Journal of Health, Medicine and Nursing
ISSN 2422-8419 An International Peer-reviewed Journal
Vol.108, 2023

An Information System Model for Integrating Knowledge of Uganda Herbal Medicine

Erma Ssewankambo* Hudson Nandere Francis Lowu
Dept. of Computing and Informatics, School of Science and Technology
Bugema University, P.O. Box 6529, Kampala, Uganda
* E-mail: Corresponding author essewankambo@bugemauniv.ac.ug

Abstract
With health being a priority to all, knowledge on different varieties of herbal medicine is important. This study examines indigenous herbal medicine in Uganda to facilitate the development of a web-based information system model through which knowledge can shared. The research design involved an experimental approach to design and test the information system model and a descriptive qualitative design to collect qualitative data about herbal medicine and the diseases they cure. The study was conducted in the Buwama sub-county, Mpigi district, Uganda, where traditional medicine is widely used in primary health care. The target population was fifty (50) practicing traditional medicine trainees, and purposive sampling was used to select respondents. Data were collected through semi-structured interviews and reviewed existing documents about different kinds of herbal medicine. An architectural framework for the web-based information system model was designed using entity-relationship diagrams that represent data flows, inputs, and outputs of the system. The findings of this study show that integration of traditional medicine into modern healthcare systems in Uganda is possible and is appreciated by most health care practitioner. The developed information system model can contribute to improving the accessibility and use of indigenous herbal medicine, promoting their recognition and validation, and ensuring their safe and effective use. The study findings show that a web-based information system model is a promising approach to support the documentation, sharing, and management of indigenous herbal medicine in Uganda.
Keywords: Herbal Medicine, System Model, Traditional Medicine, Indigenous Medicine, Web-Based System**DOI:** 10.7176/JHMN/108-02
Publication date: May 31st 2023

1. Introduction

Herbal medicine has gained popularity worldwide as a complementary and alternative form of treatment (Ogrima et al, 2014). It is defined as the use of plant-derived materials, which contain either raw or processed ingredients from one or more plants, and are prepared with healing human health benefits (World Health Organization, 2005). Traditional medicine is widely used around the world with 80% of the population in developing countries using it for health maintenance and therapeutic management of diseases (WHO, 2013). The use of herbal remedies worldwide has been stimulated by several factors, including the notion that all herbal products are safe and effective. In recent years, there has been a significant increase in the use of herbal medicine in the developed world, where many herbs and herbal extracts are used as prescription drugs (Amundsen, 2013; Abbott, 2010; Mumo, 2012). In Uganda, traditional medicine is widely used, especially in rural areas where patients end up spending a lot of time in long queues at health centers, waiting to see doctors who are in short supply (World Health Organization, 2020). Traditional herbal medicine is widely used for the prevention, diagnosis, and treatment of social, mental, and physical illnesses, including malaria, digestive and respiratory problems, toothaches, skin diseases, and childbirth complications (World Health Organization, 2020). In Uganda, traditional healers or herbalists have come up with associations to represent their collective interests. The Natural Chemotherapeutics Research Laboratory (NCRL) provides financial and technical support to practitioners in identifying medicinal plants, assessing the efficacy and toxicity of their herbal medicine, and following established standards (Minieatts, 2016).

Uganda was one of the first countries in sub-Saharan Africa to gain full Internet connectivity (Di Pierro et al., 2020). However, with all this innovation, information about herbal medicine is still not well-organized for locals to access freely anywhere, anytime they feel like (WHO, 2013; Minieatts, 2016). The problem of not having enough drugs and healthcare staff in hospitals and healthcare centers mostly in rural areas means that patients end up not meeting doctors and not getting the prescribed medicine because most of the drugs are not freely available at the health centers (Chen et al., 2016). Meanwhile, herbs are freely available in rural areas (Barros et al., 2020). The challenge is to create a platform that enables patients to access information about herbal medicine freely, anytime, and anywhere. With mobile networks revolutionizing the telecoms sector, Uganda has an opportunity to create a digital platform that will enable patients to access information about herbal medicine, including its efficacy and toxicity. This platform should be user-friendly, easy to navigate, and should be available in different languages (WHO, 2013). It helps to empower people to take charge of their

health by giving them the necessary information to make informed decisions about their health. Moreover, it improves access to health information and promotes the use of herbal medicine in the country (Heinrich et al., 2020). Creating a digital platform to promote the use of herbal medicine is not without challenges. There are concerns about the safety and efficacy of herbal medicine, especially when used in combination with conventional medicine (Deng et al., 2020). Therefore, it is essential to provide accurate information to patients about the possible side effects and interactions of herbal medicine with conventional medicine. Also, a digital platform requires constant updating to reflect the latest research findings about herbal medicine.

2. Motivation and Problem

In Uganda, herbal medicine has been widely used for a long time due to its availability and affordability. However, there is still a lack of proper documentation and central organization of information related to the preparation procedures and visual identification of herbs (Sekagya, 2011). The limited access to this information and the lack of knowledge of the proper use of herbal medicine by the public has led to potential health hazards. Despite the country's abundant presence of herbal medicine, there is a limited number of individuals who have the knowledge and skills to identify and prepare these herbs. Additionally, the available information is not easily accessible to the public, which increases the risk of misuse or misidentification of herbs. To address this issue, it is crucial to develop a comprehensive database of herbal medicines that contains accurate and detailed information on their preparation procedures and visual identification. This database should be easily accessible to the public to enable the effective and safe use of herbal medicine. Moreover, the availability of mobile networks and information and communication technology (ICT) infrastructure provides an opportunity to enhance the knowledge of herbal medicine and increase its accessibility to the public. By leveraging ICT, the public can access accurate and up-to-date information on herbal medicine, including its uses and potential side effects, through their mobile devices. Therefore, the development of an ICT-based platform that provides easy access to accurate and reliable information on herbal medicine could promote its efficient and effective use by the public.

3. Objectives

The primary goal of this study is to enhance the accessibility of information about the traditional herbal medicine that is commonly used to treat various ailments. The specific objectives of this research project are as follows: Firstly, to collect data from reliable sources on functional and non-functional requirements that could be used to design an effective herbal information system. This step will involve conducting extensive research on traditional herbal medicine used in Uganda, as well as existing information systems and technologies that can be integrated to create an effective platform. Secondly, based on the findings from the research conducted, design a comprehensive herbal information system model that meets the requirements gathered. This step will involve identifying the various components and functionalities required to create an effective and user-friendly system that can be used by individuals from different backgrounds and levels of education. Thirdly, develop a prototype of the herbal information system model using appropriate technologies and tools. This step will involve selecting the most appropriate software development approach that is best suited to the project's needs and requirements. The prototype will be designed to provide a user-friendly interface that allows users to easily access information on traditional herbal medicine and related products. Finally, test and validate the developed herbal information system model prototype to ensure it meets the specified requirements. This step will involve conducting user acceptance testing, system testing, and performance testing to ensure that the system is reliable, efficient, and effective.

