Development and Success Evaluation of a Chatbot-based Herbs and Fruits Therapeutic Properties Inquiry System

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ABSTRACT
In this research, we explored the use of a conversational-based inquiry system in healthcare through the development of medicinal herbs and fruits therapy chatbot for different ailments and tested the application for success using the DeLone & McLean Success Model. Our methodology involves gathering medicinal herbs and fruits from published materials, design a mobile chatbot application, and finally, system testing for intention to use, user satisfaction, net benefits, and acceptability using 30 respondents. The results from the evaluation show that a large percentage of the respondents supported the use of cell phones, PDAs, and smartphones for obtaining therapeutic information about herbs and fruits. Also, a large percentage were satisfied with the system, found the application beneficial, and would always use the developed application. Conclusively, conversational-based inquiry systems and AI applications can be developed for information provision on medicinal herbs and fruits therapeutics of various ailments and illnesses.

General Terms
Intelligent Information Systems, Mobile Computing

Keywords
Herbs, Fruits, Conversational-based Inquiry Systems, Chatbots, Information Systems, Traditional medicine, Therapeutic Information

1. INTRODUCTION
Sub-Sharan Africa of which Nigeria is a part has been identified to be bedeviled with the problem of disease and an inadequate number of healthcare workers [19]. Africa as a whole is also known to have the greatest disease burden (22% of the global cases) because of the small healthcare workforce and only 3% of health workers worldwide are available on the continent. Also, the continent has less than 1% of the global financial resources [38]. From the foregoing, it is pertinent that a way to alleviate the identified problems is needed. Fortunately, nature has provided for us, fruits and plants that have medicinal properties for our health use However, most of us remain ignorant of these natural remedies that nature provides for us.

Two-thirds of newly identified chemicals extracted every year are from higher plants and three-quarters of the population of the world used plants for disease prevention and therapeutic purposes. In the United States, chemical synthesis is dominant in the pharmaceutical industry, but one-quarter of those pharmaceuticals are chemicals derived from plants [3]. Herbs are effective in treating diseases [5, 6, 9, 22, 26, 36] including viral diseases and they have little or no side effects, unlike the synthetic anti-viral drugs to which diseases are becoming resistant. Herbs can also be used for the prevention of diseases. The limitedness of the efficacy of drugs available in the market for viral diseases has led to the development of vaccines against diseases like smallpox, rabies, polio, hepatitis, smallpox, etc. But there are still a lot of viral diseases that are a source of public health concern as no effective vaccination has been developed against them [14]. Therefore, there is a need to go the way of herbs. This is more so as synthetic drugs for the treatment of diseases are costly [12].

Fruits also have the properties to prevent diseases and can also be used to treat ailments [5, 6, 9, 10, 20, 28, 30, 37]. Consequently, there is also the need to take advantage of this natural provision for the health benefits of the populace. In this work, a chatbot that provides health information about different sicknesses and how to cure them with herbs and fruits was developed and tested to determine its success using DeLone & McLean Success Model. The results of the test carried out are presented.

2. RELATED WORKS
2.1 Chatbots
Chatbots are software created using artificial intelligence (AI) [35]. Their purpose is to simulate an actual conversation between two individuals. Such conversation includes inquiries about a product, information regarding events, knowledge, or facts about certain things [1]. Available methods of engaging in such conversations include instant messaging software, web applications, mobile applications, and telephony applications. Currently, these methods are still employed in conversations regarding inquiries. In situations that involve a large number of individuals seeking some information, direct conversations become quite ineffective, hence the need for the integration of automated tools, in this case, chatbots into the various conversation techniques [8]. Chatbots are one of the current technologies which hinge on human-computer interaction (HCI). They leverage on a basic question and answer process using natural language processing (NLP).

Two main sub-processes have been identified in the development of chatbot-based systems. The first sub-process is the analysis of the user's request while the second is the chatbot application's response [1]. The identification of the user's intent involves the extraction of relevant entities from the request of the user using the vocabulary of the language

that the chatbot was designed for. Afterward, the intent of the intended user is identified based on the extracted entities. Various machine learning methods exist for this process. They include the Support Vector Machine (SVM), the K-nearest neighbours, and Random Forest. After the intent of a user might have been determined, then the chatbot will provide a response based on the identified intent. This response could be a generic answer which gives the user an idea of the information being requested or a more specific answer on the information [17].

