**CHAPTER ONE**

## INTRODUCTION

A healthy ecosystem is important for sustaining human life and bees are key contributors to maintaining good ecosystem health, it is therefore the responsibility of those in technology to develop solutions that work for the benefit of bee-keepers to monitor bees and the state of the colony.

The objective of this paper is to propose a precision bee keeping monitoring information system called SwarmBI. The physical location of the hive will be in Kathungi subdivision which is in Kitui County

## BACKGROUND OF THE STUDY

There has been a need for incorporating technology in the farming sector here in Kenya so as to ensure maximum yield in terms of capacity is met by the farmer.With the emergence of Internet of Things (IOT) it has become possible to use sensors to enable automation of activities. In a typical farm IOT is already in use where a farmer can turn on sprinklers or they could even be set to automatically turn themselves on at a particular time of day. Technology is very pervasive and it is not difficult to believe that it has found its way into agriculture and is showing to have a plenty of benefits.

## PROBLEM STATEMENT

In Kitui County the government is pushing for registration of 5000 bee-keepers so as to reap the benefits of the multi-million industry. Research has shown that a properly managed bee-industry could produce 400metric tonnes of honey annually Dasgupta.S(2009). The purpose of the registration is to ensure experts reach farmers for training on harvesting and best practices when handling a beehive at the point of handling the hives the colony is often disturbed and this leads to decrease in amount of honey produced .Environmental factors such as temperature and humidity which are key in providing proper conditions for the colony to function naturally remain unchecked as there is no internal mechanism of knowing such conditions inside the beehive.

The gap is that there is need for more efficient monitoring of the internal conditions of the hive because if the extremes are properly controlled it will have a direct impact in the amount of honey that can be collected from each individual hive. The monitoring can be done from a central kit that contains devices capable of collecting and recording such environmental inputs. In Kitui alone if implemented there is a market of the already registered 5000 bee-keepers who can be well served by the system.

The proposed system will have allow for Data collection through The physical kit inbuilt with sensors.This sensors interact with the decision support module in the form of a Raspberry Pi with GSM support to change the data into a form that can be transmitted to a Server and stored in a database .Comprehensive analysis of the recordings will be facilitated through the use of a computer or mobile device. The SwarmBI interface will be the centre-piece of the entire design as it will be capable of providing several reports, estimating future conditions and recommend actions targeted at improving optimal yield.

## OBJECTIVES

The objectives span the following aspects:

1. To develop the stationary system to monitor conditions inside a beehive
2. To develop the interface through which analysis of the data collected can be done
3. To develop an alternative means for delivery of analytics through use of a Menu driven interface for mobile devices without internet connectivity.
4. To test the system in a real case scenario in Kitui and receive results from a location in Nairobi.

## SCOPE AND LIMITATION OF THE STUDY

The proposed system will be able to satisfy the objectives stated and respond appropriately despite the geographical distance of communication between the stationary device and point of access of the user. A user should be able to get real-time temperature and humidity readings and a mechanism will also be put in place such that once the readings go above a certain threshold an alert is triggered to warn of extreme conditions and a need to have someone at the site of the beehive to assess what could have caused the spike.

The Menu driven approach for data analysis delivery will involve use of a USSD which seems an appropriate means for some users who may be located in the rural regions.

The system will be limited in terms of its scale as it will make use of only one beehive, therefore comparative study between honey yields attained from different beehives will not be possible.

Other limitations include:

1. Programming Skills- development of the analytics interface will require Python programming language, which might limit the developer,there is therefore need to familiarise oneself with the technicalities of such a language.
2. Mobile Wireless and Computing knowledge –this is due to the fact that there will be a problem of a big geographical distance for communication to occur.

## JUSTIFICATION

The project will demonstrate the powerful capabilities of IOT devices and sensors in the field of Precision Apiculture. This devices will be proven capable of delivering high value information concerning the conditions inside the beehive to the hands of the farmer without need to put on gloves and protective gear to poke around the beehive and disturb the bees .It will reduce unnecessary intrusion which may prevent the colony from realizing its potential in terms of honey deposits.

The manner in which the development of the system will be done will also be one which seeks to achieve:

1. Flexibility- the Information system has to be based on simplicity and easily modified to better suit the beekeeper’s needs.
2. Fault tolerant-It should be efficient in handling potential errors and maintain stable connectivity between the stationary beehive and mobile or desktop interface.
3. Allow for efficiency in decision making-it should be capable of simplifying the maintenance of bee colonies, by providing reports and insightful analysis that can trigger decision making.
4. Customer satisfaction-there is a need to ensure the cost of actualizing such a functional system is low so that it does not end up in the price of accessing the kit to a farmer which may hinder uptake of the monitoring system.