4. Related work

This section presents a review of related works done by scholars on herbal medicine information systems. The literature was sourced from journal articles, book sections, conference proceedings, reports, and electronic resources. Sanjoy and Yogeshwer (2003) stated that there is an increasing global demand for herbal medicine, especially in developing countries where they are being used as primary healthcare due to cultural acceptability and compatibility with the human body. Joanne et al. (2007) defined herbal medicine as herbal remedies, products, medicinal products, phytomedicine, phytotherapeutic agents, and phytopharmaceuticals. Noraziah et al. (2004) conducted an empirical study on medicinal herb information systems in Malaysia and found that people were interested in using herbs but lacked information on their uses and preparation methods. Innettutor (2016) developed an Herbal Plants and Medicinal Usage Information and Archiving System that allowed for easy data retrieval and management but did not provide information on preparing and administering herbs for treating ailments.

HerbMed is an electronic herbal database developed by the American Botanical Council in 2009. It provides access to scientific data on 257 of the most popular herbs in America. However, users have to pay $9.98 per day to access the system. Frang et al. (2007) developed the Comprehensive Herbal Medicine

Information System for Cancer (CHMIS-C), which integrated information on 203 cancer-related molecular targets, 527 anticancer herbal recipes, 937 individual ingredients, and 9366 small organic molecules isolated from herbal medicines. The system, however, only considered cancer. The Saudi Herbal Plant Information System (SHPIS) was developed in Saudi Arabia and provided information on 120 varieties of herbal plants distributed into 59 families. Its aim was to enhance knowledge of herbs and promote their use in treating various diseases in Saudi Arabia, (Asif & Khan, 2017). Helpherbalists (2009) observed that interest in herbal medicine and spices increased as trade among Europe, the Middle East, India, and Asia flourished in the second and third centuries. Both China and India developed extensive medical systems that focused on using herbs to create bodily balance and harmony. According to Kamboj (2000), herbal medicine is still the mainstay of healthcare for about 75-80% of the world's population, especially in developing countries. Ogirima et al. (2013) suggested that the continual development of mobile computers and ease of access to the internet opened up new opportunities for creating robust user-centric applications, such as decision support systems for herbal medicine prescriptions. They presented an integrated method to develop a web-based decision support system for herbal medicine prescriptions.

The reviewed literature reveals the increasing demand for herbal medicine as primary healthcare. However, there is a need for adequate information on preparing and administering herbs for treating ailments. The development of electronic databases such as HerbMed and CHMIS-C has provided access to scientific data on herbs. SHPIS aims to enhance knowledge of herbs and promote their use in treating various diseases in Saudi Arabia. The historical use and modern research validation of herbal medicine make it a safe, effective, and low-cost alternative to conventional medicine. The development of decision support systems for herbal medicine prescription, which utilizes web platforms and mobile computers, presents new opportunities for creating robust user-centric applications.

5. Methodology

The methodology used in the study consisted of the research design, study area, study population, sample size, procedures, methods, and instruments of data collection. The research was carried out using an experimental research design and a descriptive qualitative design. The study was conducted in Uganda, Mpigi district, Buwama sub-county, and Buyijja Parish. The target population was practicing traditional medicine trainees from the Buwama sub-county, and purposive sampling was used to identify respondents.

The sample size was determined using Krejcie & Morgan's (1970) table, and the research used an interview schedule method with the help of interview guides to collect data. The study also reviewed existing documents about different kinds of herbal medicine, including their scientific names and how they look. The study design involved collecting qualitative data about herbal medicine and the diseases they cure. A web-based information system model for herbal medicine was designed using an architectural framework, which showed the available technology to be used and the flow of information. The logical design of the model was presented using entity-relationship diagrams, while the physical design related to the actual input and output processes of the model. The system model was designed, which included a database for storing information about the different herbal medicine and web pages that would help users retrieve the required information.

The information system model for integrating the indigenous Uganda herbal medicine from different herbalists was developed using programming languages that included PHP, CSS, and HTML to develop user interfaces and MYSQL to develop databases. The system was tested using different browsers, including Mozilla Firefox, Internet Explorer, and Google Chrome. Uganda does not have an automated information system that integrates information about the different kinds of herbal medicine, so the developed information system was tested in the Ugandan environment. The study was conducted in the Buwama sub-county, which has a high density of 70% of the population using herbal medicine in primary health care. The target population was 50 adults, both men and women who were practicing traditional medicine trainees from the Buwama sub-county. The sample size was 44 herbalists. The study used an experimental research design and a descriptive qualitative design to collect data. The information system model for herbal medicine was designed, and the system was tested using programming languages such as PHP, CSS, and HTML. The study contributes to addressing the need for an automated information system that integrates information about different kinds of herbal medicine in Uganda.

6. Model Design

6.1 Architectural Framework

The architectural diagram below shows the components required for setting up a prototype of the working herbal information system model. The system model is a web based application, which could be accessed by anyone having internet, the visitors could access the system model either using a smart phone, a computer. The information is stored in the database server which is secured with a fire wall, at the back end the herbalist having administrator rights could update the information in the system.

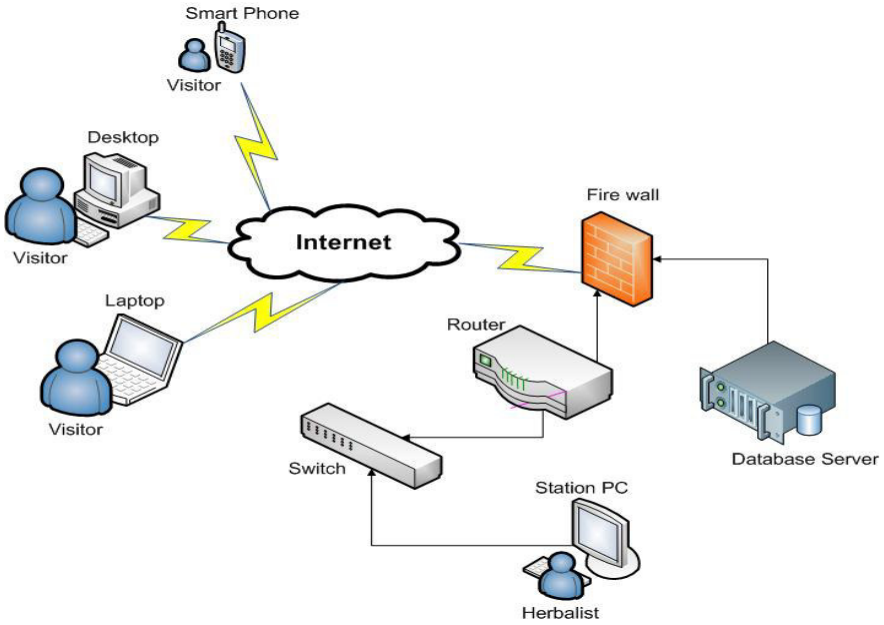

Figure 1: Architectural Framework

6.2 Entity Relationship Diagram (ERD)

The Entity relational diagram describes the conceptual database design and data dictionary, it also describes the relationships among entities as shown in the figure below. The concept of the system was designed and all the relevant entities involved were identified. Below are the entities which were chosen to capture the system information: - Ailment, Ailment treatment, Plant, Research Centre, Herbalist and Herb.

