



اونيورسيتي مليسيا قهغ السلطان عبد الله  
**UNIVERSITI MALAYSIA PAHANG**  
**AL-SULTAN ABDULLAH**

**SMART CAMPUS MAINTENANCE MANAGEMENT SYSTEM**

<b>GROUP NO.:</b>	<b>GROUP 1, SECTION 1B</b>	
<b>MEMBERS DETAILS:</b>	<b>STUDENT ID</b>	<b>NAME</b>
	CB22001	WAN NOOR DINA BINTI MEOR AHMAD SHUKRI
	CB22016	ABDULRAHEEM MOHAMMED BAGABER
	CB23137	KEH BAN NING
	CB23130	MUHAMMAD HARIZ HAIKAL BIN NORISMAN

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## **1.0 Introduction**

An efficient maintenance management is a very important functioning need in institutions of higher learning, especially those ones that have vast campuses and dormitories. Lots of universities still use manual or semi-digital maintenance reporting procedures, which leads to a low speed of response, broken communication, a lack of performance visibility, and the inefficiency of using resources. These issues have a direct impact on the living conditions of students, the rate of their productivity at work, and the quality of service provided on the campus.

To address these issues in its operations, NexTech Smart Solutions Sdn. Bhd. has offered to develop a Smart Campus Maintenance Management System. The project is in line with the strategic plan of the client to convert campus operations into the digital realm with the help of the smart infrastructure solution. The system will help reshape the traditional maintenance processes into an automated, centralized, and data-driven platform based on the application of Internet of Things (IoT), mobile apps, and cloud-based analytics, thus assisting to make efficient decisions and improve the performance in a measurable way.

### **1.1 Project Background**

University campuses generally experience a large amount of maintenance problems involving hostels, classrooms, laboratories and facilities used by the whole institution. The traditional maintenance procedures tend to rely on manual reporting and face-to-face communication, thus causing a delayed detection of faults, lack of proper coordination in performing tasks, and tracking the performance of technicians. Since the campus environments are getting more complex, these restrictions are limiting the institution in its effort to sustain the level of services and operational efficiency.

The technology company NexTech Smart Solutions Sdn. Bhd. is a Malaysian firm dealing with smart campus and IoT-based solutions; it saw the necessity to implement an integrated solution that would cover these areas of operation. It is suggested that the Smart Campus Maintenance Management System is created to serve the vision of the client regarding the creation of a sustainable, data-driven campus. The system, based on real-time IoT monitoring and mobile-based maintenance management, will contribute to a higher level of transparency, a higher response time, and the possibility of the management to assess the performance of maintenance based on quantifiable indicators which follow organizational objectives.

## **1.2 Proposed Solution**

The proposed solution is a centralized Smart Campus Maintenance Management System which involves the combination of IoT sensors, mobile apps and web-based administrative portal into one system. A mobile application is available to the students where they can post maintenance requests, append supporting images, monitor request status, and get real-time updates.

IoT sensors in the facilities within the campus detect any fault in the facilities automatically and send an alert to the backend system via MQTT communication protocol. The job assignments are made to the maintenance technicians by means of the mobile application that provides opportunities to receive the updates in the real-time, track the job with the help of GPS, and file the work evidence. Administrators can use a web-based dashboard to track the maintenance operations, real-time sensor notification, and the performance indicators: response time, task execution rate, and repeat problems. This is implemented on a reliable cloud platform of role-based access control, and encrypted data transfer to enhance reliability, scale and data security.

## **1.3 Project Aim and Scope**

### **1.3.1 Project Aim**

The main objective of the project is to develop and implement a smart, integrated campus maintenance management system, based on IoT and mobile platform, and cloud-based analytics to enhance the efficiency of the maintenance response, the visibility of services, and the performance of operations in higher learning institutions.

### **1.3.2 Project Scope**

- Creation of mobile application that students would use to post, follow-up and get response to maintenance requests.
- Creation of a mobile application where technicians will get assignments, check the status of the job, implement GPS tracking, and work documentation.
- Adoption of an online administrative portal to monitor maintenance operations and report.
- Administrative portal on the web that has been implemented to monitor maintenance operations and performance reports.
- IoT sensors to detect faults and generate real-time alerts.
- Installation of a real-time database and cloud-based solution to operate a backend system.

