SMART CART

A PROJECT REPORT

Submitted by

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in partial fulfillment for the award of the degree

of

BACHELOR OF TECHNOLOGY

IN

INFORMATION TECHNOLOGY

Dr. N.G.P. INSTITUTE OF TECHNOLOGY COIMBATORE- 641 048

(AN AUTONOMOUS INSTITUTION)

ANNA UNIVERSITY: CHENNAI 600 025

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BONAFIDE CERTIFICATE

Certified that this project report "**SMART CART**" is the bonafide work of **"K S NAGHUL PRANAV (710722205017) , SARATH C (710722205041), SHREENITHI K (710722205046) , SHRUTHI A (710722205047) "** who carried out the project work under my supervision.

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ABSTRACT

Smart Campus Cleaning Management System (SCCMS) is a new mobile application designed to improve cleanliness and maintenance information on campus. The aim is to solve problems of maintaining a clean and hygienic environment, making it easier for students and staff to report problems. SCCMS includes features such as QR code scanning to identify specific issues, classification of maintenance problems, uploading images and descriptions, and notification alerts for admin and cleaning staff. Designed with a user-friendly interface, SCCMS integrates QR code functionality, push notifications, and real-time status updates to streamline communication and improve overall campus cleanliness. The SCCMS also incorporates Machine Learning (ML) algorithms that analyze captured images during the reporting process. By using image recognition, the system can automatically classify and identify the type of cleanliness issue reported, such as trash, spills, or maintenance requests. This feature ensures that each issue is categorized correctly, improving the efficiency and accuracy of the maintenance process.

Keywords: Cleanliness Reporting, Smart Campus, QR Code Integration, User Engagement, Maintenance Management.

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LIST OF ABBREVIATIONS

SCCMS	-	Smart Campus Cleanliness Management System
GPU	-	Graphics Processing Unit
IDE	-	Integrated Development Environment
IOT	-	Internet of Things
OpenCV	-	Open-Source Computer Vision Library
RAM	-	Random Access Memory
FCM	-	Firebase Cloud Messaging (implied from code context)
UI	-	User Interface
NB-IoT	-	Narrowband Internet of Things
AI	-	Artificial Intelligence
SRS	-	System Requirement Specification

CHAPTER 1

INTRODUCTION

Ensuring cleanliness in large schools is a constant challenge due to complex facilities and lack of effective reporting systems. Despite regular cleaning schedules, some areas remain empty, creating dissatisfaction among students, staff. Manual methods are often time-consuming, ineffective, do not provide timely solutions. Project leverages technology, QR code integration, push notifications to improve communication between users, maintenance staff. Scalable, user-friendly systems are essential to ensure uptime, quality maintenance. QR code integration ensures accuracy of problem area, while reward function encourages cleaning staff to participate. Application not only improves campus hygiene but also provides a model for other campuses to follow, brushing to be done efficiently and for sake of brushing in order.

1.1 ABOUT THE PROJECT

Smart Campus Cleanliness Management System (SCCMS) is an intelligent campus management solution designed to enhance the cleanliness and maintenance process by improving reporting accuracy and streamlining communication. Developed using Flutter for the mobile interface, the system offers a smooth, user-friendly experience across devices. It incorporates Machine Learning algorithms to classify and identify cleanliness issues in real-time. As users report an issue by capturing an image, the system instantly analyzes it to categorize the problem (such as trash, spills, or maintenance requests) and adds it to the maintenance log.Once the issue is classified, notification alerts are sent to admin and cleaning staff for timely action. Additionally, the system includes a QR Code Integration, allowing students and staff to scan a code in various campus locations to quickly report issues. The Product Locator Module can be likened to a Campus Map feature, which helps users find and report problems in specific campus areas, such as classrooms or corridors.By combining machine learning with a modern user interface, SCCMS offers a fast, contactless, and efficient cleanliness reporting solution that benefits both campus management and cleaning staff, ensuring a cleaner and safer campus environment.

1.2 PROBLEM STATEMENT

In traditional campus maintenance systems, reporting cleanliness issues often involves manual processes that are time-consuming and inefficient, leading to delayed responses and unresolved problems. Students and staff frequently face difficulties in identifying the right personnel or channels to report issues, causing frustration and reduced satisfaction. Moreover, the lack of a centralized system means there's limited transparency in the status of reported issues—whether they are resolved, pending, or in progress. The absence of smart technologies like QR code scanning, digital maps, and real-time dashboards further hinders operational efficiency. To address these challenges, the SCCMS app provides an automated and user-friendly solution. It allows users to scan QR codes to quickly report issues, track the status of their reports under "My Report", and navigate the campus through an interactive map. The admin dashboard provides a comprehensive overview of all cleanliness reports, categorized by status (resolved, pending, or in progress), while cleaning staff can log in to manage and update their assigned tasks. This integrated approach enhances accountability, streamlines communication, and significantly improves the cleanliness and maintenance experience across the campus.

1.3 OBJECTIVE

The objective of the Smart Campus Cleaning Management System (SCCMS) is to revolutionize traditional campus cleanliness management by integrating automation and smart technologies. The system aims to streamline the issue reporting process using QR code-based scanning that allows users to instantly report cleanliness issues without the need for manual paperwork or in-person complaints. This automation reduces response time and enhances user convenience. Additionally, SCCMS features an interactive campus map to help users precisely mark or locate areas with reported issues, improving communication and operational efficiency. With a user-friendly interface built using Flutter, the app ensures a seamless experience for students, staff, and administrators. The system also includes dedicated dashboards for administrators to monitor issue status—categorized as resolved, pending, or in progress—and a login portal for cleaning staff to manage and update their tasks. Ultimately, SCCMS aims to enhance campus hygiene, reduce administrative overhead, and provide a cleaner, smarter, and more responsive environment for all campus residents.