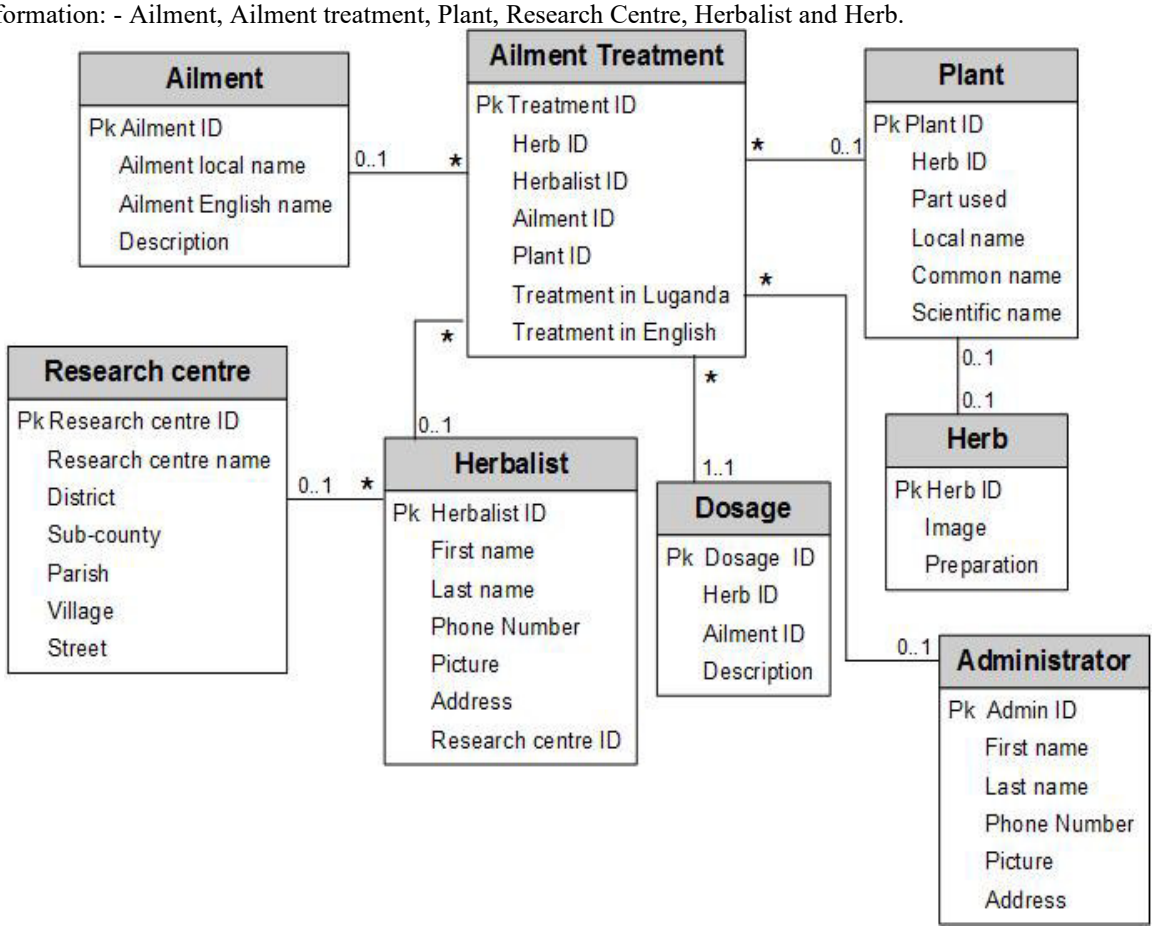

Figure 2: Entity Relationship Diagram

6.3 Data Flow Diagrams

The context diagram (Data Flow Diagram Level 0) below describes the users of the system, that is the administrator how controls and manages any information to be updated to the system. The Visitors are those individuals who would be able to access the herbal information system through their computers or smart phones.

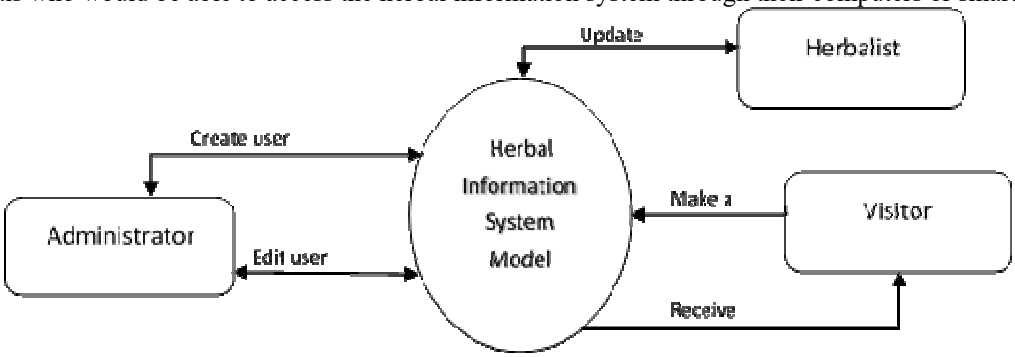

Figure 3: The Context Diagram

The dataflow diagram (Level 1) below describes the flow of information within the information system. The external entities that is the visitors and the herbalists could access and update the information and data respectively. Two main processes (1 & 2) are involved which include managing content and searching content.

The herbalist manages the content which involve updating the data about the herbs and ailment information. Which are then stored in the different tables in the data base, where they are arranged systematically for easy extraction.

The visitor is able to search for the any ailment from the system as shown by process 2 in the figure, the system searches the data stores for the information and a response is returned for the visitor.