- Application of security protocols such as HTTPS encryption and role based access control.
- Delivery of analytics dashboards to facilitate the process of performance assessment and the use of data to make decisions.

## 2.0 Organization Structure & Responsibilities

### 2.1 Project Steering Committee

The Project Steering Committee (PSC) serves as an important role in providing strategic oversight, governance, and making key decisions in every phase of the Smart Campus Maintenance Management System project, following the established UMPSA governance framework as demonstrated by the SPPA UMPSA Steering Committee structure (*Committee – PRISA. (2023). Axicom.my.*

<https://ump.axicom.my/committee/>). Without effective oversight, the project will suffer from scope creep, budget overruns, and misalignment with organizational goals. While successful outcomes, targets achieved and risks or challenges are more likely to be handled properly when the PSC exists in a project. This committee ensures alignment with university objectives and approves major project decisions.

<b>Committee Structure:</b>
Chairman - Deputy Vice-Chancellor (Academic & International) <ul style="list-style-type: none"><li>• Provides overall strategic direction and final decision authority</li><li>• Approves project budget and resource allocation</li><li>• Ensures project alignment with university strategic goals</li><li>• Final escalation point for major project decisions</li></ul>
Deputy Chairman 1 - Chief Information Officer, Knowledge Management & Information Technology Department <ul style="list-style-type: none"><li>• Provides technical oversight and IT infrastructure guidance</li><li>• Ensures integration with existing university systems</li><li>• Approves security protocols and data management policies</li><li>• Oversees IoT infrastructure compliance with university standards</li></ul>
Deputy Chairman 2 - Dean, Student Development <ul style="list-style-type: none"><li>• Represents student user requirements and experience</li><li>• Ensures system meets student accessibility and usability needs</li><li>• Provides student feedback and requirement validation</li><li>• Oversees student training and adoption programs</li></ul>

**Committee Members:**

**Assistant Vice-Chancellor, Center for Corporate & Qualitative Affairs**

- Represents administrative requirements and processes
- Ensures compliance with university policies and procedures
- Approves administrative workflow changes
- Oversees quality assurance standards

**Director, Centre for Academic Management**

- Provides academic process expertise and integration guidance
- Ensures system supports academic administrative functions
- Approves academic-related system modifications
- Validates academic workflow requirements

**Busary Representative**

- Oversees financial aspects and budget management
- Approves expenditure and cost variations
- Ensures financial compliance and value for money
- Monitors budget adherence and financial reporting

**General Manager, Student Affairs Department**

- Represents student user requirements and experience
- Ensures system meets student accessibility and usability needs
- Provides student feedback and requirement validation
- Oversees student training and adoption programs

**Secretariat - Senior Executive (Division Head)**

- Manages committee administration and documentation
- Coordinates meeting schedules and agenda preparation
- Maintains committee records and decision tracking

- Facilitates communication between committee and project team

**External Member - NexTech Smart Solutions Project Director**

- Provides vendor perspective and technical expertise
- Reports on project progress and deliverables
- Ensures contractual obligations are met
- Represents vendor capabilities and limitations

**Committee Responsibilities:**

- Strategic decision making and project governance
- Budget approval and resource allocation exceeding RM50,000
- Risk escalation and mitigation decisions
- Quality gate approvals at major project milestones
- Stakeholder communication and change management
- Project success criteria validation
- Policy compliance oversight
- Integration approval with existing university systems