1.4 SCOPE AND LIMITATIONS OF THE STUDY

Scope: The proposed Smart Campus Cleaning Management System (SCCMS) aims to improve campus hygiene management by digitizing and automating the cleanliness issue reporting and monitoring process. The system enables users to report issues by scanning QR codes placed around the campus, eliminating the need for manual complaints and improving the speed and accuracy of issue submission. It also features an interactive campus map to assist users in identifying and locating affected areas easily. The scope of this study focuses on developing these key features using Flutter for the user interface, ensuring a responsive and user-friendly experience across devices. The admin dashboard provides real-time visibility into report statuses—categorized as resolved, pending, or in progress—while a dedicated login for cleaning staff facilitates task management and updates. The system is designed to be scalable, allowing future integration with notification systems, performance analytics, and additional campus services to further enhance operational efficiency and accountability.

Limitations: The proposed SCCMS system faces several challenges that may impact its overall performance and scalability. One key limitation is the dependency on reliable network connectivity and device compatibility, which is essential for real-time QR code scanning, issue reporting, and access to campus maps. The accuracy of machine learning-based issue prioritization or anomaly detection may vary depending on the quality and volume of input data, such as user-submitted images or text descriptions. Inconsistent lighting conditions and unclear image uploads can reduce the effectiveness of automated classification or categorization features. Additionally, the system may require considerable computational resources to support real-time analytics and dashboard updates, which could be a constraint in environments with limited hardware or infrastructure. Variations in campus layouts and maintenance protocols can also affect the consistency and accuracy of reported locations or task assignments. Furthermore, integration with existing campus management systems, such as scheduling platforms or facility databases, is not yet implemented, limiting broader operational synergy. Addressing these limitations will be essential for improving the system's robustness, accuracy, and adaptability for wide-scale deployment.

1.5 ORGANIZATION OF THE REPORT

The subsequent chapters of this report are organized as follows: Chapter 2 provides a review of existing research and systems related to campus cleanliness and maintenance management, highlighting technologies that align SCCMS app. Chapter 3 outlines the requirements specification, including the necessary hardware and software components, and describes the tools and frameworks—such as Flutter for the frontend and any machine learning models used for report analysis—applied in the system's development. Chapter 4 presents a detailed analysis of current campus maintenance methods, identifying their limitations and contrasting them with the advantages of the proposed SCCMS model. This chapter also includes a block diagram illustrating the system architecture. Chapter 5 covers the implementation process, breaking down each stage of development including issue reporting via QR codes, integration of machine learning for report prioritization or categorization, and the testing of the user and admin dasboards. Finally, Chapter 6 summarizes the conclusions of the project, emphasizing key outcomes, and discusses possible directions for future enhancements such as predictive maintenance, AI-driven task allocation, and expanded integration with campus systems.

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

The literature survey presents an in-depth analysis of the emerging technologies supporting smart cleanliness management systems within modern campus environments. With advancements in artificial intelligence and mobile technologies, systems like SCCMS are reshaping how maintenance issues are reported, tracked, and resolved. The integration of QR code scanning, machine learning, mobile applications, and real-time dashboards has enabled efficient issue reporting, categorization, and response tracking. This review examines various frameworks and implementations of smart maintenance and facility management systems, assessing their effectiveness in automating issue detection, enabling seamless user interaction, and ensuring system scalability. Particular emphasis is placed on technologies such as OpenCV for image processing, machine learning for prioritizing and analyzing reports, and cloud-based dashboards for centralized monitoring. The survey also explores predictive maintenance techniques, staff performance tracking, and intelligent task allocation. Limitations such as hardware dependency, inconsistent data quality, integration complexity with legacy systems, and varying campus infrastructures are critically analyzed. By consolidating existing research, this survey provides a foundation for refining the SCCMS design, improving system accuracy, and enhancing overall cleanliness and operational efficiency across educational campuses.

2.2 REVIEW OF LITERATURE SURVEY

Kaushik Kumaran et al., (2024) designed an IoT-based waste management system combined with a smart credit mechanism specifically for college campuses. The innovation lies in motivating students to dispose of waste properly by rewarding them with credits. These incentives help build responsible habits among students while ensuring cleaner surroundings through the integration of smart bins and monitoring systems [1].

Jackielou Malot and Gerry Paul Genove (2025) developed an IoT-enabled system for Mountain Province State Polytechnic College, aiming to streamline the waste collection process using real-time data. The system is designed to track bin fill levels and send alerts when collection is due, ensuring that campus areas remain clean and hygienic without manual checks, ultimately improving operational efficiency [2].

F. I. Azman, M. S. F. M. Fazdli, and N. L. Saleh (2023) introduced a smart restroom monitoring solution that uses sensors to track cleanliness. The system collects real-time data about restroom usage and sanitation status, enabling maintenance staff to respond promptly when cleaning is required. This leads to better hygiene and greater user satisfaction in shared campus facilities [3].

Amar Lokman and R. Kanesaraj Ramasamy (2023) proposed a predictive maintenance model tailored for smart toilets using IoT and data analytics. The system predicts when maintenance should occur based on usage patterns, minimizing breakdowns and ensuring that restrooms remain clean and functional without unnecessary interruptions [4].

Ken Polin, Tan Yigitcanlar, Mark Limb, and Tracy Washington (2023) offered a broad review and conceptual framework for developing smart campuses. Their work discusses how IoT and data analytics can be integrated into various campus operations, including cleanliness management. The paper serves as a foundation for designing digital infrastructure that supports smarter and cleaner campus environments [5].

