JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
TECHNOLOGY FOR DEVELOPMENT

JHUB AFRICA
INNOVATIONS FOR TRANSFORMATION

# Smart Nyuki

## IoT IN APICULTURE

## BEE SMART, FARM SMART!

2024

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## The Team

- Dr. Lawrence Nderu - Project Investigator
- Rop Brian - IoT Engineer
- Methuselah Nyongesa - Machine Learning Engineer
- Charles Mwangi - Front-end developer
- Moses Njau - Back-end developer
- James Karanja - IoT Engineer

# Problem Statement



## Present gaps in traditional and conventional beekeeping

Some practices and problems have been observed to be present in today's scene in apiculture which prove to be unsustainable for beekeeping in terms of the health and wellness of the bees and which ultimately have an effect on the yields of honey harvested from the hives.

These include:

- **Disturbance of Bee Activity through unnecessary inspections -** if not done carefully, inspections can offset the internal conditions of the hive and be a cause of stress and disturbance to bees that can lead to migration which translates to loss for the beekeeper.
- **Lack of Real-Time Data to detect critical changes in hives -** a beekeeper would only be aware of what is happening inside and around the hive when s/he is physically present there and one can't be there to monitor the hive around the clock.
- **Delayed Response to threats in the hive -** due to the fact that a beekeeper can't be permanently situated at the apiary, threats to the hive such as pests(e.g the honey badger) end up ravaging the hive and the farmer is only left to count losses rather than prevent it.
- **Unprecedented Swarming -** swarming is a natural phenomenon whereby the population of the colony increases due to favorable conditions such as abundance in nectar. The colony then splits into two with some leaving the hive. A beekeeper cannot be able to take advantage of this by increasing the size of the hive or having another hive where the bees can be accommodated.

# Problem Statement



- **Inconsistent Honey Production -** this happens through estimation of harvesting times rather by physically checking for indicators on the hive rather than having precise data on when exactly harvesting should be done. Ill-informed or novice farmers are therefore prone to harvesting at inappropriate times which affects the production levels and the bees themselves.

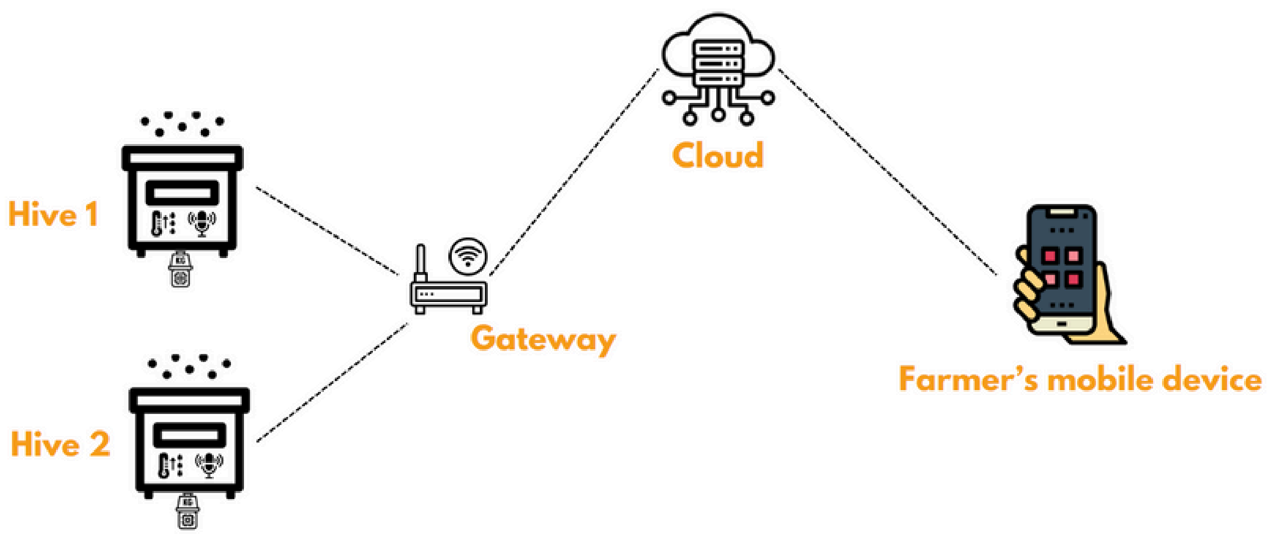
These challenges were observed from doing primary research whereby we had an online form which we sent to farmers and to organizations that were concerned with apiculture. We also paid a visit to an apiary belonging to Yatta Beekeepers in Juja whereby an employee conversed with us on the same while taking us around the apiary. *He shared an example of an  instance in which pests had become a nuisance whereby a honey badger would push a hive from its stand to the ground with a great force and then feed on the honey, only leaving the beekeeper to find a damaged hive and a migrated colony on his next inspection.*
The internet proved to be helpful in providing an avenue for researching as a secondary source of data.