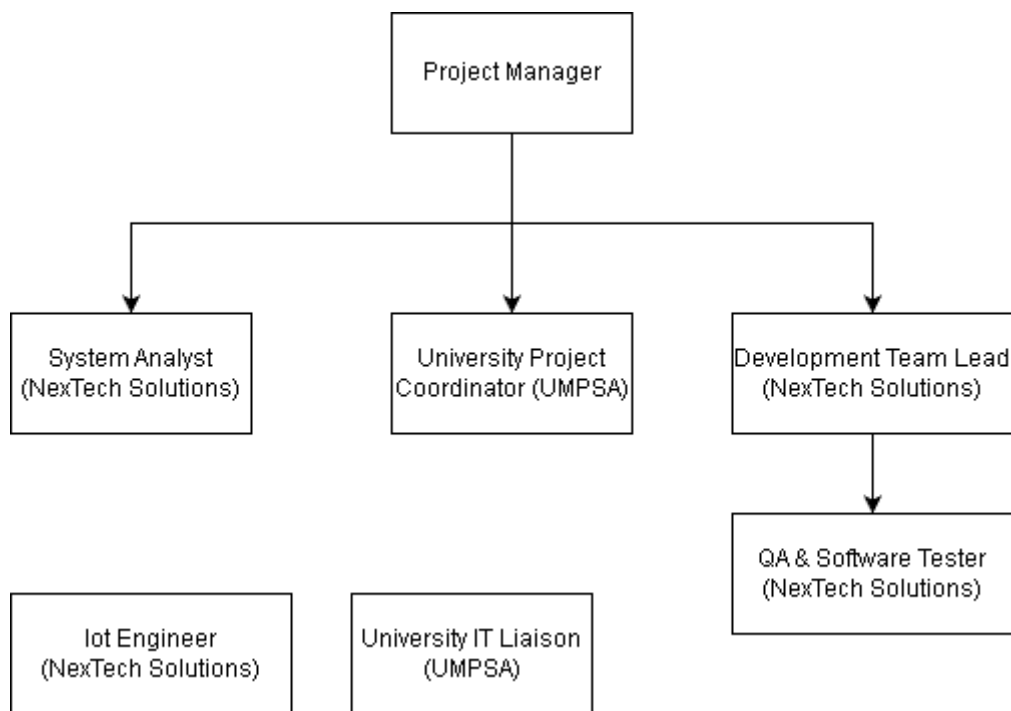
**Meeting Frequency:** Monthly during project execution phases, bi-weekly during critical phases, or as required for urgent decisions

**Decision Authority:**

- Budget variations up to 15% of total project cost
- Scope changes affecting university operations
- Resource reallocation between project phases
- Vendor performance escalations
- Timeline adjustments exceeding one month
- Risk mitigation strategies requiring university resources

## 2.2 Project Management Team

The Project Management Team consists of a qualified leader or project manager and a group of individuals or team members who work together on Smart Campus Maintenance Management System project with consensus on same goals and objectives. Everyone on the project team fulfills their responsibility, performs their tasks, and contributes to the success of the project.



### 2.3 RACI Matrix

<b>Responsible</b>	This team member does the work to complete the task. Every task needs at least one Responsible party, but it's okay to assign more.
<b>Accountable</b>	This person delegates work and is the last one to review the task or deliverable before it's deemed complete. On some tasks, the Responsible party may also serve as the Accountable one. Just be sure you only have one Accountable person assigned to each task or deliverable.
<b>Consulted</b>	Every deliverable is strengthened by review and consultation from more than one team member. Consulted parties are typically the people who provide input based on either how it will impact their future project work or their domain of expertise on the deliverable itself.
<b>Informed</b>	These team members simply need to be kept in the loop on project progress, rather than roped into the details of every deliverable.

#### Project Activities RACI Matrix

Project Activity	Project Manager	System Analyst	Development Team	QA Tester	University Coordinator	University IT	Steering Committee
Project Planning & Initiation	A	C	C	C	C	C	I
Requirements Gathering	C	A	C	I	C	C	I
System Design	C	A	R	I	I	C	I
IoT Infrastructure	C	C	A	I	I	R	I

e							
Development (Mobile/Web)	C	C	A	C	I	C	I
Database Implementation	C	C	A	C	I	R	I
Security Implementation	C	C	R	C	I	A	I
System Integration	A	C	R	C	C	A	I
Testing (Unit & Integration)	C	C	C	A	C	R	I
User Acceptance Testing	C	C	I	R	A	C	I
Training Development	C	A	I	I	R	C	I
System Documentation	C	A	R	C	C	R	I
Go-Live Deployment	A	C	C	C	R	R	C
Post- Implementation Support	A	C	R	C	R	R	I
Budget Management	A	I	I	I	C	I	C
Risk	A	C	C	C	C	C	I