Michael Clark and Lily Adams (2023) presented a flexible IoT framework that enhances the management of campus facilities, particularly waste management. By enabling real-time monitoring of bins and facility usage, the system helps optimize resource allocation, allowing cleaning and maintenance teams to focus on areas with the greatest need [6].

Yuchen Zhang and Zhao Yang Dong (2022) conducted a systematic review of technologies applied in smart campuses, such as machine learning and IoT. Their study highlights how these technologies contribute to better resource and cleanliness management, enabling educational institutions to operate more sustainably and efficiently [7].

Manlio Bacco, et al., (2022) explored environmental monitoring in the context of smart cities, but their findings are also relevant to campuses. They emphasized the use of participatory sensing and mobile applications for collecting environmental data, which can be adapted to monitor cleanliness levels and inform campus maintenance decisions [8].

Sabbir Ahmed, Sameera Mubarak, Santoso Wibowo, and Jia Tina Du (2023) proposed a data analytics framework that forecasts waste generation trends. This helps optimize waste collection schedules by predicting when and where bins will fill up, which can significantly enhance the effectiveness and timeliness of campus waste management efforts [9].

Yitao Chen, et al., (2023) focused on crowd management using LiDAR technology on smart campuses. By identifying crowded outdoor areas, the system helps target high-traffic zones for more frequent cleaning, which contributes to maintaining cleanliness where it's needed the most [10].

Donny Soh Cheng Lock, et al., (2022) addressed the urgent need for safe and clean campuses during the COVID-19 pandemic. Their system includes cleanliness monitoring and contactless operations to improve hygiene and readiness, ensuring that campuses can operate safely even during health crises [11].

Danial Sim, et al., (2021) developed a smart waste management system that utilizes sensors to detect bin fill levels and automatically plans optimal collection routes. This automation reduces overflow issues and makes waste collection more energy- and time-efficient on university campuses [12].

Md. Shahariar Nafiz, et al., (2023) introduced 'ConvoWaste,' an automatic waste segregation system powered by deep learning. The machine separates waste based on type, improving recycling efforts and reducing manual sorting requirements, making it highly useful for smart campus applications [13].

Saadia Kulsoom Memon, et al., (2019) proposed 'SMARGAR,' an IoT-based garbage monitoring system specifically designed for historic college campuses. It ensures timely waste collection by tracking bin status, helping preserve the aesthetics and hygiene of culturally significant educational institutions [14].

CHAPTER 3

SYSTEM REQUIREMENT SPECIFICATION

3.1 INTRODUCTION

The System Requirement Specification (SRS) for the Smart Campus Complaint Management System (SCCMS) defines the essential hardware, software, and system functionalities required for the successful development and deployment of the proposed solution. This chapter outlines the technical and operational requirements necessary to ensure the application functions efficiently and reliably within a campus environment.The SCCMS application integrates modern technologies such as machine learning, QR code scanning, and mobile application development to streamline complaint registration, enhance reporting accuracy, and improve issue tracking. Users can report issues by capturing images, scanning location-based QR codes, and accessing campus maps to mark problem areas.

Key features include:

- **QR Code Scanning** for location tagging
- **Report Issues** with image upload capability
- **View My Reports** for status tracking
- **Campus Map** for spatial navigation
- **Admin Login** for monitoring complaint statuses
- **Staff Login** for viewing the specific location of reported issues

To improve image validation, SCCMS uses machine learning to analyze images captured during issue reporting. This ensures that only relevant images—such as clear waste or damage photographs—are accepted, enhancing the reliability of the data. The machine learning module is optimized for on-device or server-side image filtering to support real-time validation.

By adhering to the defined requirements, the SCCMS project ensures scalability, data integrity, user-friendliness, and efficient complaint resolution, ultimately supporting a cleaner, safer, and more responsive campus environment.

3.2 SOFTWARE DESCRIPTION

The Smart Campus Complaint Management System (SCCMS) is primarily a software-driven solution, leveraging mobile application development, QR code technology, and machine learning to provide a seamless and intelligent complaint management experience. The software components are thoughtfully selected and integrated to ensure intuitive user interaction, accurate issue reporting, and efficient administrative follow-up.

1. Mobile Application Development (Flutter Framework)

The user interface (UI) of the Smart Campus Complaint Management System (SCCMS) is developed using **Flutter**, an open-source UI software development toolkit by Google. Flutter allows the creation of cross-platform mobile applications from a single codebase, ensuring consistent performance and appearance across both Android and iOS devices. Its rapid development features, flexible UI components, and strong ecosystem make it an excellent choice for building an intuitive, responsive application tailored to complaint reporting, image capture, QR code scanning, and map-based navigation.

2. Image Validation Model (Machine Learning)

The SCCMS system incorporates a machine learning-based image validation module to ensure the integrity and relevance of submitted complaints. This model analyzes images captured during issue reporting and filters out irrelevant or low-quality submissions, allowing only valid photos—such as visible waste, infrastructure damage, or maintenance issues—to be accepted. This enhances data quality, reduces false reports, and streamlines the resolution process for campus staff.

Key Features:

● Automated image classification to detect valid complaint-related content

● High accuracy and low latency for real-time image validation during report submission.

● Optimized for mobile deployment to support efficient on-device or cloud-based validation

3. Backend Integration and Data Management

To support core functionalities such as issue reporting, image uploads, QR code-based location tagging, real-time status updates, and role-based access control, the SCCMS application leverages **Firebase** as its backend platform. Firebase provides a scalable, cloud-based solution for real-time data synchronization, secure user authentication, and media storage, ensuring smooth operation and data consistency across all users—students, staff, and administrators.

