Project Proposal: Mushroom Guardians

ICS 2309 - Commercial Programming & BCT 2315 - Computer Systems Project

Team Members and Admin Numbers | April 2025

1. Project Title

Mushroom Guardians – A Smart, FIWARE-Powered Platform for Intelligent Mushroom Farming

2. Project Background and Context

Farming remains the bedrock of many rural livelihoods in Kenya. Among various agricultural ventures, mushroom farming offers a high-value opportunity for youth and women in semi-urban and rural areas. However, its delicate nature demands consistent and precise monitoring of environmental conditions such as temperature, humidity, and carbon dioxide levels. Unfortunately, most mushroom growers rely on manual observation, which is error-prone, time-consuming, and insufficient in offering predictive insights. Crop failure rates are consequently high, and the learning curve for new entrants is steep.

Mushroom Guardians emerges as a solution to bridge this critical gap. Built on the powerful FIWARE open-source platform, this system leverages Internet of Things (IoT) sensors, context-aware data analytics, and cloud technologies to deliver a real-time monitoring and farm management experience. The system does not merely offer data—it provides actionable intelligence. With instant alerts, trend visualization, and adaptive feedback, Mushroom Guardians transforms traditional farming into smart farming. This project is not only technically stimulating but socially transformative, targeting SDGs such as Zero Hunger, Decent Work, and Innovation.

3. Team Members and Roles

The success of Mushroom Guardians is driven by a dedicated, multidisciplinary team committed to building a product that works in the real world. Our roles have been defined with the principles of Agile development in mind:

- Lawrence Nderu – Product Owner: Responsible for project vision, stakeholder engagement, and prioritizing the product backlog. Jane ensures that user needs are accurately captured and reflected in the development process.
- John Kamau – Lead Developer: Oversees backend architecture, ensures integration of all components, and drives code quality through peer reviews and mentorship.
- Mary Wambui – UI/UX Designer: Designs intuitive, accessible, and mobile-responsive interfaces using Figma and user research.
- Joseph Otieno – Backend Engineer: Implements server-side logic, APIs, and database interactions. Handles data persistence and security features.
- Aisha Noor – DevOps Engineer: Manages CI/CD pipelines, cloud deployments, and monitors system performance.

The team meets bi-weekly for sprint planning and retrospectives, and daily check-ins are conducted on Slack. Project progress is tracked using Trello boards and GitHub issues.

4. Problem Statement and Justification

Mushroom farming is particularly sensitive to microclimatic variations. Minor deviations in temperature or humidity can result in drastic yield loss. Yet, most farmers lack the means to monitor their environments effectively. Existing digital farming tools are either too expensive, too generic, or require complex installations and technical skills. This disproportionately affects smallholder mushroom farmers who often operate on minimal budgets with limited technical exposure.

Mushroom Guardians is developed in response to these challenges. It presents a user-friendly interface with multilingual support, robust analytics, and seamless integration with low-cost IoT hardware. Farmers receive real-time updates and alerts via mobile or web dashboards, allowing them to act before environmental threats escalate. With a focus on localization, affordability, and simplicity, our solution is tailored to the real needs of the end-users. Additionally, data collected can be analyzed for patterns that support agronomic research and predictive modeling.

5. Project Objectives

This project aligns with the course's objectives to build deployable, commercial-grade software and includes the following goals:

- Design and build a smart farm management system tailored for mushroom production.
- Integrate real-time environmental data collection via FIWARE’s Orion Context Broker and IoT Agents.
- Store and analyze time-series data using QuantumLeap and TimescaleDB.
- Implement secure user management with role-based access controls.
- Deploy the application on cloud infrastructure using DevOps practices such as GitHub Actions and Docker.
- Produce detailed documentation, from architecture to user manuals, and publish a research paper analyzing the impact and technical implementation.
- Validate the system through real-world piloting and feedback collection from active mushroom farms.
- Propose and explore monetization strategies for commercial sustainability.

6. Functional Overview

The application comprises multiple functional modules, each designed with both the farmer and system administrator in mind. At its core is the monitoring dashboard—a clean, responsive interface that visualizes real-time sensor data. This includes temperature, humidity, and CO_2 levels collected via connected sensors. Alerts are generated when any parameter crosses a critical threshold. These alerts are not limited to on-screen notifications but can also be sent via SMS or WhatsApp for offline or low-connectivity areas.