Management							
Stakeholder Communication	A	C	I	I	R	I	C
Quality Assurance	C	C	C	A	C	C	I
Change Management	C	C	I	I	A	C	C
Policy Compliance	C	C	C	C	C	A	I

ESCALATION PROCEDURES	COMMUNICATION PROTOCOLS
<p><b>Level 1 - Operational Issues (0-24 hours):</b></p> <ul style="list-style-type: none"> <li>• Technical problems and routine development issues</li> <li>• Handled by: Development Team Lead, IoT Engineer, QA Tester</li> <li>• Escalation criteria: Issue impacts daily development progress or quality standards</li> <li>• Resolution authority: Technical team leads with Project Manager oversight</li> </ul>	<p><b>Daily Technical Standups:</b></p> <ul style="list-style-type: none"> <li>• Participants: Development Team, QA Tester, IoT Engineer, Project Manager</li> <li>• Frequency: Daily during development phases (Phases 3-4)</li> <li>• Purpose: Progress updates, impediment identification, coordination, daily goal setting</li> <li>• Tool: Project management dashboard and video conferencing</li> </ul>
<p><b>Level 2 - Management Issues (24-72 hours):</b></p> <ul style="list-style-type: none"> <li>• Resource conflicts, timeline delays</li> <li>• Handled by: Project Manager, System Analyst, University Project Coordinator</li> </ul>	<p><b>Weekly Progress Reviews:</b></p> <ul style="list-style-type: none"> <li>• Participants: Project Manager, System Analyst, Team Leads, University Project Coordinator</li> <li>• Frequency: Every Friday during project execution</li> <li>• Duration: 1 hour structured</li> </ul>

<ul style="list-style-type: none"> <li>• Escalation criteria: Issues affecting project milestones or requiring resource reallocation</li> <li>• Resolution authority: Project Manager with University Coordinator support</li> </ul>	<p>review</p> <ul style="list-style-type: none"> <li>• Purpose: Milestone tracking, resource planning, risk review, issue resolution</li> <li>• Deliverable: Weekly status report to steering committee</li> </ul>
<p><b>Level 3 - Strategic Issues (72 hours - 1 week):</b></p> <ul style="list-style-type: none"> <li>• Major scope changes, critical risks, stakeholder conflicts, budget variations 10-15%</li> <li>• Handled by: University IT Liaison, University Project Coordinator, Senior Project Stakeholders</li> <li>• Escalation criteria: Issues requiring university policy decisions or significant resource changes</li> <li>• Resolution authority: University department heads with Steering Committee consultation</li> </ul>	<p><b>Bi-weekly Stakeholder Updates:</b></p> <ul style="list-style-type: none"> <li>• Participants: Project Manager, University Coordinator, Key University Stakeholders, Department Representatives</li> <li>• Frequency: Every second Tuesday</li> <li>• Duration: 45 minutes presentation and discussion</li> <li>• Purpose: Progress communication, requirement validation, stakeholder alignment, change management updates</li> <li>• Deliverable: Stakeholder communication summary</li> </ul>
<p><b>Level 4 - Executive Issues (Immediate to 1 week):</b></p> <ul style="list-style-type: none"> <li>• Project viability threats, budget overruns &gt;15%, strategic alignment conflicts, legal issues</li> <li>• Handled by: Project Steering Committee</li> <li>• Escalation criteria: Issues</li> </ul>	<p><b>Monthly Steering Committee Meetings:</b></p> <ul style="list-style-type: none"> <li>• Participants: All Steering Committee Members, Project Manager (presenting)</li> <li>• Frequency: First Tuesday of each month</li> <li>• Duration: 2 hours comprehensive</li> </ul>