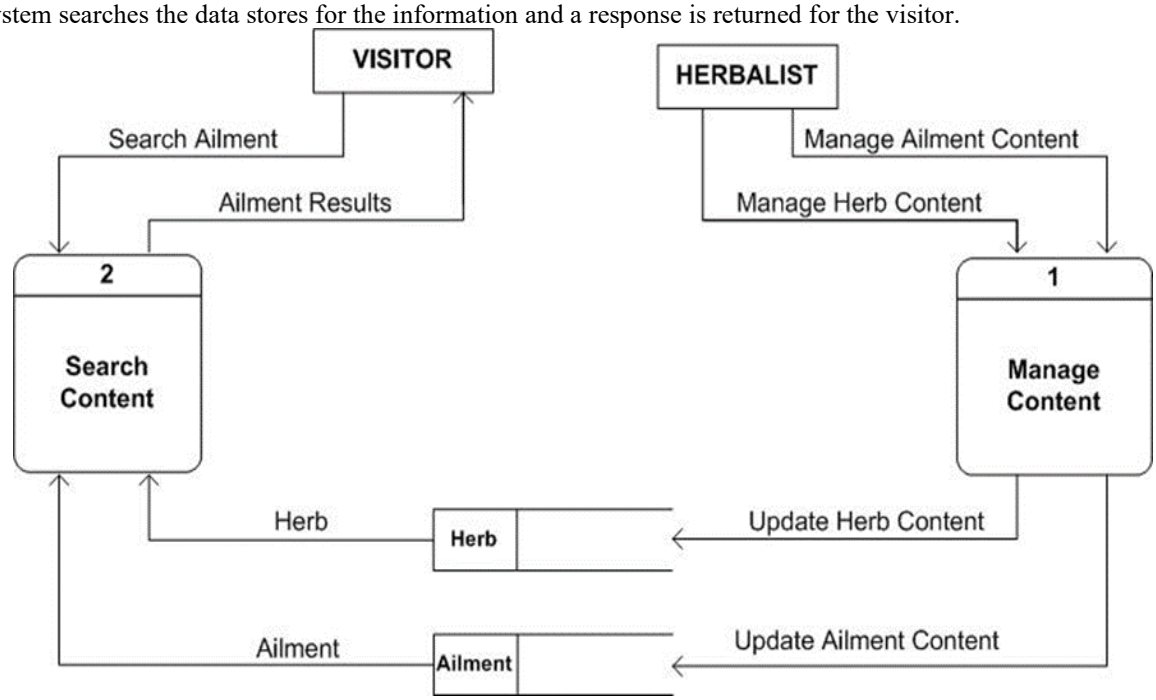

Figure 4: Data Flow Diagram Level 1

6.4 Over-abstract Model

This is a graphical representation of the actual system, showing how the different components interact and how the data flows between them.

The model shows that the herbal information system model is accessed by the administrator, visitor and herbalist. The administrator can create new user accounts for the herbalists and also edit the existing user accounts. The Herbalist as a user can update the content of the model by adding new data in the system and also edit the existing content. The visitor as the user can search for an ailment in the system model by first choosing the language and then type in the ailment to search for the corresponding herb that can be used to cure the ailment.

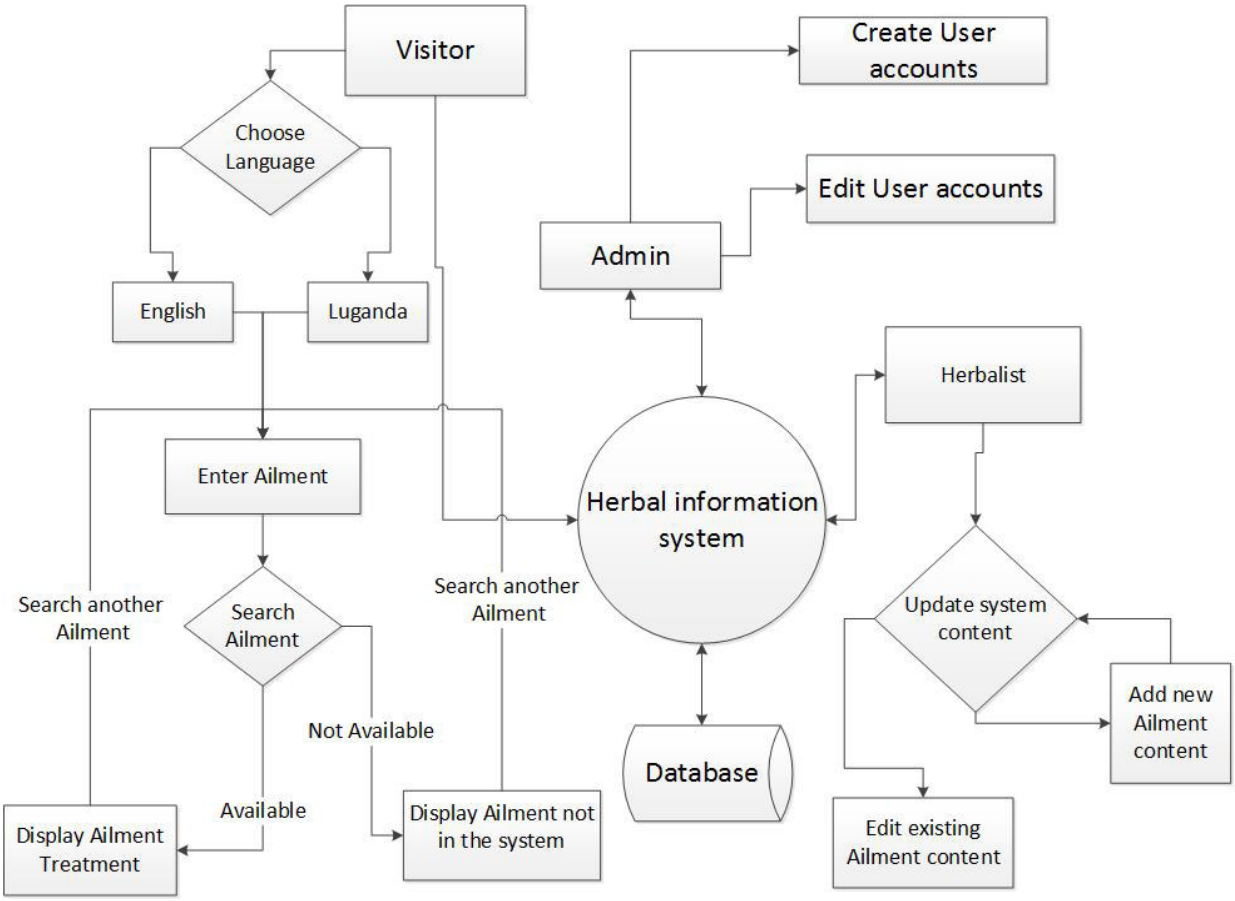

Figure 5: Over-abstract Model

6.5 Database Design

This design includes the different tables, fields, and relationships between them. MySQL was used to design the database because it is a light-weight, fast and free database server system.