In the domain of medicine and healthcare, various chatbot applications have been proposed and implemented. The application areas have been information sourcing and activity management. It has been established that chatbots are beneficial in healthcare in the support, motivation, coaching of patients, and other organizational tasks [27]. This is because information and communication technology (ICT) enthusiasts readily accept its use, especially in the healthcare domain [23].

2.2 Herbs and Fruits Therapy

Herbs and fruits are part of the main ingredients from which alternative therapy in healthcare is derived [34]. Researches on the efficacy, active ingredients, usage, and therapeutic properties of various medicinal plants in the treatment of various diseases have been carried out in the past [2, 11, 18]. Also, attempts at digitizing the storage and retrieval of these therapeutic properties of herbs and fruits have been made. An instance is the creation of a framework for knowledge capture in the African traditional treatment of malaria in which a holistic approach of knowledge capture and retrieval of malaria therapy was proposed [7].

2.3 Expert and Decision Support Systems

Also, expert and decision support systems for diagnosis and prescription of herbal medicine for different ailments have been proposed [25]. Notable examples are the development of an expert system for supporting Chinese medicine and diagnosis [32], the development of a multi knowledge-based

expert system using the structured query language inference mechanism for herbal medicine [21] and the knowledge-based service for African traditional herbal medicine [13]. Some other research attempts in this domain are channeled towards the automated identification of medicinal plants and herbs as well as their therapeutic properties [29]. Some of these include the development of an automated plants classification in Chinese medicine using leaf morpho-colorimetry, fractal dimension, and visible/near infrared spectroscopy [39], identifying medicinal plants using machine [15], and the real-time identification of medicinal plants with machine learning [33]. All these were attempts to digitize the medicinal properties of herbs and fruits, their identification, and their usage in the treatment of various illnesses and ailments.

However, the application of a conversational-based inquiry system for therapeutic knowledge of medicinal plants and fruits is still lacking to the best of our knowledge.

2.4 Model of Information Success

Information Success is beset with different definitions and explanations. However, it is of the general belief that its essence as an Information Theory is to provide an understanding comprehensive enough of Information System success through identification, description, and explanation of the relationships that exist among the most important dimensions of success with which Information Systems are usually measured [24].

There are different kinds of success models. However, DeLone and Mclean's Success Model stands out from them all because it has been the most used in determining the success or failure of Information Systems [24]. The model was originally proposed in 1992 but has since undergone several refinements in the latter part of 1992, in the year 2003, and 2004. These refinements were based on the comments and observations of different scholars working in the same area. The model consists of the following dimensions: Net Benefits, User Satisfaction, Use/Intention to Use, Service Quality, System Quality, and Information Quality [4, 16]. The model is presented in Figure 1.
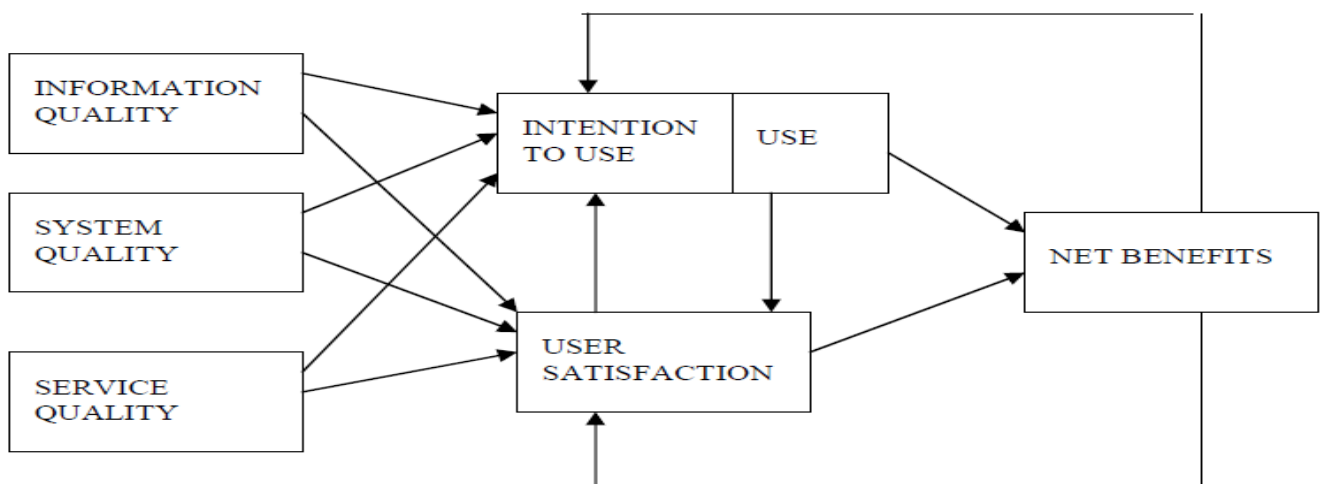

Figure 1: DeLone & McLean Success Model [16]

3. METHODS

Information about fruits and herbs and their therapeutic properties were gathered from different published materials and used for the development of the chatbot accessible via mobile phones. The chatbot was developed using Dialogflow.