<p>threatening project success or requiring executive authority</p> <ul style="list-style-type: none"> <li>Resolution authority: Steering Committee with final decision by Chairman</li> </ul>	<p>review</p> <ul style="list-style-type: none"> <li>Purpose: Strategic oversight, major decision making, budget review, risk assessment, policy compliance</li> <li>Deliverable: Executive decision summary and action items</li> </ul>
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## **DOCUMENT APPROVAL AUTHORITY**

### **Technical Documents:**

- System Architecture: System Analyst (A), Development Team Lead (R), University IT Liaison (C)
- API Specifications: Development Team Lead (A), System Analyst (C), University IT Liaison (C)
- Test Plans: QA Tester (A), System Analyst (C), University Project Coordinator (C)
- IoT Design: IoT Engineer (A), System Analyst (C), University IT Liaison (A)
- Security Protocols: University IT Liaison (A), IoT Engineer (R), Development Team Lead (C)

### **Project Management Documents:**

- Project Plans: Project Manager (A), Steering Committee (I), University Project Coordinator (C)
- Budget Reports: Project Manager (A), Steering Committee (A), Busary Representative (C)
- Change Requests: Project Manager (A), System Analyst (C), Steering Committee (A for major changes)

### **University-Specific Documents:**

- Training Materials: University Project Coordinator (A), System Analyst (R), Academic Management Director (C)

- User Manuals: System Analyst (A), University Project Coordinator (C), End User Representatives (C)
- Operational Procedures: University Project Coordinator (A), University IT Liaison (C), Student Affairs Department (C)
- Integration Procedures: University IT Liaison (A), System Analyst (R), Development Team Lead (C)

### 3.0 Project Costing

The cost estimation method employed in the project is the bottom-up cost estimation technique, in this method the cost of the entire project is obtained by estimating the cost of the individual work packages, activities and necessary resources. The total budget will be made up of all the costing which will be aggregate. The bottom-up costing is appropriate in this project because of its complex nature that requires software development and integration of the IoT devices, cloud infrastructure and multi-phase implementation. According to the bottom-up estimation method, the project cost breakdown in detail is as presented in the table below:-

<b>Cost Measurement Category</b>	<b>What Is Being Measured</b>
Human Resource Wages	Man-month cost of project team members
System Analysis and Design	Effort for requirements, system design, and UI/UX
Web & Mobile Development	Coding and integration effort for web and mobile apps
Backend & Database Setup	API development and database configuration effort
IoT Device Procurement & Integration	Cost of IoT devices, sensors, and integration work
Cloud Hosting & Security Setup	Cloud service usage and system security setup
Analytics & Dashboard Development	Dashboard design and reporting effort
Pilot Testing & Quality Assurance	Testing, bug fixing, and pilot deployment effort
Training & Documentation	Training sessions and preparation of manuals

Maintenance & Warranty	Post-deployment support and system maintenance
Contingency & Miscellaneous	Allowance for unforeseen project costs

### 3.1 Resource Assumption

<b>Role</b>	<b>Average Monthly Cost (RM)</b>
Project Manager	18,000
Business Analyst	14,000
UI/UX Designer	12,000
Frontend Developer	15,000
Mobile App Developer	16,000
Backend Developer	16,000
IoT Engineer	15,000
QA/Test Engineer	12,000
Cloud/Security Engineer	17,000
Trainer / Technical Writer	10,000

### 3.2 Bottom-Up Cost Breakdown

#### 3.2.1 System Analysis and Design

Activity	Resource	Effort	Cost (RM)
Requirement gathering & stakeholder workshops	Business Analyst	2 months	28,000
System architecture & database schema	Backend Dev	1.5 months	24,000
UI/UX wireframes & prototypes	UI/UX Designer	2 months	24,000
Project planning & documentation	Project Manager	1 month	14,000
<b>Subtotal</b>			<b>90,000</b>

#### 3.2.2 Web & Mobile Development

Item	Resource / Unit	Effort / Quantity	Cost (RM)
Admin web portal development	Frontend Developer	4 man-months	60,000
Mobile app (Flutter)	Mobile Developer	4 man-months	64,000
UI integration & responsiveness	Frontend/UI support	2 man-months	30,000
Feature integration & refinement	Full-stack support	Lump sum	50,000
Project coordination	Project Manager	2 man-months	36,000
<b>Subtotal</b>			<b>240,000</b>