There are some key features which includes the backend integration and data management:

● **Firebase Authentication** for secure login and role management (student, staff, admin)

● **Firebase Storage** for storing and accessing complaint images

● **Real-time synchronization** of complaint data and status updates across devices

● **Scalable architecture** to support campus-wide deployment and future feature expansion

4. Computer Vision

To enhance the user experience during complaint reporting and navigation, the SCCMS application integrates **Lottie animations** for visually engaging and informative feedback. These lightweight, vector-based animations are used throughout the app to guide users through steps such as scanning QR codes, uploading images, submitting reports, and checking complaint statuses. By providing real-time, animated feedback, the system ensures intuitive interaction and reduces user errors.

Key Features:

- **Smooth, high-quality animations** for guiding users through reporting and scanning processes.
- **Real-time visual cues** during image capture, submission, and status tracking.

CHAPTER 4

PROJECT DESCRIPTION

4.1 EXISTING SYSTEM

In many educational institutions, the process of reporting and managing campus-related issues—such as waste disposal problems, damaged infrastructure, or maintenance requests—is predominantly manual and inefficient. Students and staff typically report issues through verbal communication, handwritten logs, or by emailing concerned departments. These methods lack standardization, traceability, and real-time feedback.

In most cases, there is no centralized platform to track reported complaints, visualize their locations on a campus map, or monitor their resolution status. Additionally, users often receive little to no feedback about whether their issues are acknowledged or resolved. This lack of transparency and automation leads to delayed response times, unaddressed issues, and frustration among campus users.

Administrative staff must rely on fragmented communication channels and manual logs to assign and follow up on tasks, which increases the chances of errors and missed reports. Furthermore, there is no mechanism to validate the authenticity or relevance of the images submitted with complaints, which can result in false or unclear issue reports.

Overall, the current system is unstructured, time-consuming, and lacks the technological integration needed for effective campus maintenance and issue resolution.

4.1.1. DRAWBACKS OF EXISTING SYSTEM

● **Lack of Real-Time Reporting:** Students and staff cannot report issues instantly or track their status, leading to delays in issue resolution.

● **No Centralized Platform:** Complaints are often communicated through scattered channels like verbal requests, emails, or paper logs, making it difficult to monitor and manage them efficiently.

● **No Location Tagging:** Without precise location information, maintenance staff often struggle to locate the reported issue, which delays response time.

● **No Image Validation:** Submitted complaints may include irrelevant or unclear images, making it harder to assess the issue accurately.

● **Limited Transparency**: Users rarely receive updates on whether their complaint has been acknowledged, assigned, or resolved, reducing trust in the system.

● **Manual Record-Keeping**: Administrative teams must maintain physical or disorganized digital logs, which are prone to errors, duplication, or data loss.

4.2 PROPOSED SYSTEM

The proposed system introduces a smart, technology-driven solution to streamline and modernize the campus complaint management process. At its core, the Smart Campus Complaint Management System (SCCMS) features a cross-platform mobile application developed using Flutter, designed to allow students and staff to efficiently report campus issues and track their resolution.

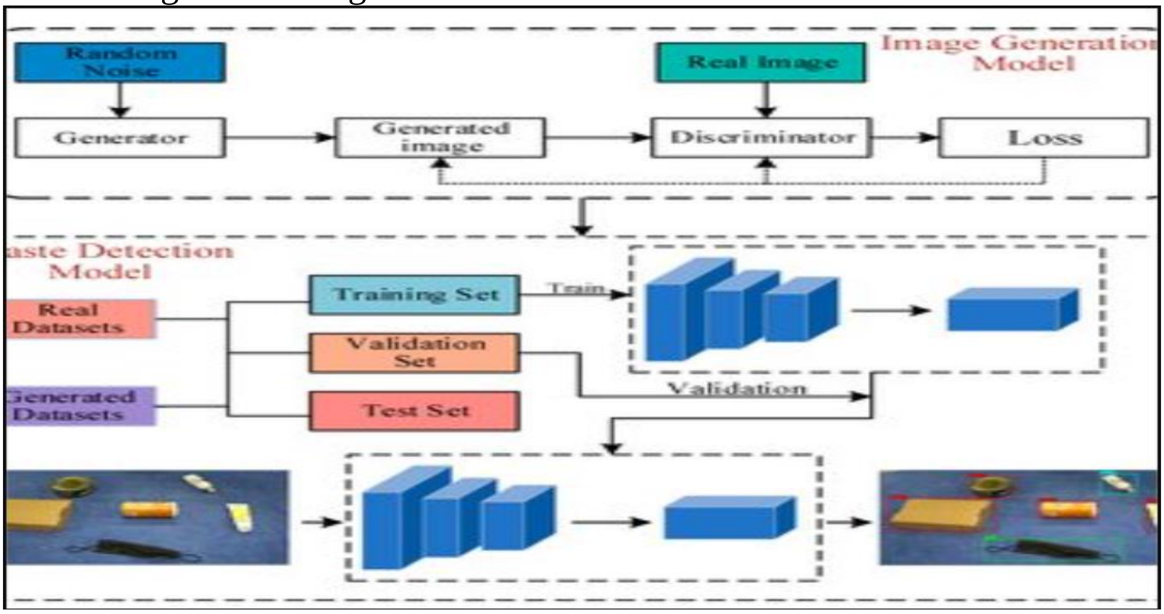
The system integrates key features such as user login, QR code scanning, campus map navigation, real-time complaint tracking, and role-based access for admins and staff. Users can scan QR codes placed at various campus locations to accurately tag the complaint location and attach relevant images during report submission.