Administrators can add new farms, configure sensor thresholds, and manage user roles. For research and long-term farm planning, the platform also stores historical data. Through interactive charts and downloadable reports, farmers can analyze trends, identify productivity bottlenecks, and make informed decisions. All modules are protected by JWT-based authentication, and the design follows MVC principles for maintainability.

7. Technical Methodology

We adopt Agile as our primary software development methodology. Work is broken down into six sprints, each delivering a tangible output. CI/CD pipelines using GitHub Actions ensure that every commit is tested and deployed seamlessly. Docker containers ensure consistent environments across development, staging, and production. Our backend is built on Node.js and Express for its lightweight, asynchronous architecture, while PostgreSQL and TimescaleDB are used for relational and time-series data, respectively.

The frontend is developed using React.js with TailwindCSS for styling. We use Figma for prototyping and gathering user feedback before implementation. Data from sensors is pushed via FIWARE IoT Agents into Orion Context Broker, which maintains a digital twin of each farm environment. QuantumLeap exports this data to TimescaleDB for historical analysis. The entire system is deployed on Heroku during development, with plans to move to AWS upon scaling.

8. Market Strategy and Commercial Viability

Mushroom Guardians is designed to serve small-to-mid-sized farmers in Kenya and eventually, East Africa. Our go-to-market strategy begins with piloting in Kiambu and Machakos counties, where JHUB Africa already has operational partnerships. The solution will be bundled with low-cost sensor kits and offered through agricultural cooperatives and NGOs.

Our revenue model is hybrid. A freemium version gives farmers access to basic features like real-time monitoring and threshold alerts. A premium subscription unlocks advanced analytics, downloadable reports, and integrations with digital marketplaces. For organizations or cooperatives, we offer enterprise plans with multi-farm dashboards and support.

Digital marketing efforts will include social media campaigns, YouTube tutorials in local languages, and farmer workshops. We also plan to partner with agricultural extension officers and host demo days in partnership with county governments.

9. Resource Requirements

The initial phase of the project requires both human and technical resources. Team members contribute time and expertise, while hardware and cloud services require funding.

Resource	**Description**	**Cost Estimate (Ksh)**
Raspberry Pi Kits	Sensor kits with CO_2, temp & humidity	30,000
Cloud Services	Heroku, GitHub Actions	5,000
Internet	Access for testing and deployment	3,000
Miscellaneous	Transport, workshop materials, testing	7,000
Total		**45,000**

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10. Risk Assessment and Mitigation

Project risks are proactively addressed in planning. Key risks include hardware malfunction, software integration challenges, and external delays such as internet outages or shipment delays. We mitigate hardware issues by performing rigorous lab testing before field deployment. Software modules are built and tested in isolation before being integrated, ensuring that bugs are caught early. We’ve adopted a strict MVP definition to avoid scope creep and maintain focus on core features.

Security is another critical area. We are embedding secure coding practices from day one—sanitizing inputs, hashing passwords with bcrypt, and enforcing HTTPS-only traffic. A penetration test will be conducted during Sprint 5.

11. Deliverables & Timeline

Each sprint is time-boxed to two weeks, and every sprint ends with a deliverable that contributes to the final product.

Sprint	Activities	Deliverables
1	Project setup, UI mockups, repo initiation	Proposal, Figma Wireframes
2	Auth system, DB models, backend setup	Login system, DB schema
3	Sensor integration, live data stream	Live dashboard
4	Alert system, analytics charting	Notification engine, graphs
5	DevOps setup, CI/CD pipeline, deployment	Live app with automation
6	Final tests, user feedback, documentation	Research paper, final report

12. Intellectual Property and Licensing

The source code will be released under the MIT License, allowing open community use and adaptation. Commercial rights will be managed through JHUB Africa. We plan to document our work extensively on GitHub and may create a developer handbook to support open contributions.

13. Expected Impact

Mushroom Guardians is more than a project. It is a movement towards digitized, equitable agriculture. By equipping farmers with predictive tools and real-time insights, we aim to reduce post-harvest loss, increase incomes, and encourage sustainable farming practices. In doing so, we not only fulfill academic requirements but contribute meaningfully to the Kenyan digital agriculture agenda and global food security.

14. References

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