### 3.2.3 Backend & Database Setup

Item	Resource / Unit	Effort / Quantity	Cost (RM)
API development	Backend Developer	3 man-months	48,000
Database configuration	Backend Developer	1.5 man-months	24,000
Real-time data handling	Backend Developer	1 man-month	16,000
Security & RBAC	Backend/Security Engineer	Lump sum	20,000
Integration testing	QA Engineer	Lump sum	12,000
<b>Subtotal</b>			<b>120,000</b>

### 3.2.4 IoT Device Procurement & Integration

Item	Unit	Quantity / Effort	Cost (RM)
Arduino / Raspberry Pi	Device	Multiple units	55,000
Sensors (various types)	Device	Multiple units	40,000
Firmware & MQTT setup	IoT Engineer	2 man-months	30,000
Device testing & calibration	IoT & QA Team	Lump sum	20,000
On-site deployment	Technical Team	Lump sum	15,000
<b>Subtotal</b>			<b>160,000</b>

### 3.2.5 Cloud Hosting & Security Setup

Item	Unit	Cost (RM)
Cloud hosting (11 months)	AWS / Google Cloud IoT	35,000
SSL & HTTPS configuration	Service	8,000
Encryption & access control	Security setup	17,000
Monitoring & backup	Cloud services	10,000
Security testing	Penetration checks	10,000
<b>Subtotal</b>		<b>80,000</b>

### 3.2.6 Analytics & Dashboard Development

Item	Resource / Unit	Cost (RM)
KPI definition & data modelling	Business Analyst	15,000
Dashboard development	Developer	30,000
Visualization & reports	Developer	15,000
User testing	QA/Admin	10,000
<b>Subtotal</b>		<b>70,000</b>

### 3.2.7 Pilot Testing & Quality Assurance

Item	Cost (RM)
Functional testing	20,000
Performance testing	15,000
Bug fixing & optimisation	15,000
Pilot deployment support	10,000
<b>Subtotal</b>	<b>60,000</b>

### 3.2.8 Training & Documentation

Item	Cost (RM)
Training sessions	18,000

User & technical manuals	12,000
Training materials	10,000
<b>Subtotal</b>	<b>40,000</b>

### 3.2.9 Maintenance & Warranty

<b>Item</b>	<b>Cost (RM)</b>
Quarterly system checks	20,000
Bug fixes & minor updates	25,000
Technical support	15,000
<b>Subtotal</b>	<b>60,000</b>

### 3.2.10 Contingency & Miscellaneous

<b>Risk Area</b>	<b>Cost (RM)</b>
Scope changes	10,000
Extra cloud usage	8,000
Hardware replacement	7,000
Minor upgrades	5,000
<b>Subtotal</b>	<b>30,000</b>

### 3.3 Final Cost Summary

<b>Cost Component</b>	<b>Cost (RM)</b>
<b>Total Project Cost</b>	<b>950,000</b>

The cost estimate is calculated using the rate of the existing Malaysian ICT industry considering realistic assumptions on the number of man-months, price of cloud services and the price of IoT hardware. Controlled contingency of 3 percent is incorporated to take care of minor uncertainties without bursting the project budget. This bottom-up costing gives a realistic and transparent financial plan that is in line with the industry so as to ensure that the project is feasible, sustainable, and within the approved budget during the entire implementation period of 11 months.

## 4.0 Project Scheduling

### 4.1 WBS Chart

The Work Breakdown Structure (WBS) decomposes the Smart Campus Maintenance Management System (SCMMS) into a five-phase hierarchy to ensure all deliverables are accounted for:

- **1.0 Initiation:** Project planning, requirement elicitation, and stakeholder analysis.
- **2.0 Design:** System architecture, UI/UX prototyping, and IoT/Cloud infrastructure design.
- **3.0 Development:** Technical implementation including IoT device setup, backend/API development, web admin portal, and mobile application development.
- **4.0 Testing:** Comprehensive validation including internal QA, security testing, and User Acceptance Testing (UAT).
- **5.0 Deployment:** Final system go-live, user training, and documentation handover.