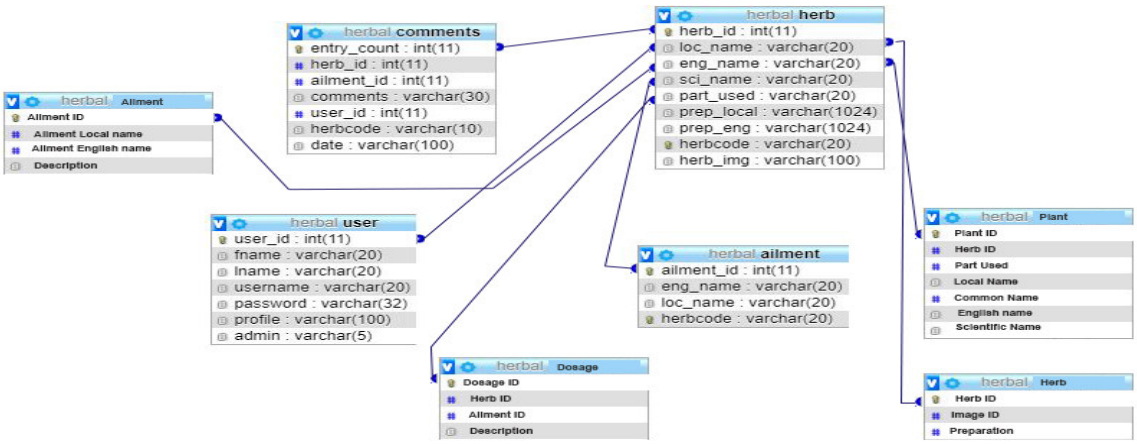

Figure 6: The Database Design

6.6 User Interface Design

The user interface components were designed and developed in PHP (Hypertext Preprocessor) and CSS (cascading style sheets) using Macromedia Dreamweaver version 8, which is a free source, light weight and could run on almost every computer and Microsoft operating systems. Below are some of the captured code used in developing the user interfaces. The home page of the herbal information system model was designed to give options for the visitor to search for the any ailment by first choosing the language to use that is either Luganda or English. On searching the information would be displayed for the user. At the bottom of the page is the comment option where the visitor would make any comment or suggestions about the herbal medicine information as view

on the system model. At the top right corner of the page is the log in button that provided the option for the herbalist (administrators) to log into their accounts to make system data update.

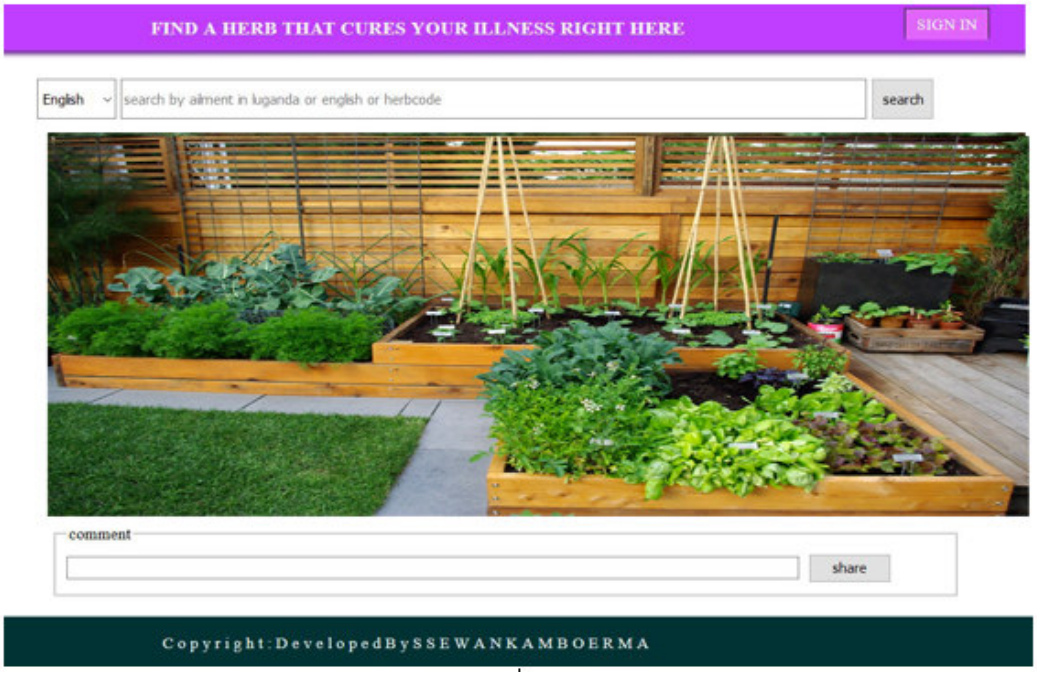

Figure 7: A screen shot of the Home page

The Herbalist account page was designed to allow herbalists to login. The figure 8 is a representation of the logged in account for the herbalist where the herbalist can add anew herb that could be used to treat any ailment. The page gives the herbalist the option to fill in the local (Luganda), English and scientific names of the herb, the part used to cure the ailment, both the English and Luganda ailment names, the image of the herb and the preparation procedures for the herb both in Luganda and English. At the top right corner of the page is the logout button where the herbalist can sign out from his or her account.