# CHAPTER TWO

## LITERATURE REVIEW

## Background information on Precision bee keeping systems

Majority of farmers practising apiculture still use traditional production systems which mainly comprise of hollow log hives. These hives constitute the single largest number of hive types in the country estimated at 1,273,000 with 73% of the hives concentrated in the eastern part of the country. Other traditional hives include the bark hives made of bark that has been peeled from the trunk of a tree. Chazovachii, B., Chuma, M., Mushuku, A., Chirenje, L., Chitongo, L., &Mudyariwa, R.(2013).

Honey harvesting is very intrusive in nature requiring periodic assessment of the hive by using smoke to drive bees away from one end away from where honey collets and physically checking inside to see if enough honey has been collected .This method is harmful to the colony as it interferes with their natural activities and disrupts a set routine. Crane Eva(1999)

Despite this being the fact, a small minority of farmers have abandoned these practices due to the fact that it does not maximise productivity as yields are often below the expected amount. Owners of bee farms are adopting to start making use of commercial structures such as the Kenya Top Bar Hive and the Langstroth hive which both are created from plywood .Their designs are simple but very functional as compared to the traditional methods. Yirga, G., &Ftwi, K. (2010).Beekeeping for rural development.

The invention of the movable-comb hive is the· work of the ancient Greek beekeepers who used basket hives in which a series of bars were used to form the top of the hive (Mann, 1976) .These types of hives are designed to allow the combs to be removed, inspected and returned back to the hive. The Kenya Top Bar Hive has a movable comb hives and movable frame hives which also allows for colony segmentation. This improved practice in design aspect is also part of beekeeping technology.

## Existing systems

There has been some basic application of use of tags which emit radio signals inside beehives to help in tracking and identification,but the functionalities are still limited and do not tackle the farmers main concern when handling bees .The following systems have been recognized for their ability to offer some level of monitoring .

### EFC beekeeping

There hasn’t been a lot of use of technology into the beekeeping industry however EFC is a fairly recent company that makes use of technological components to enhance the beekeeping experience.

They make use of a RFID chip which identifies a particular hive to a unique owner therefore enhancing traceability. The working of the RFID chip leverages use of a mobile phone and still requires some level of intrusion and on site presence from the user.

The chip records information such as the setup date, this being the day the beehive was put up together with the chip. It also records the colonization date and periodic days of harvesting.

The existing system is capable of performing the following operations:

1. It is capable of tracing the device to appropriate owner.
2. Capturing routine data such as periodic days of harvest.
3. Sending notification or alerts to owner.
4. Provide some basic analytics.

### MyBee

MyBee is a precision bee keeping information systems that uses DHT22 sensors located at the centre of the beehives monitor the conditions, collecting pieces of information, which are sent through a wireless network to a server. Therefore, using the Mobile System beekeepers can monitor, via a web interface on a computer or mobile device, the conditions of the bee colonies.

It is capable of performing the following:

1. Display monitored data.
2. Generate graphs.
3. Provide notifications and reports.
4. Provide statistics.

The system that I propose will perform the following functions but through the introduction of management and computation intelligence layer will be capable of offering:

1. Flexibility- the information system has to be based on simplicity. The system should therefore be easily maintained and modified to better suit the beekeeper’s needs.
2. Fault Tolerant-the information system has to efficiently handle potential errors. Thus, the system was implemented with several precautionary measures including data redundancy.
3. Security-it has to provide security mechanisms to ensure that the data is not violated.
4. Provide decision support- provides information about possible-future values of the monitored elements, which is performed by the Computational Intelligence.

# CHAPTER THREE

## METHODOLOGY

This is the specific procedures and techniques used to identify, select and analyse information about an area of research.

## Structured System Analysis and Design Methodology

Upon assessing the scale of the proposed system the best choice was the SSADM which is a widely used methodology for the creation of information systems.

The approach breaks down an application project into modules, stages and provides a framework for describing projects in a manner suited to managing the project.

The stages apply certain techniques and a sequence and carry conventions and procedures for recording and interpreting the information with the help of diagrams and text.

The methodology accepts that the problem cannot be fully understood or defined upfront and so there is need to deliver on what is known quickly to allow for enough time to pivot and re-align objectives.

**Reasons for choosing SSADM**

1. It offers techniques which are very useful in approaching the development of a system such as data flow modelling, logical data modelling and entity behaviour modelling.
2. Rapid response to changes-it offers possibility to tailor the planning of project to the actual requirements of the business and if this requirements change they can be factored in easily.
3. Practical timelines- it allows one to plan and manage a project well, hence delivery of project in time.

**Stages of Development**

1. Feasibility Study – Stage 1

This being the first stage, the feasibility study ensures that the proposed system attains:

Economic feasibility – the assessment of whether the implementation of the system is economically possible

Technical feasibility – looking at the technology needed to develop the proposed system

Operational feasibility – a measure of how well the proposed system will solve the problems currently at the school.