To ensure the relevance of submitted complaints, a machine learning-based image validation module is used. This module analyzes uploaded images and filters out irrelevant or incorrect submissions—such as selfies or unrelated content—ensuring that only accurate representations of issues like waste, damage, or hazards are accepted.

Administrators have access to a secure login interface to monitor the status of all reported issues, while campus staff can log in to view and respond to complaints based on their tagged locations via the campus map.

With real-time synchronization powered by Firebase, the system ensures that all users receive timely updates and that complaint data is centrally managed, improving transparency, accountability, and resolution efficiency.

Fig 4.1: Wastage Generate and Identiication architecture



The SCCMS (Smart Campus Complaint Management System) app integrates machine learning to automate and enhance the accuracy of campus issue reporting. A central feature is the image validation module, which ensures that only relevant complaint images—such as those showing waste, infrastructure damage, or maintenance problems—are accepted during submission. This module uses a lightweight image classification model optimized for mobile deployment, allowing real-time verification of uploaded photos directly within the app. By automatically filtering out irrelevant or unclear images, the system reduces the number of false or low-quality reports and streamlines the resolution process for campus staff.

The application allows users to report issues by capturing or uploading photos and scanning QR codes placed around the campus to tag the complaint location accurately. Users can view submitted reports and monitor their status in real-time through a dedicated interface, with complaint locations visualized on an interactive campus map. Firebase provides real-time data synchronization, storage, and user authentication, supporting role-based access for students, staff, and administrators. Administrators can log in to review complaints, verify image content, and assign tasks to staff, while staff members can access complaints filtered by location for faster resolution. Notifications are sent to users when the status of a complaint changes, ensuring transparency and timely communication.

With the integration of machine learning, QR code-based location tagging, campus map visualization, and Firebase-backed real-time interactions, SCCMS offers a modern, efficient, and intelligent approach to managing campus complaints, improving overall operational responsiveness and user satisfaction.

4.2.1 ADVANTAGES OF PROPOSED SYSTEM

Below are the key advantages of this system:

- The integration of machine learning for image validation ensures that only relevant and clear images—such as waste or infrastructure damage—are accepted, improving the quality of reports and reducing false or irrelevant submissions.
- QR code scanning enables users to accurately tag the location of an issue, streamlining the process of locating and resolving complaints by staff members.
- The campus map integration allows both users and staff to visualize the exact location of reported issues, enhancing navigation and accelerating the response process.
- Real-time complaint tracking using Firebase ensures users can monitor the status of their submissions, providing greater transparency and fostering trust in the system.
- The system supports role-based access: users can report and view complaints, staff can view location-specific reports, and administrators can monitor, validate, and assign complaints for resolution.
- Developed using Flutter, the app delivers a consistent and responsive user experience across both Android and iOS platforms, with fast development cycles and minimal platform-specific overhead.
- SCCMS is more affordable and scalable than hardware-based systems, relying solely on mobile and cloud technologies. It allows for easy future expansion with features such as smart notifications, predictive issue analysis.
- By minimizing manual contact and using image-based reporting, the system promotes a hygienic, touch-free complaint submission process—an important consideration in post-pandemic environments.

CHAPTER 5

IMPLEMENTATION AND RESULTS

5.1 SYSTEM IMPLEMENTATION

The implementation of the Smart Campus Complaint Management System involves the seamless integration of mobile technology, machine learning, and cloud-based services to create an efficient, user-friendly platform for campus issue reporting and management. The core concept focuses on enabling students and staff to report problems through a mobile application, validating images using machine learning, tagging issue locations via QR code scanning, and providing real-time tracking of complaint statuses. A machine learning model is employed to validate and accept only relevant complaint images, such as waste or infrastructure issues, ensuring higher quality and actionable reports.

The SCCMS mobile application is developed using Flutter to ensure a consistent and responsive experience across both Android and iOS platforms. Firebase is used as the backend to manage real-time data synchronization, user authentication, and image storage. The implementation begins with collecting and preparing a dataset of campus-related waste and damage images for training the image validation model. This model is then trained and fine-tuned to classify valid complaint images with high accuracy. Meanwhile, the app's interface is designed to allow users to log in, scan QR codes to report location-based issues, upload photos, view the status of their complaints, and navigate the campus map for issue tracking.

Once the machine learning module, mobile app, and Firebase backend are developed, comprehensive system integration is carried out to ensure all components function together smoothly. Extensive testing is conducted to validate real-time image verification, QR code accuracy, user roles (student, staff, admin), and the overall responsiveness of the app. The final product is a robust and scalable campus maintenance solution that simplifies the complaint process, improves resolution speed, and fosters a cleaner and better-managed campus environment.