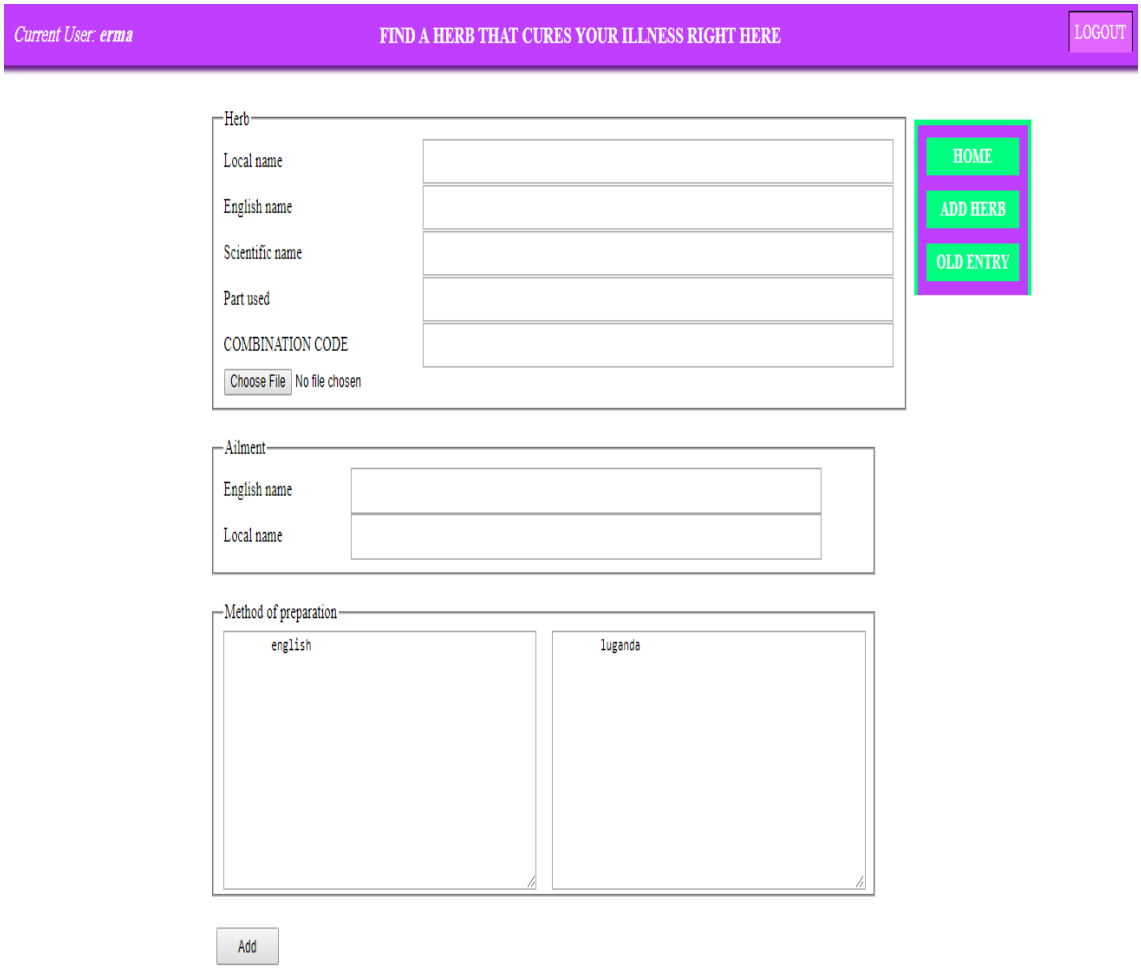

Figure 8: The Herbalist Account page

The Ailment search page was designed to enable the use do a thorough search for different ailments available in the system. Figure 9 shows when the visitor was searching for an ailment in English called "Malaria".

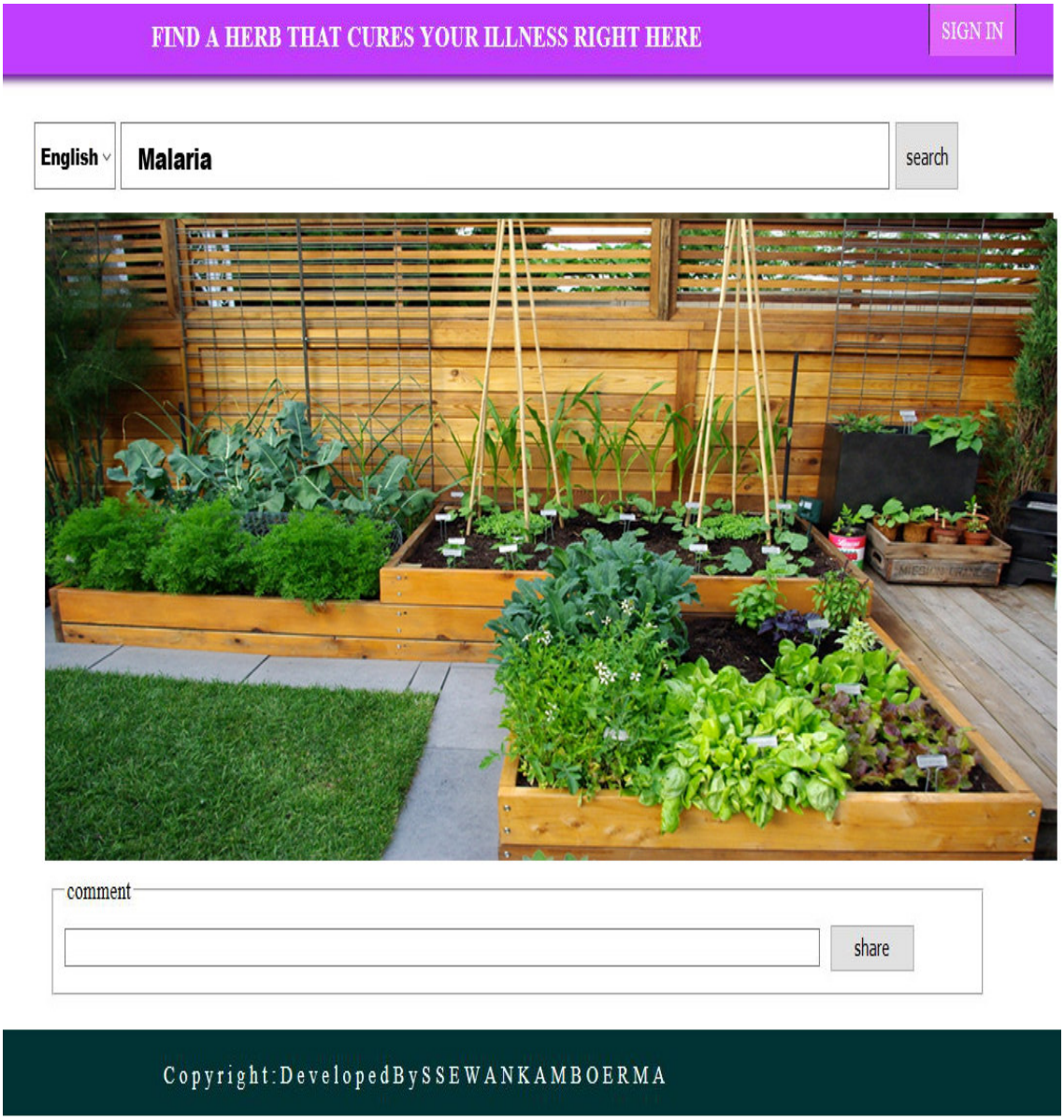

Figure 9: The Ailment Search page

Ailment Results page was designed and developed to provide results for the ailments after searching. Figure 10 shows the results after the visitor had searched for an ailment, “Malaria” in this case. The herbal information system displays then the results as shown.