1. Requirements Analysis Stages 1&2

This stage involves studying the existing system if any is in existence, be it manual or an actual software, and coming up with a proposal for a new system for development

1. Requirements Specifications – Stage 3
2. Logical System Specification - Stage 4&5

Assessment of technical system and logical design

1. Physical Design – Stage 6

## Data collection methods

The following are the methods that will be used to gather data that would help anticipate system bottlenecks and correct them.

1. Observation-involves viewing an actual process so as to gain practical knowledge of the steps it takes to achieve a certain result or deliver a particular output. In this case it would have to deal with how the beehive is checked for honey
2. Interviews-the data collector prepares structured oral or written questions and delivers them to the audience in a bid to illicit an immediate response in the hope that the feedback will be more authentic, however at times interviews and observations can go hand in hand and become a structured walkthrough.
3. Document review-involves going through literature work created by other developers and researchers on similar systems.The objective here is to gain insight about the kind of challenges they encountered and better equip yourself with means to navigate such terrain.

Documents to be reviewed include journals, books, and online content.

## Tools required to analyse the data

The following are the best tools to be used in analysis of the acquired data:

1. Program flowcharts –This is a detailed representation of the various steps to be performed within a system in order to produce a desirable output from given inputs. Algorithms which introduce a particular constraint are also listed
2. Entity Relationship Diagram- it is a type of structural diagram for use in database design. The ERD contains different symbols and connectors that symbolize two important information; the major entities within the system scope and the inter-relationships among these entities. The diagrams will then guide the creation of the database tables and relationships
3. Sequence diagram-used to show interactions between objects represented as lifelines in a sequential order.

## Tools to implement and test the system

The tools for development include the following;

1. Operating system -Windows 10
2. Development platform -Java Development Kit
3. Development language -Java and Python for some components
4. Database-MySQL

## Time Schedule

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Item** | **Activities** | **Estimated duration** | **Expected start date** | **Expected end date** | **Deliverable** |
| 1 | Proposal writing | 6 | 26th October | 1st November | Proposal |
| 2 | Data collection | 7 | 3rd November | 10th November | Findings report |
| 3 | Literature review | 5 | 12th November | 17th November | Comprehensive literature |
| 4 | Analysis | 7 | 18th November | 25th November | Diagrams use case diagram, |
| 5 | Preliminary design | 17 | 28th November | 15th December | ER diagrams |
| 6 | Detailed design | 5 | 15th December | 20th December | Sequence and package diagrams |
| 7 | Implementation | 24 | 21st December | January 15th | Developed system |
| 8 | Unit Testing | 1 | 18th January | 19th January | Test report |
| 9 | Validation testing | 1 | 22nd January | 23rd January | Validation report |
| 10 | Documentation | 7 | 30th January | 7th February | System Documentation |

**Table 1: project time plan**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ACTIVITY** |  |  |  |  | **WEEK** |  |  |  |  |  |  |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Proposal writing |  |  |  |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |  |  |  |
| Literature review |  |  |  |  |  |  |  |  |  |  |  |
| Analysis of the system |  |  |  |  |  |  |  |  |  |  |  |
| Preliminary design |  |  |  |  |  |  |  |  |  |  |  |
| Design |  |  |  |  |  |  |  |  |  |  |  |
| Implementation |  |  |  |  |  |  |  |  |  |  |  |
| Unit Testing |  |  |  |  |  |  |  |  |  |  |  |
| Validation testing |  |  |  |  |  |  |  |  |  |  |  |
| Documentation |  |  |  |  |  |  |  |  |  |  |  |

**Table 2 project Gant chart**

## Project costs

This will cover the minimum requirements required and their associated costs needed to ensure the project reaches its conclusion.

|  |  |  |
| --- | --- | --- |
| **CLASSIFICATION** | **QUANTITY** | **AMOUNT** |
| Equipment   * Stationery * Raspberry Pi * Sensors * GSM Modem | 1  1  3  1 | 300  8000  8000  5000 |
| **SUB TOTAL** |  | 21400 |
| Software   * MySQL * Netbeans * Anaconda | 1  1  1 | Free download  Open source  Free download |
| **SUBTOTAL** |  | - |
| Facilitation expenses   * Transport cost * Printing * Binding |  | 4000  500  500 |
| **SUBTOTAL** | - | 5000 |
| **TOTALS** | - | 26400 |

**Table 3 Project budget**

## Conclusions

There is an obvious opportunity to incorporate technology in order to maximise amount of yield being harvested by a beekeeper. The study aims to also find out the cheapest but most suitable combination of components that can achieve the highest functionality but also placing it in a friendly place in terms of affordability by a farmer from rural Kenya where the test-scenario will be carried out.

## References

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