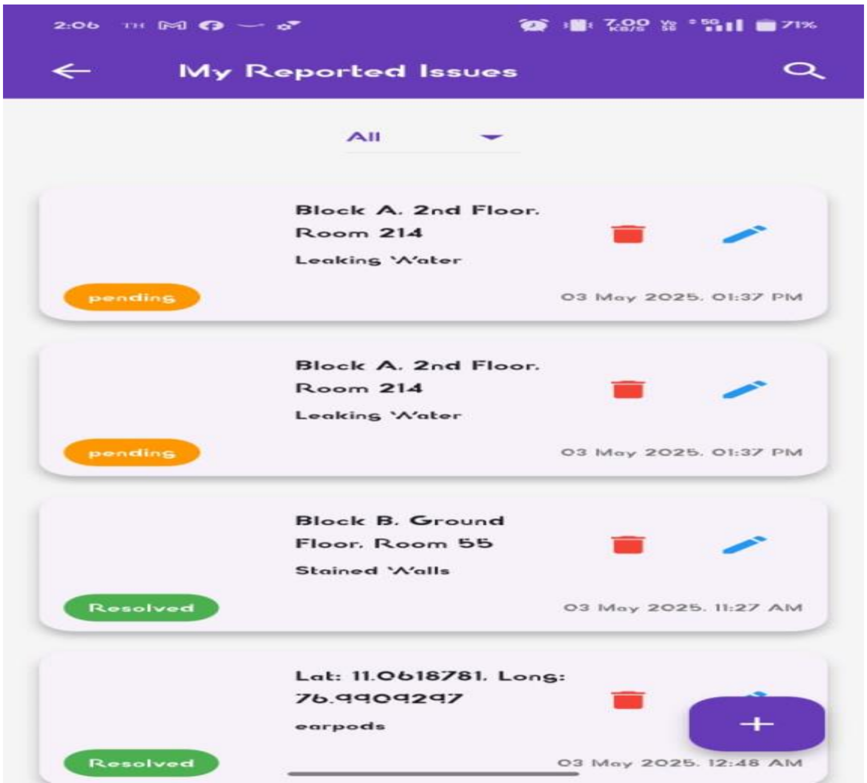
5.1.1 COMPLAINT REPORT DATASETS

The complaint report dataset forms the core foundation for developing a reliable and intelligent validation and classification system within the Smart Campus Complaint Management System (SCCMS). This dataset is a curated collection of images and metadata representing a wide range of issues commonly reported across campus environments, such as waste disposal problems, infrastructure damage, sanitation concerns, and maintenance faults. Each image in the dataset is carefully annotated with corresponding labels to enable supervised learning for the machine learning model used in validating the relevance of reported issues.

The dataset is diversified to include images taken under varying lighting conditions, perspectives, and locations across campus, ensuring the trained model can perform accurately in real-world scenarios. Reports are categorized into meaningful classes such as "garbage," "damaged property," "leakages," or "clean areas," enabling efficient classification and filtering during the image validation process. Emphasis is placed on maintaining high-quality annotations to maximize the accuracy and reliability of the model's predictions.

The complaint dataset is designed to be scalable and adaptable, allowing for continuous updates as new types of issues emerge or campus infrastructure evolves. This flexibility supports long-term use and system improvement without the need for complete retraining. By focusing on campus-specific complaint data rather than generic datasets, the SCCMS model achieves more specialized performance, ensuring that only relevant and valid reports are accepted, which in turn enhances the system's operational effectiveness and response accuracy.

Fig 5.1.1 Report issue List



5.1.2 IMAGE PREPROCESSING

Image preprocessing is a foundational step in ensuring that the machine learning model embedded in the SCCMS app performs efficiently and accurately. When a user captures an image to report an issue on campus—such as a waste bin overflow or water leakage—the image undergoes several transformations before being passed to the classification model. Initially, all images are resized to a fixed dimension, such as 640x640 pixels, to standardize inputs and optimize resource usage during inference. Pixel values are normalized to fall within a 0–1 range to improve model convergence speed and accuracy.

To enhance the model's robustness against variations in lighting, angle, and environment, data augmentation techniques are applied. These include horizontal flips, slight rotations, zooms, brightness and contrast adjustments, and cutouts. This step not only diversifies the training dataset but also prepares the model to handle real-world conditions on campus. Additionally, label annotations for each image are prepared, ensuring they stay consistent with any image transformations. By ensuring high-quality, uniform inputs, preprocessing boosts the system’s capability to detect and classify campus-related issues with greater precision.

5.1.3 IMAGE FEATURE EXTRACTION

Feature extraction in the SCCMS system is managed by a deep learning model trained to detect and identify campus-related issues such as waste mismanagement or infrastructure damage. The model extracts low-level features like edges and textures in initial layers and progresses to more abstract features like object shapes and contextual relevance in deeper layers. These layers work together to interpret the semantic content of an image captured through the app.

For example, a photo showing a pile of garbage is converted into high-level representations that highlight the pile's structure, contrast, and background context.

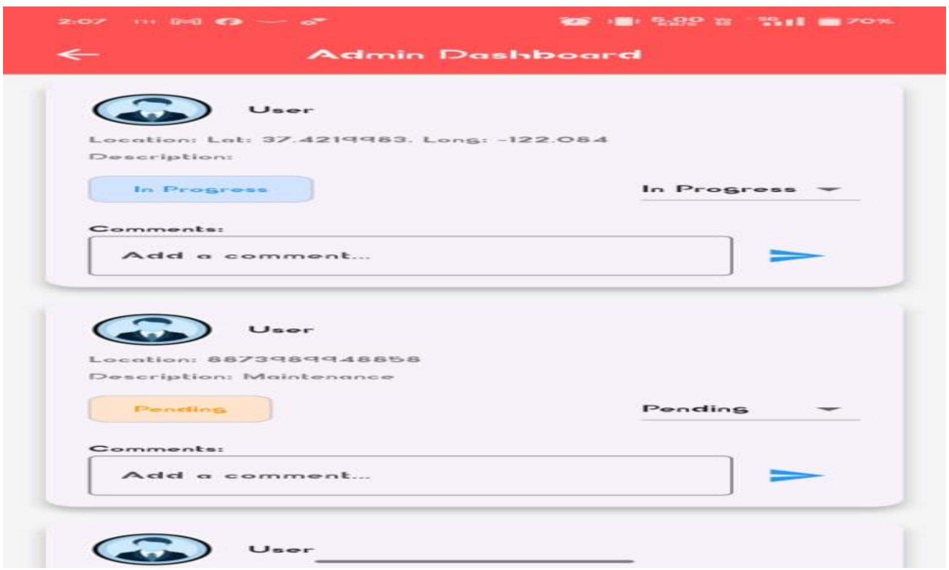
These learned representations help the model make reliable predictions. Because SCCMS is designed for near real-time feedback, this feature extraction process is optimized for speed without compromising accuracy, ensuring immediate classification and issue tagging.