# Solution



These particular problems can be solved and improvements made to an apiary by leveraging the use of IoT devices, the cloud and data analytics to give timely information concerning the hive and perform predictive analysis to help a farmer gauge the health and performance of the hive both presently and in the future.

IoT sensors will be placed inside the hive to monitor the internal conditions. These sensors include: a load cell placed under the hive to measure its *weight*, a temperature and humidity sensor in the hive to measure *humidity and temperature* simultaneously and a microphone to measure the frequency and the volume of the *sound* in the hive.
These metrics give valuable insights upon analysis as to the health of the colony.
The data gathered from the hives is analyzed and can be viewed remotely and in real-time on a dashboard in a beekeeper's smart device. Whenever the metrics exceed or go below the set threshold, a warning notification is sent to the device to alert a beekeeper to take the necessary action.



# Architectural Implementation



The specific sensors that will be placed inside the hive are:

- DHT22 AM2302 - temperature and humidity
- 0-50Kg load cell - weight
- KY-037 sound sensor

These sensors are connected to a LoRa module and interfaced with a microcontroller, an ESP32 Board, which is programmed to read data from the sensors and send it to the connected LoRa module.
The LoRa module then receives the data from the sensors and sends it to a another LoRa module over the LoRa network. This module is in turn connected to an ESP32 board which acts as a concentrator, meaning that it receives data over the LoRa network from several hives with a similar setup of sensors.
The ESP32 board then connects to the internet through a local Wi-Fi network or through GSM and then sends the received data to a cloud database (Supabase) using the HTTP protocol.

## Programming languages & Software

Program the sensors and the ESP32.

Languages and Libraries used to develop the application.

The IDEs to be used with extensions such as ESP-IDF and Platform IO.

Database used

# Evaluation of Architecture



The solution addresses the problems by having ever-present ‘eyes’ in the hive with the sensors doing the monitoring and a farmer accessing the data from the dashboards whenever and wherever s/he needs to.
The alerts and warning notifications are included to ensure the farmer is on the know whenever something is off in the hive and attention is needed, such a rapid increase in the frequency of the sounds produced by the bees to a frequency that is raised when they’re in alarm and which could signify intrusion either by a pest or by a human being.
Harvesting times can be precisely determined when the weight of the hive shown in the graph flattens and plateaus after a gradual increase over time.

The challenges that we’re trying to work around is with the precision of the collected data so as to prevent false alarms and notifications from being received unnecessarily and with the integration of the sensors into the hives in a non-intrusive manner so as to prevent the bees from seeing them as foreign material and covering them with propolis which would impair functionality.
Measures to counter this have been developing a casing for the components and testing the data under varying conditions to ensure refined results.
The sensors should also be able to function reliably regardless of the weather conditions, including extreme environmental conditions such as heavy rain, high humidity, extreme temperatures, strong winds, and dust.