsApp Chabot to people who might benefit from it** |  |
| Not at all I would not recommend this app to anyone | 1 (2.9) |
| There are very few people I would recommend this app to | 1 (2.9) |
| Maybe There are several people whom I would recommend it to | 1 (2.9) |
| There are many people I would recommend this app to | 9 (26) |
| I would recommend this app to everyone | 23 (66) |
| Unknown | 2 |
| **Number of times to use covid-19 WhatsApp Chabot** |  |
| 1 None | 1 (2.7%) |
| 3 3-10 | 12 (32) |
| 4 10-50 | 13 (35) |
| 5 >50 | 11 (30) |
| Star rating of the covid-19 WhatsApp Chabot |  |
| ★ One of the worst apps I’ve used | 1 (2.7) |
| ★★★ Average | 12 (32) |
| ★★★★ | 19 (51) |
| ★★★★★ One of the best apps I've used | 5 (14) |

Table 5 shows the frequency of rating the Malawi MoH COVID-19 Chabot based on subjective quality. The section had 3 questions, and the total score was 15. The mean subjective quality score was 11.45.

Regarding rating the Malawi MoH COVID-19 on individuals' recommendations to others who would benefit from the COVID-19 Chabot, 66% agreed to recommend it to everyone, and 26% decided to recommend it to many people who could benefit from it.

Regarding rating the number of people who will use the Malawi MoH COVID-19 Chabot in the next 12 months, 35% of the participants agree to use it 10 to 50 times within the next 12 months, 32% agree to use it 3- 10 times, and 30 % agree to use it above 50 times. 2.7% did not indicate the number they can use it in the next 12 Months.

Regarding the Malawi MoH COVID-19 Chabot starring, 51% of the participants rated it slightly above average (4 stars), and 32% rated it as average (3 stars). 14% raring it as the best app (5 stars) and 2.7% rate it as the worst app (1 star).

| **Awareness of COVID-19 Chabot** | **Strongly  disagree(n%)** | **Disagree**  **(n%)** | **Neutral**  **(n%)** | **Agree**  **(n%)** | **Strongly Agree(n%)** |
| --- | --- | --- | --- | --- | --- |
| Chabot increases awareness of the importance of addressing covid 19 myths | 0 (0) | 1 (2.7) | 5 (14) | 20 (54) | 11 (30) |
| Chabot is likely to increase intentions and motivation to get the COVID-19 vaccination test | 0 (0) | 1 (2.7) | 12 (32) | 18 (49) | 6 (16) |
| Chabot is likely to change attitudes toward improving the COVID-19 response | 0 (0) | 1 (2.9) | 4 (11) | 22 (63) | 8 (23) |
| Chabot is likely to encourage the general public to test for COVID-19-vaccinated | 0 (0) | 2 (5.6) | 8 (22) | 19 (53) | 7 (19) |
| Chabot is likely to increase covid 19 related health behaviors | 1 (2.7) | 1 (2.7) | 8 (22) | 17 (46) | 10 (27) |
| Chabot is likely to increase knowledge and understanding of COVID-19 | 1 (2.8) | 2 (5.6) | 1 (2.8) | 20 (56) | 12 (33) |

Table 6 shows the frequency of how the Malawi MoH COVID-19 can increase awareness, knowledge, attitude, and intention to change, as well as help-seeking and behavior change. The section had six questions. With response 1=from strongly disagree to 5= strongly agree.

Regarding Malawi MoH COVID-19, Chabot increased awareness of the Importance of addressing COVID-19 myths; 54% agreed, 30% strongly agreed, 14% were neutral, and 2.7% disagreed.

Regarding Malawi MoH COVID-19, Chabot is increasing knowledge and understanding of COVID-19 among the general public and health workers. 56% agree, 33% strongly agree, 2.8% neutral, 5.6% disagree, and 2.8% strongly disagree.

Regarding Malawi MoH COVID-19 Chabot's changing attitude towards improving COVID-19 response, 63% agreed, 23% strongly agreed, 11% were neutral, and 2.9% strongly disagreed.

Regarding Malawi MoH COVID-19 increasing / Motivation to get COVID-19 vaccination and testing, 49% agree, 32% neutral, 16% strongly agree, and 2.7% disagree.

Regarding Malawi MoH COVID-19, the general public should be encouraged to test for COVID-19 vaccination. 53% agree, 19% strongly agree, 22% were neutral and 5.6% disagree.

Regarding Malawi MoH, COVID-19 increased/decreased COVID-19-related healthy behaviour (e.g., wearing face masks, sanitizing, and hand washing). 46% agree, 27% strongly agree, 22% neutral, and 2.7% disagree and strongly disagree.

**Qaulitative results**

Among the reasons not to use the chatbot again, the following were the highlighted themes

-low covered on the usage of smartphones and religious belief one of the respond stated ..*COVID-19 is satanism*…#7

Lack of awareness on the existence of the COVID-19 chatbot among the general public was one of the reasons that the chatbot was not highly utilized. …"*Chatbot is a new word to me and this is my first time hear about it. all message about COVID-19 was passed through radio station. CBO got the information regarding COVID-19 through radio…*"#10 this was on stated from one of the participants from the general public using the national workshop.

**Suggested features to include in the future COVID-19 chatbot:**

During the national workshop participants suggested features to be added in the COVID-19 chatbot. The following are features that the respondents suggested to be included in the future COVID-19 chatbot:

* Addition of more local languages
* Make the chatbot adaptive to the occurrence of a pandemic/epidemic, e.g including information on the new variants of the COVID-19
* Referral to other platforms, links to hospital pathways
* Adaptable to other public health emergencies

“*Addition of AI and other pandemic, Make the chatbot more interactive*”..#27 one of the responded suggested the addition of AI within the COVID-19 chatbot.

Discussion