5.1.4 ISSUE CLASSIFICATION

Once the app captures and preprocesses an image, the system uses a machine learning model to classify the issue. Whether it's waste disposal, a leaking pipe, or broken infrastructure, the model assigns a label based on trained classes. This classification allows the system to tag the report appropriately and forward it to the correct administrative department.

Each reported image is mapped against a predefined class of issues using the trained model, and the app retrieves associated metadata, such as issue type and urgency level. This automated classification eliminates the need for manual categorization by users, improving reporting efficiency and ensuring consistent problem identification across the campus.

Fig 5.1.4 Issue Classification

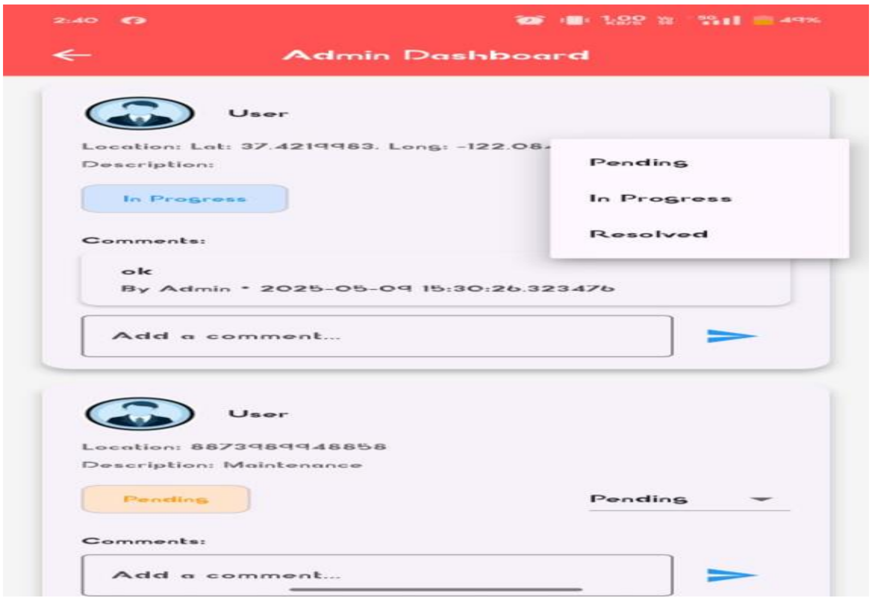


5.2 RESULT GENERATION

The SCCMS app ensures quick and accurate reporting by linking every classified image to the appropriate issue category and updating the admin dashboard in real time. Each identified issue is logged and linked to its GPS location (using QR code data or user input), making it easier for maintenance teams to locate and resolve problems. This functionality helps improve campus cleanliness, response time, and operational transparency.

Alongside generating user-side confirmations and acknowledgments, the system also compiles issue data for administrative review and analytics, promoting a data-driven approach to campus maintenance.

Fig.5.2 Issue Confirmation and Resolved Status



5.2.1 TRAINING PERFORMANCE

The machine learning model used in SCCMS undergoes a structured training process, utilizing a curated dataset of campus-related issues. High training accuracy reflects the model's ability to recognize diverse problem categories, while validation accuracy ensures that it generalizes well to unseen images.

By continuously monitoring these performance metrics, the system maintains high reliability. Balanced training and validation performance confirm that the model can function in various campus scenarios without degradation in accuracy, ensuring dependable classification outcomes even in edge cases.

5.2.2 EVALUATION METRICS

Evaluation of the SCCMS model is based on several core metrics:

- **Precision** evaluates how many reported issues classified by the model are actually correct, ensuring that irrelevant reports are minimized.
- **Recall** checks how many actual issues the model can successfully identify from the images, ensuring no important problems are missed.
- **Accuracy** provides an overall measure of correct classifications across all issue categories.
- **F1 Score** combines precision and recall to offer a balanced metric for the model's overall effectiveness.

Together, these metrics validate the SCCMS model's ability to support accurate and trustworthy issue reporting on campus.

5.2.3 TESTING DATASETS

To ensure the SCCMS model works effectively in real-life scenarios, the dataset is split into training, validation, and testing sets:

- **Training Set:** 87%
- **Validation Set:** 8%
- **Testing Set:** 5%

The testing set contains previously unseen images of campus issues to evaluate the model's performance in live conditions. Once an image is uploaded through the app, it is resized, normalized, and passed into the trained model. Predictions from the model are then compared against a database of known issues, and the result is displayed to the user instantly.

This end-to-end process ensures the app offers a robust, real-time experience for users reporting campus problems and enables administrators to act promptly and efficiently.

CHAPTER 6

CONCLUSION

The Smart Campus Complaint Management System (SCCMS) developed in this work illustrates the impactful use of deep learning and automation in enhancing campus cleanliness and maintenance processes. By integrating a machine learning model for image-based issue identification, QR code scanning for precise location tagging, and real-time data submission through a mobile interface, the system enables efficient and streamlined reporting of waste-related issues. This reduces manual oversight, promotes a cleaner campus environment, and encourages active participation from students and staff.

Initial testing validates the system's effectiveness in accurately identifying different types of waste and infrastructure problems, as well as its ease of use. Its modular architecture ensures adaptability, allowing the system to scale across various departments and campus facilities. SCCMS demonstrates strong potential as a tool for improving operational efficiency, user involvement, and overall campus hygiene.