A total of 30 respondents tested the system using an iPhone running iOS 11 with a RAM of 4 gigabytes and with Safari running on it. Data analysis was performed on the obtained data from the respondents after testing the system. The

questionnaire measured three dimensions of the Delone & Mclean Model namely:

i.   Intention to Use
ii. User Satisfaction
iii. Net Benefits

The respondents also responded to questions about their support for the use of chatbots for obtaining therapeutic information about herbs and fruits. Sections in the questionnaire also captured the experiences of the participants with mobile devices as well as their demographic data. The questionnaire was scaled 1 to 5 to indicate "strongly disagree", disagree", "undecided", "agree" and "strongly agree" respectively.

3.1 Study Respondents

Out of the 30 respondents, 19 (63.3%) are males while 11 (36.7%) are females. 8 (27%) of them were within the age range of 15 – 20, 18 (60%) within 21-30, 1 (3%) within 41-50, 2 (7%) within 51-above and 1 (3%) did not specify the age

range. 2 (6.7%) respondents indicated their experiences with mobile devices as average, 13 (43.3%) as good and 15 (50%) as experts. 21 (70%) used laptop/notebook to enhance their work, 6(20%) used PDA/cell phone, 2 (7%) used tablet PC and 1(3%) used desktop PC. 29 (97%) owned mobile phone/PDA/laptop while only 1 (3%) did not. 2 (7%) have owned their digital devices for the past 1 year, 1(3%) for the past 1½ years, 3(10%) for the past 2 years and 24 (80%) for over 2 years. 1 (3.3%) respondent made calls 1-2 times a week, 7(23.3%) 5-6 times a week while 22(73.3%) made calls more than 7 times a week.

3.2 Snapshots of the Chatbot

Figure 2 shows the interaction of a user with the chatbot on how to treat typhoid fever. Figure 3 shows the response of the chatbot when the user complained of a migraine. Figure 4 shows the interaction of a user with the chatbot on how to treat cold. Figure 5 shows the interaction between the user and the chatbot on how high blood pressure could be treated with moringa.
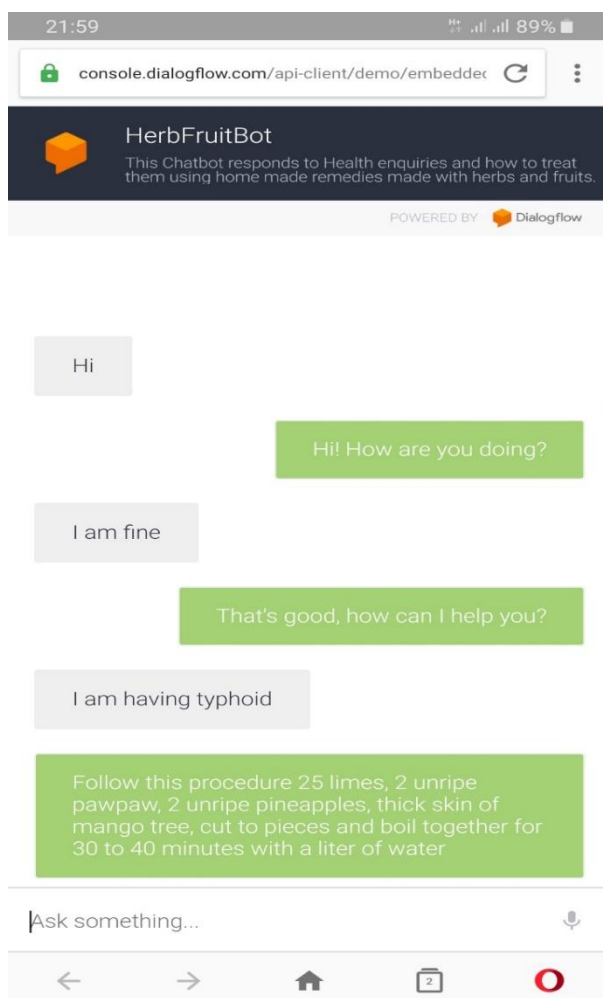

