Conclusion and Future work

8.1 Introduction

In the previous chapter we discussed the evaluation process in details. It mainly emphasise on the planning of evaluation process and designing of relevant tests.

This chapter present the outcome of the evaluation procedure which was set up in the previous chapter. In addition to that chapter includes achievements of each and every objective of the research. During the project formation, ten objectives have been set up and this chapter will evaluate the achievements of each and every objective in details. Furthermore a discussion on the limitations of the systems and proposes future improvements.

8.2 Objective Achievement

During the project formation, ten objectives have been set up as milestones of the research. The objectives were set up in the way to make sure to define the research targets properly, and make sure to achieve a tangible outcome through the research. This section will evaluate the level of achievements concentrating each and every objectives of the research.

8.2.1 Critical study on Agriculture domain and influencing factors

Both global and local situations in the Agriculture domain was critically studied based on advancements. Study has been carried out with the supportive document such as government publications, research papers, newspapers and web based news forums and articles. It has been identified that Agriculture sector in Sri Lanka lacks the up-to-date timely provision of information where necessary, devastating results of recent mealy bug attack could be taken as good example. Similarly in the history there were many incidents such as invasion of foreign weeds and pests that put our farmers in greater pressure.

8.2.2 Critical study on current ICT approaches

In this information era ICT has been utilised effectively in almost every field. Similarly the use of Information Systems in Agriculture domain seen in many developed countries, within which use of multiple technologies were observed. Lot of researches carried out in Agriculture filed to explore on the use of ICT approaches for sustainability. This includes the traditional ICT approaches as well as modern AI based approaches. During the process of critical analysis of research work, seventeen research papers were reviewed and studied. Out of it there are nine systems which are based on AI technologies.

8.2.3 Study on multi agent systems technologies and ontological knowledge definition

Comprehensive study on multi agent related systems and researches have been carried out in the initial stage of the project. These studies were mainly focused on the latest research in the domain of agriculture. Those include the current approaches and the importance of multi agent based researches and other traditional AI related areas such as expert systems. Further best practices used by the researches during the development and implementation of the multi agent systems were evaluated and studied. The use of multi agent technology in agriculture domain as well as various other domains was critically analysed using case studies.

8.2.4 Critical study on swam intelligence and communication methods

Comprehensive study carried out on communication mechanism between agents and well recognised communication standards were identified. Similarly knowledge representation methods and software tools available for designing of ontology and creating of knowledge bases were identified.

8.2.5 Brainstorming with relative domain experts

Expert knowledge is one of the key requirements when it comes to knowledge intensive research. . However scarcity or Expertise increased the difficulty of finding helpful personalities. A "Govi Jana Seva" officer was agreed to provide his inputs based on his own experience on the day today problems faced by farmers. Based on

his on the job experience and guidelines developed the ontlogies and knowledge bases of the system.

8.2.6 Design and development of prototype multi agent system

Prototype agent system has been developed with the use of MadKit agent development environment. System consists of three modules such as communication module, system access module and agent swarm. Primarily java based open standards, technologies and tools have been used to develop the system.

8.2.7 Access to the system via web interface

Multi agent system deployed as a web based tool where users can access the system through the internet. Initially users have to register with the system thereafter they can maintain a private user profile within the system which includes information such as user's personal information and cultivation related information. This information will be used by the agent module during the process of solving queries and questions raised by the users.

8.2.8 Access to the system via Short Message Service (SMS)

Registered users can access the system through mobile channel by sending SMS. This channel provides a limited access to the system where users would able to solve simple queries. When it comes to real world implementation, SMS access facilitated using a Subscriber Identity Module (SIM) and a mobile internet device. Once the device is attached to the hosting environment of the AIS system, it will grab SMS messages sent to the mobile number.

8.2.9 Evaluate the proposed MAS.

Evaluation carried out mainly in two ways. Developer level evaluation and user level evaluation. Developer level evaluation carried out using a scenario based approach to test the behaviour of the system. Furthermore results and outcomes of the system validated with the help of domain experts using scenario based approach. System access module evaluated with a peer review among some friends.

8.2.10 Documentation of the final dissertation

This dissertation serves the fulfilment of objective of MSc thesis.

8.3 Evaluation outcomes and comments

Different level of evaluation criteria used with the system. Scenario based evaluation procedure can be considered as a unit testing of the system and it was successfully carried out.

The most critical part of the evaluation process is the validation of information retrieved from the system. This was done with the help of domain expert. According to final results it shows that more than 80% of acceptable outcome can appear with the scenarios where most of the agents are familiar with the input queries. However for some queries, it was noted that if the number of agents who are knowledgeable about the request is less than four, the output acceptable level reduced to thirty to forty percent. At the same time it was observed that by improving knowledge base with more information, AIS produced acceptable solution to the problem.

Most of the responses received for web and SMS modules contained comments which suggest improvements and mostly suggested aspects such as security and graphical enhancements. However the system access channels will serve the main purpose of the AIS.

8.4 Validation of Hypotheses

Research has been carried out based on the hypothetical assumption, pointing out the possibility of problem solving in complex competitive domain could be achieved by negotiation among different entities with the help of simple communication.

Evaluation results revealed that when more agents know about a particular query, it is possible to achieve the success rate of more than 80%. This proves the validity of our hypothesis and encourages using multi agent technology in similar software developments in future.

8.5 Limitations

Prototype of the system is implemented to query only about the Green Chilli and Salad leafs. When it comes to these cultivations some of the most important aspects are already stored in the knowledge base.

System totally relies on the input information provided by the uses and the farmers. In other words different people can describe same thing in different ways. Therefore based on these inputs which accompanied with human error, could create differences in outputs given from the system. Similarly when users posting queries, system will accept the words provided the spellings are correct.

Do not have any means of information gathering mechanism such as photographs, censors, scientific instruments, therefore this affect the reliability of inputs.

Difficult to represent some of the knowledge because of the inherent fuzziness, for example system does not support the correct measurement of the exact fertilizer quantity needed for a given farm land. When providing inputs to the system, factors such as colour of the leaves, and other symptoms with pests could carry fuzzy information.

Since the system support only English language and sometimes Sinhala representation of English, It is harder to a person such as a farmer to grasp the system without help of a person who is familiar with English and computers.

8.6 Future work

Improvement of knowledge bases with new knowledge and expansion of knowledge bases improve the quality of the outcomes of the system. On the other hand currently it is difficult to find any well defined ontologies for the agricultural domain. The prototype system is able to cover only a limited area of the domain therefore knowledge bases do not contain enough information about all the other areas of Agriculture. This should be improved by feeding the knowledge base with adequate information on other areas. Global standards such as Agricultural Information

Management Standards (AIMS) [26] could be used in future to fill the gaps in Agriculture knowledge representation.

At the moment, since most villages are equipped with computer centres, the resources could be utilised effectively to provide access to the AIS and support farmers to solve their problems. At the same time it is best to introduce this solution in Unicode Sinhala and Tamil which will reduce the language barrier. The user friendless of the mobile channel should be increased in order to support Unicode. Finally Implementation of the knowledge bases in Sinhala and Tamil will increase the usability of the system.

8.7   Summary

This chapter concluded the final outcome of the project. It presented the achievements of each and every objective of the research. Furthermore it included the comments and responses received from the domain expert and the system users. Finally it presented the limitations and the future work for potential enhancements.