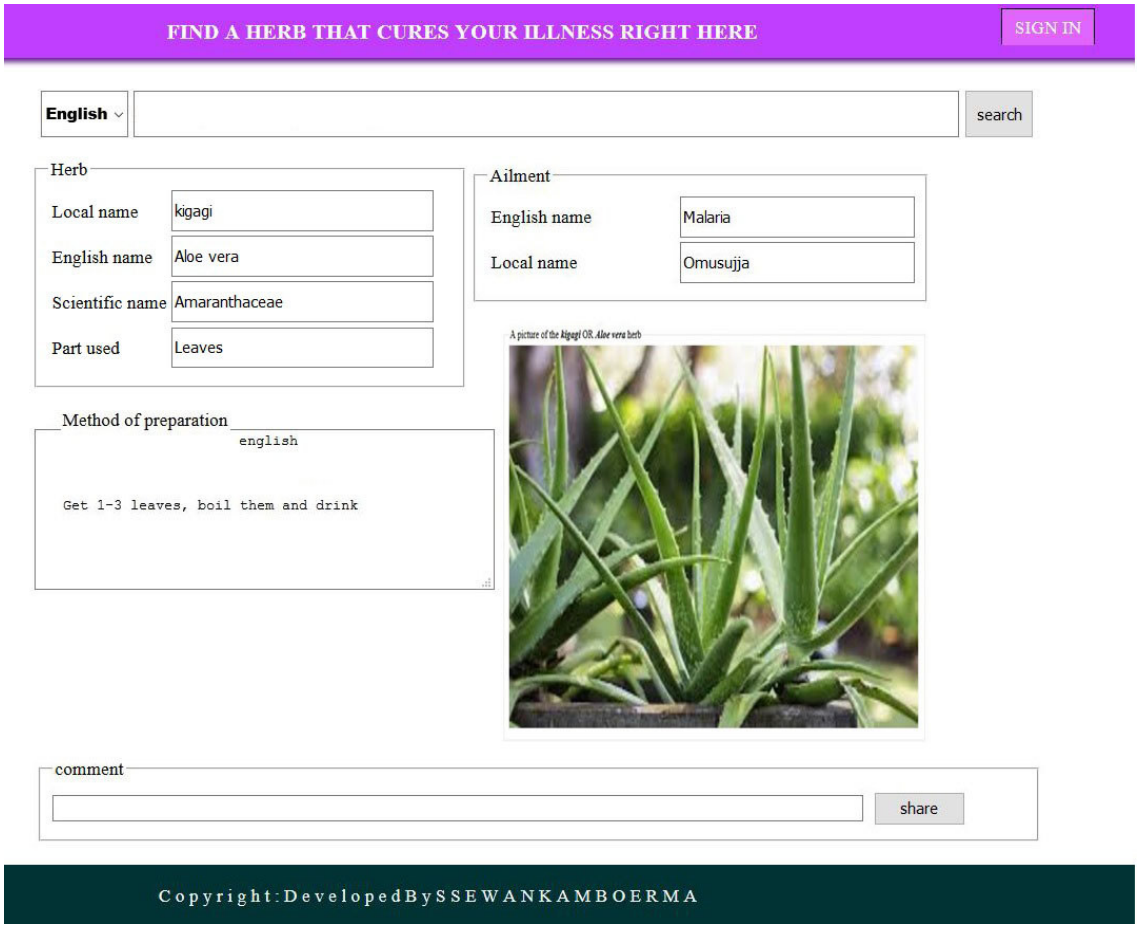

Figure 10: The Ailment Results page

7. Results and Discussion

The first objective was met by collecting data from reliable sources on functional and non-functional requirements that are to be used to design an effective herbal information system. This step involved conducting extensive research on traditional herbal medicine used in Uganda using interviews, as well as existing information systems and technologies from the literature review. According to the literature carried out from the different scholars, it was found that with the existence of the internet, 70% of the herbal information systems do not fully provide information about the different kinds of herbal medicine on how they look, their local names and how they could be prepared. Data obtained from the interviews were analyzed using content analysis and the findings were tabulated. Found that of the 44 respondents, 15 were good at reading and writing Luganda making a percentage of 34%. 20 respondents were good at English making a percentage of 50% and 9 respondents were good at reading and writing both Luganda and English which made a percentage of 16%. This helped in identifying one of the functional requirements for the model.

Language	Number of Respondents	Percentage (%)
Luganda	15	34
English	20	50
Both	09	16

Table 1: Frequency table for languages

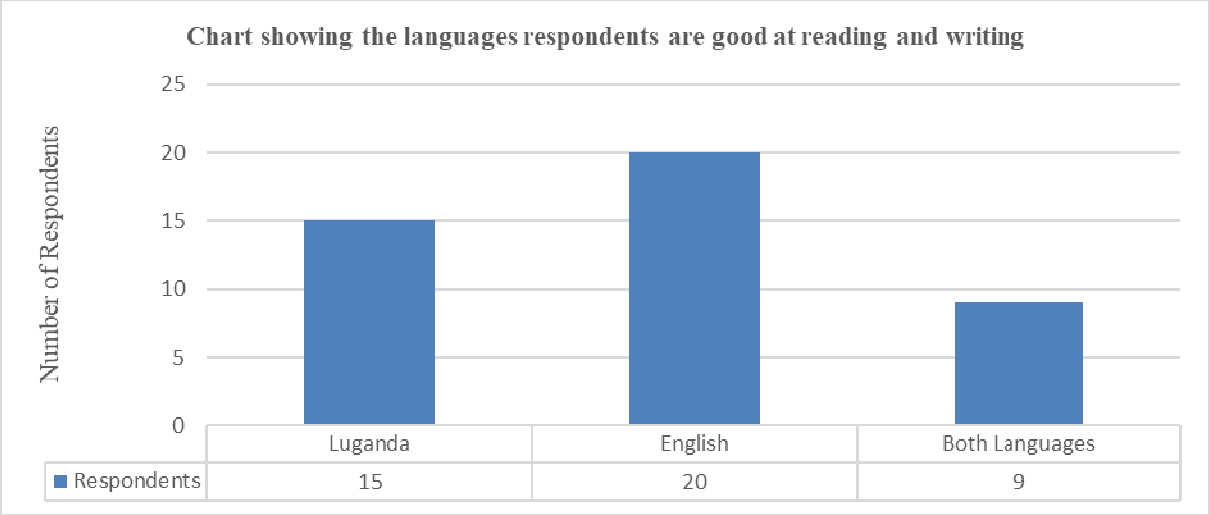

Figure 11: A chart showing languages from respondents

The following functional requirements were identified:

1. The herbal information system model had to allow the visitor to search for any ailment either in English or Luganda since these are the common languages used in the area.
2. The herbal information system model had to display the herbal information used in the treatment of the searched ailment.

The system was designed to meet the following non-functional requirements:

1. The herbal information system model had to allow administrators to update the system content.
2. The herbal information system model had to allow searching for any ailment using any keyword and display the results for the visitor.

In addition, the second objective was met by designing a comprehensive herbal information system model that meets the requirements gathered, based on the findings from the research conducted, as shown in the "Model design" section. This step involved identifying the various components and functionalities required to create an effective and user-friendly system that can be used by individuals from different backgrounds and levels of education. More so, the third objective was met by developing a prototype of the herbal information system model using appropriate technologies and tools such as HTML, PHP, MySQL, CSS, JavaScript, and Maria DB, among others. This step involved selecting the most appropriate software development approach that is best suited to the project's needs and requirements. The prototype was designed to provide a user-friendly interface that allows users to easily access information on traditional herbal medicine and related products.