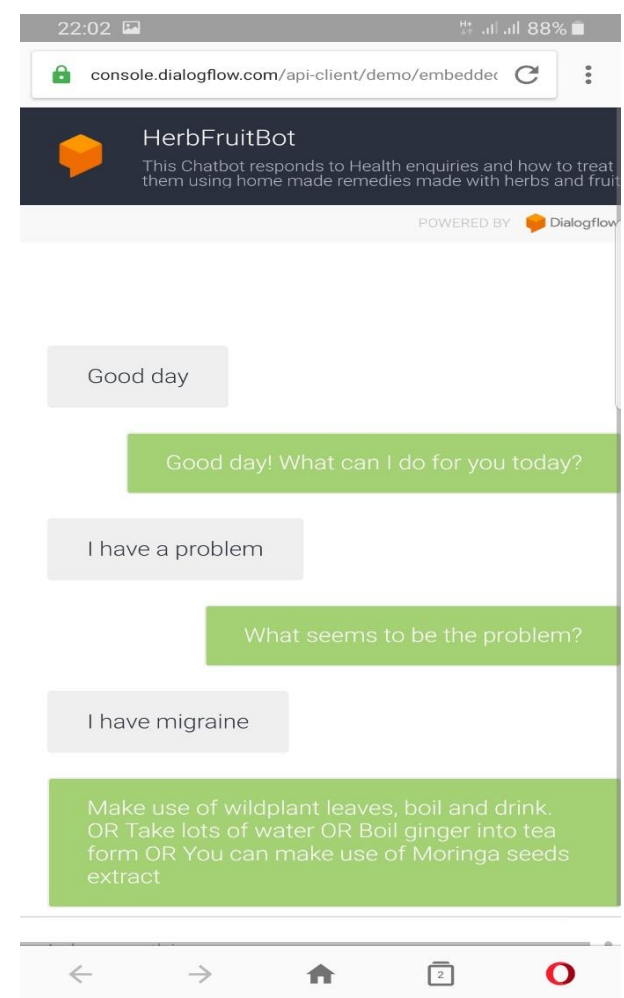**Figure 2: User Interaction in Treating Typhoid Fever**
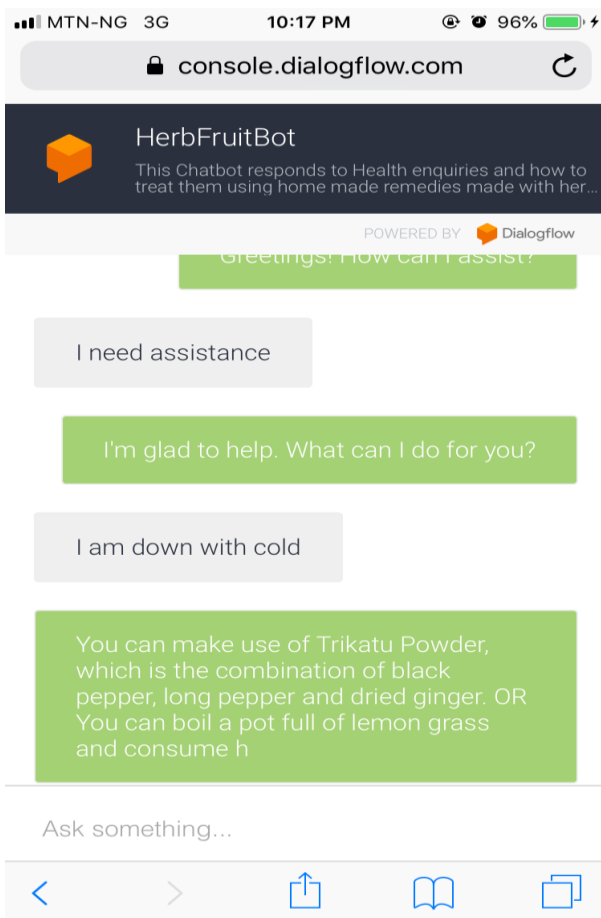