6.1. FUTURE SCOPE

The SCCMS can be further enhanced to support a more interactive and automated campus management experience. Integration of voice-based complaint logging and mobile app controls will allow users to report issues hands-free or remotely. Incorporating real-time campus mapping and navigation features can help maintenance staff locate complaints more efficiently.

Advanced AI models can be trained on a wider dataset to improve the classification of waste and infrastructure issues, further increasing the system's accuracy. Adding an IoT-based alert system can notify users about frequently reported zones or unaddressed complaints. Furthermore, the inclusion of data analytics dashboards can help administrators identify recurring problem areas and allocate resources more effectively.

With these upgrades, SCCMS can evolve into a comprehensive smart campus management platform, driving sustainability, responsiveness, and user engagement across educational institutions.

APPENDIX

SOURCE CODE

UI FLUTTER CODE

main.dart

```
import 'package:flutter/material.dart';

import 'package:firebase_core/firebase_core.dart';

import 'package:firebase_auth/firebase_auth.dart';

import 'package:firebase_messaging/firebase_messaging.dart';

import 'package:cloud_firestore/cloud_firestore.dart';

import 'package:flutter_local_notifications/flutter_local_notifications.dart';

import 'package:shared_preferences/shared_preferences.dart';

// Screens

import 'screens/home_screen.dart';

import 'screens/login_screen.dart';

import 'screens/admin_dashboard_screen.dart';

import 'screens/role_selection_screen.dart';

import 'screens/cleaning_staff_dashboard.dart';


// 🔔 Local Notification Plugin

final FlutterLocalNotificationsPlugin flutterLocalNotificationsPlugin =
```

```
FlutterLocalNotificationsPlugin();

/// 🔔 Background FCM Handler

Future<void> _firebaseMessagingBackgroundHandler(RemoteMessage message) async {

  await Firebase.initializeApp();

  print("🔕 Background FCM message received: ${message.messageId}");

}

void main() async {

  WidgetsFlutterBinding.ensureInitialized();

  await Firebase.initializeApp();

  // 🔧 Setup background FCM handler

  FirebaseMessaging.onBackgroundMessage(_firebaseMessagingBackgroundHandler);

  // 🔧 Initialize Local Notifications

  const AndroidInitializationSettings androidSettings =

  AndroidInitializationSettings('@mipmap/ic_launcher');



  const InitializationSettings initSettings =

  InitializationSettings(android: androidSettings);

  await flutterLocalNotificationsPlugin.initialize(initSettings);

  runApp(const MyApp());

}
```

```
class MyApp extends StatelessWidget {
  const MyApp({super.key});
  /// 🔁 Decide the starting screen
  Future<Widget> _getStartScreen() async {
    final prefs = await SharedPreferences.getInstance();
    final rememberMe = prefs.getBool('remember_me') ?? false;
    final role = prefs.getString('user_role');
    final user = FirebaseAuth.instance.currentUser;

    if (user != null && rememberMe) {
      if (!user.emailVerified) {
        return const LoginScreen(role: 'user');
      }

      await _initFCM(user.uid);

      switch (role) {
        case 'admin':
          return AdminDashboardScreen();
        case 'user':
```

```
        return const HomeScreen();
      case 'staff':
        return CleaningStaffDashboard(staffName: user.displayName ?? 'Staff');
      default:
        return const RoleSelectionScreen();
    }
  }

  return const RoleSelectionScreen();
}

/// 🔐 Setup FCM and store the token in Firestore
Future<void> _initFCM(String userId) async {
  FirebaseMessaging messaging = FirebaseMessaging.instance;

  NotificationSettings settings = await messaging.requestPermission();

  if (settings.authorizationStatus == AuthorizationStatus.authorized) {
    final token = await messaging.getToken();
    if (token != null) {
```

```
    await FirebaseFirestore.instance.collection('users').doc(userId).update({
      'fcmToken': token,
    });
    print("✅ FCM Token updated for $userId: $token");
  }

  // Foreground notification handler
  FirebaseMessaging.onMessage.listen((RemoteMessage message) {
    if (message.notification != null) {
      _showLocalNotification(
        message.notification!.title ?? 'No Title',
        message.notification!.body ?? 'No Body',
      );
    }
  });
 }
}

/// 🔔 Show Local Notification
void _showLocalNotification(String title, String body) async {
```

```
;
}

  const AndroidNotificationDetails androidDetails = AndroidNotificationDetails(
    'default_channel', // Channel ID
    'Default Notifications', // Channel name
    channelDescription: 'This channel is used for important notifications.',
    importance: Importance.max,
    priority: Priority.high,
    showWhen: true,
  );

  const NotificationDetails platformDetails =
  NotificationDetails(android: androidDetails);

  await flutterLocalNotificationsPlugin.show(
    0, // Notification ID
    title,
    body,
    platformDetails,
  );
}
```

```
@override
Widget build(BuildContext context) {
  return MaterialApp(
    title: 'Smart Campus Cleanliness',
    debugShowCheckedModeBanner: false,
    theme: ThemeData(
      primarySwatch: Colors.green,
      scaffoldBackgroundColor: const Color(0xFFF5F5F5),
      appBarTheme: const AppBarTheme(
        backgroundColor: Color(0xFF388E3C),
        foregroundColor: Colors.white,
      ),
    ),
    home: FutureBuilder<Widget>(
      future: _getStartScreen(),
      builder: (context, snapshot) {
        if (snapshot.connectionState == ConnectionState.waiting) {
          return const Scaffold(
            body: Center(child: CircularProgressIndicator()),
          );
```

```
        } else if (snapshot.hasError) {
          return const Scaffold(
            body: Center(child: Text("Something went wrong. Please restart the app.")),
          );
        }
        return snapshot.data!;
      },
    ),
  );
 }
}
```

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