The fourth objective was met by testing and validating the developed herbal information system model prototype to ensure it meets the specified requirements. This step involved conducting user acceptance testing, system testing, and performance testing to ensure that the system is reliable, efficient, and effective. The system prototype was tested on different browsers which included Mozilla Firefox, Internet Explorer, Opera, and Google Chrome.

8. Conclusion and Future work

With the pursuit of globalization, there is a big need to have organized details about herbs, the way they are used, and the parts used. This model provides information about herbs stored in a proper database and it is a more appropriate approach compared with the traditional way where all the data is written on paper. The system model is not intended to replace orthodox medication but rather to flag the usage of herbal medication through the use of the internet anywhere in Uganda. The model attempts to enhance the effectiveness of herbal medication which has its information in the database that improves the efficiency of herbal medicine knowledge dissemination. With the herbal information system model designed, it can be used as a prescription tool, an improvement might be made by future researchers to come to make the model a prescription tool in addition to just being used to search for the herbal to treat an ailment. An improvement might be made to the model to allow individuals from different parts of the country to be able to give in information about the different herbs and the diseases they cure, which would be cross-checked and confirmed by the administrator before the information could be used by other people.

9. Acknowledgment

We would like to express our sincere gratitude to the directorate of research and the Department of Computing and Informatics of Bugema University for their support in this research. We are also thankful to the

PROMETRA Uganda herbalists for providing the necessary data for our study. Our appreciation also goes to the anonymous reviewers for their valuable feedback and suggestions that helped us improve the quality of this paper.

10. References

Abbott, R. B., Hui, K. K., Hays, R. D., Mandel, J., Goldstein, M., Winegarden, B., ... & Brunton, L. (2011). Medical student attitudes toward complementary, alternative and integrative medicine. Evidence-Based complementary and alternative Medicine, 2011.

Aqil, A., Lippeveld, T., & Hozumi, D. (2009). PRISM framework: a paradigm shift for designing, strengthening and evaluating routine health information systems. Health policy and planning, 24(3), 217-228.

Barros, L., Dueñas, M., & Ferreira, I. C. (2020). Nutritional and health benefits of traditional vegetables in some European Mediterranean regions: a review. Food & Function, 11(11), 9310-9326. https://doi.org/10.1039/D0FO01900E

Carter, S. T. C. (2015). FACTORS INFLUENCING THE USE OF TRADITIONAL MEDICINE BY PATIENTS UNDER PALLIATIVE CARE AT HOSPICE AFRICA UGANDA Sekagya Yahaya Hills.

Chen, S. L., Yu, H., Luo, H. M., Wu, Q., Li, C. F., Steinmetz, A., ... & Huang, L. F. (2016). Conservation and sustainable use of medicinal plants: problems, progress, and prospects. Chinese Medicine, 11(1), 1-17. https://doi.org/10.1186/s13020-016-0108-7

Deng, J. F., Zhong, Y. Q., Huang, Q. H., & Lin, C. Y. (2020). Recent advances in the chemical and biological diversity of natural products from Chinese medicinal plants. Phytochemistry Reviews, 19(2), 261-284. https://doi.org/10.1007/s11101-019-09633-w

Di Pierro, F., Bertuccioli, A., Marotta, F., & Rao, S. (2020). Possible therapeutic effects of adjuvant phytotherapy in COVID-19: viewpoint from Western traditional herbal medicine. Journal of Medicinal Food, 23(12), 1249-1252. https://doi.org/10.1089/jmf.2020.0208

Dighe, N., Nirmal, S., Musmade, D., & Dhasade, V. (2010). Herbal database management. Systematic Reviews in Pharmacy, 1(2), 152.

Heinrich, M., Appendino, G., Efferth, T., Fürst, R., Izzo, A. A., Kayser, O., ... & Stuppner, H. (2020). Best practice in research–overcoming common challenges in phytopharmacological research. Journal of Ethnopharmacology, 246, 112230. https://doi.org/10.1016/j.jep.2019.112230

Kamin, S. (2012). Medical marijuana in Colorado and the future of marijuana regulation in the United States. McGeorge L. Rev., 43, 147.

Kelly, A. (2009). Healthcare a major challenge for Uganda. The Guardian, April, 1.

Khedr, A. E., Kadry, M., & Walid, G. (2015). Proposed Framework for Implementing Data Mining Techniques to Enhance Decisions in Agriculture Sector Applied Case on Food Security Information Center Ministry of Agriculture, Egypt. Procedia Computer Science, 65, 633-642.

Mandeng, S. B. (2013). Traditional Healing of a" Non-Ordinary" Disease Among the Basaa of Cameroun: A Religious-Anthropological Approach.

Njan, A. A. (2012). Herbal medicine in the treatment of malaria: Vernonia amygdalina: an overview of evidence and pharmacology. In Toxicity and Drug Testing. InTech.

Ogirima Sanni, A. O., Olabiyisi Stephen, O., Omidiora Elijah, O., & Fagbola Temitayo, M. (2013). Mobile Oriented System for Prescription in Herbal Medicine. International Journal of Scientific & Engineering Research, 4(2), 1-10.

Ogirima, S. A. O., Olabiyisi, S. O., Omidiora, E. O., & Oke, A. O. (2015). Web-based decision support system for prescription in herbal medicine. Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS), 6(7), 245-254.

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. Journal of management information systems, 24(3), 45-77.

Quinn, J. R. (2014). Tradition?! Traditional Cultural Institutions on Customary Practices in Uganda. Africa Spectrum, 49(3), 29-54.

raditional herbal drugs of Bulamogi, Uganda:plants, use, and administration.

Raman, V., Avula, B., Galal, A. M., Wang, Y. H., & Khan, I. A. (2013). Microscopic and UPLC–UV–MS analyses of authentic and commercial yohimbe (Pausinystalia johimbe) bark samples. Journal of natural medicines, 67(1), 42-50.

Syed, A. H., & Khan, T. (2017). SHPIS: A Database of Medicinal Plants from Saudi Arabia. INTERNATIONAL JOURNAL OF ADVANCED COMPUTER SCIENCE AND APPLICATIONS, 8(5), 49-53.

Tekemetieu, A. A., Koussoube, S., & Fotso, L. P. (2016). An ontology-based computer-aided diagnosis system in African traditional medicine: At the Sorcerer's Stone. Kybernetes, 45(1), 30-50.

World Health Organization. (2005). WHO global atlas of traditional, complementary and alternative medicine

(Vol. 2). World Health Organization.
World Health Organization. (2020). WHO traditional medicine strategy: 2014-2023. World Health Organization. https://www.who.int/publications/i/item/9789241506090