Figure 3: User Interaction in Treating Migraine

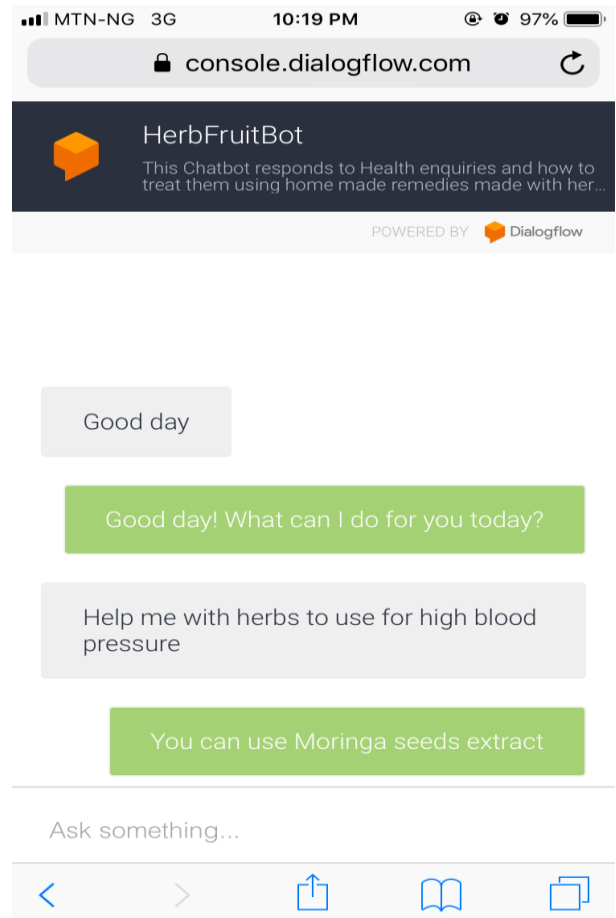**Figure 4: User Interaction in Treating Cold**

Figure 5: Treating High Blood Pressure

4. RESULTS

For the question about support for the use of cell phone/PDA/smartphone in obtaining therapeutic information about herbs and fruits, 25(83.3%) were in support while 5(16.7%) were not in support. Some of the reasons those not in support gave were the cost of buying a phone and the need for training to use the system. For user satisfaction of the system, 0% strongly disagreed that they were dissatisfied with the system, 4% agreed that they were dissatisfied with the system, 29% undecided, 43% was satisfied with the system while 24% strongly agreed that they were satisfied with the system. The mean rating for user satisfaction is 3.98. For the Net Benefits of the system, 3% strongly disagreed that the system was beneficial to them and 3% also disagreed that the system was beneficial to them. 19% were undecided, 53% agreed that the system was beneficial to them while 22% strongly agreed that the system was beneficial to them. The mean rating for the Net Benefits is 3.76. For Intention to Use, 0% strongly disagreed that they would always use the system, 3% disagreed, 20% undecided, 62% agreed that they would always use the system while 15% strongly agreed that they would always use the system to obtain information about fruits and herbs to manage their health. The mean rating for Intention to Use is 3.93. 26 (86.7%) of the 30 respondents accepted the system, none rejected it while the others were indecisive about its acceptability.

5. DISCUSSIONS

From the results presented above, it can be seen that the majority supported the use of mobile phones in obtaining information about herbs and fruits for treating their ailments. This shows that the system was accepted. For user satisfaction, the mean rating obtained is 3.98. A usability study is good if the mean rating is 4 and above using a questionnaire scaled 1 – 5 [31]. The mean rating of 3.98, approximately 4 shows that the users were satisfied with the system. For Net Benefits, the mean rating of 3.76 (also approximately 4) also shows that the users benefitted from using the system. Lastly, the mean rating of 3.93 for Intention to Use, which is also approximately 4, indicates that the users will always want to use the system to obtain information about how to treat their ailments with herbs and fruits. The overall results show that systems like this, when developed and deployed will be beneficial to the masses. With this system in place, it is expected that people will use it to get information about how to solve their health problems using herbs and fruits.

6. CONCLUSION

It has been posited in this work that Nigeria, typical of Sub-Sharan African countries, has the problem of disease burden and an inadequate number of health workers. Also, the continent of Africa of which Nigeria is a part has low financial resources to be able to solve the prevailing health problems. Consequently, towards solving this problem, this work takes the advantage of the provisions that nature has

made in terms of herbs and fruits for dealing with disease problem and developed a chatbot to provide information about herbs and fruits the people can take advantage of, to treat their ailments and include in their diet (fruits especially). The system was tested using three dimensions of the DeLone & McLean Success Model and the results obtained show that the system was accepted, the users were satisfied with the system, the users benefitted from using the system, and would always use it when deployed. This means that systems of this nature can be developed and deployed for people to take advantage of, for self-care of their ailments in places where health workers are inadequate most importantly. People without ailments can also include fruits as part of their diet for disease prevention purposes.

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