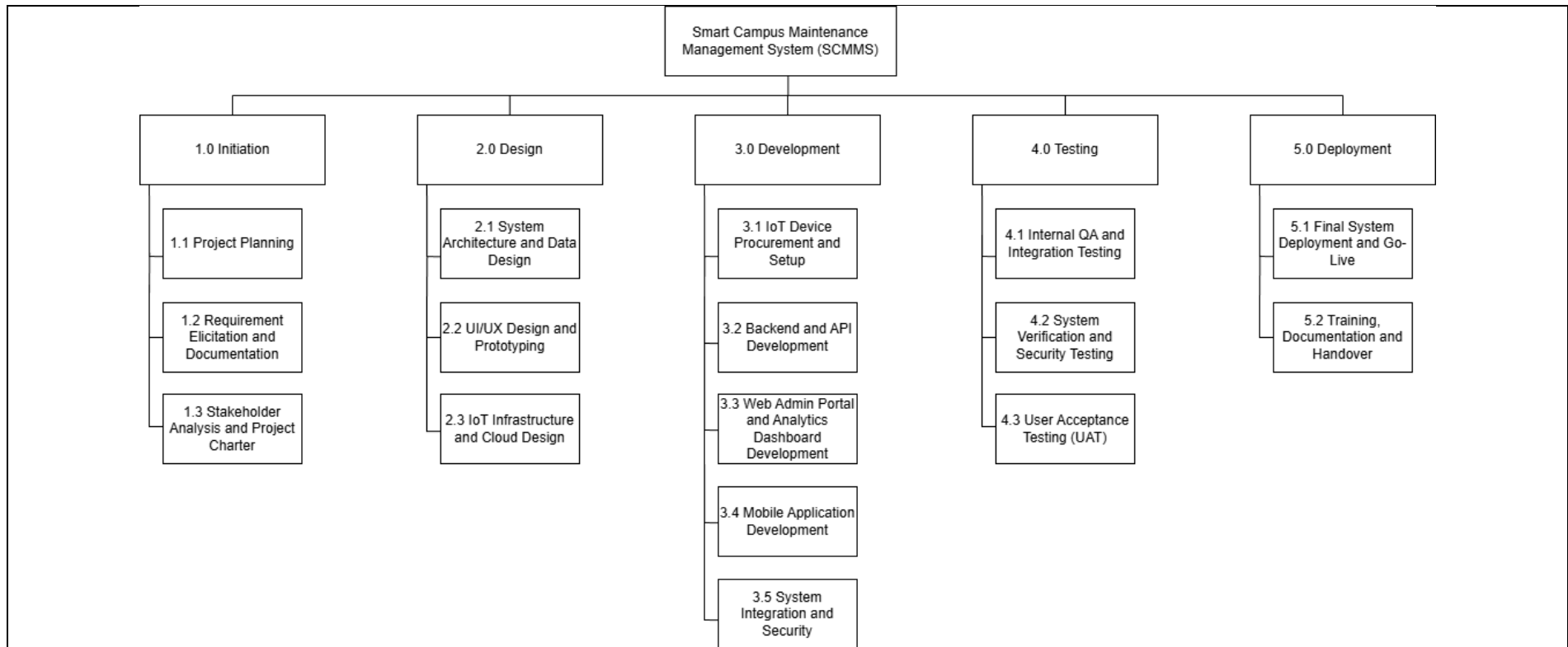


Figure 4.1: The Work Breakdown Structure (WBS) for Smart Campus Maintenance Management System (SCMMS)

## 4.2 Gantt Chart

The project time span, showing time frames, time relations, and critical milestones for the course of 11 months, is shown in the Gantt Chart.

- **Time frame:** The project starts in December 2025 with Initiation and in the middle of December 2026 ends with Final Deployment and Handover.
- **Order:** Tasks are connected with finish-to-start relations, so that design is locked before development starts and pre-Go Live testing is done.
- **Staged milestones:** Key milestones are positioned at the end of every phase as "Quality Gates" to be signed off by the Project Steering Committee.

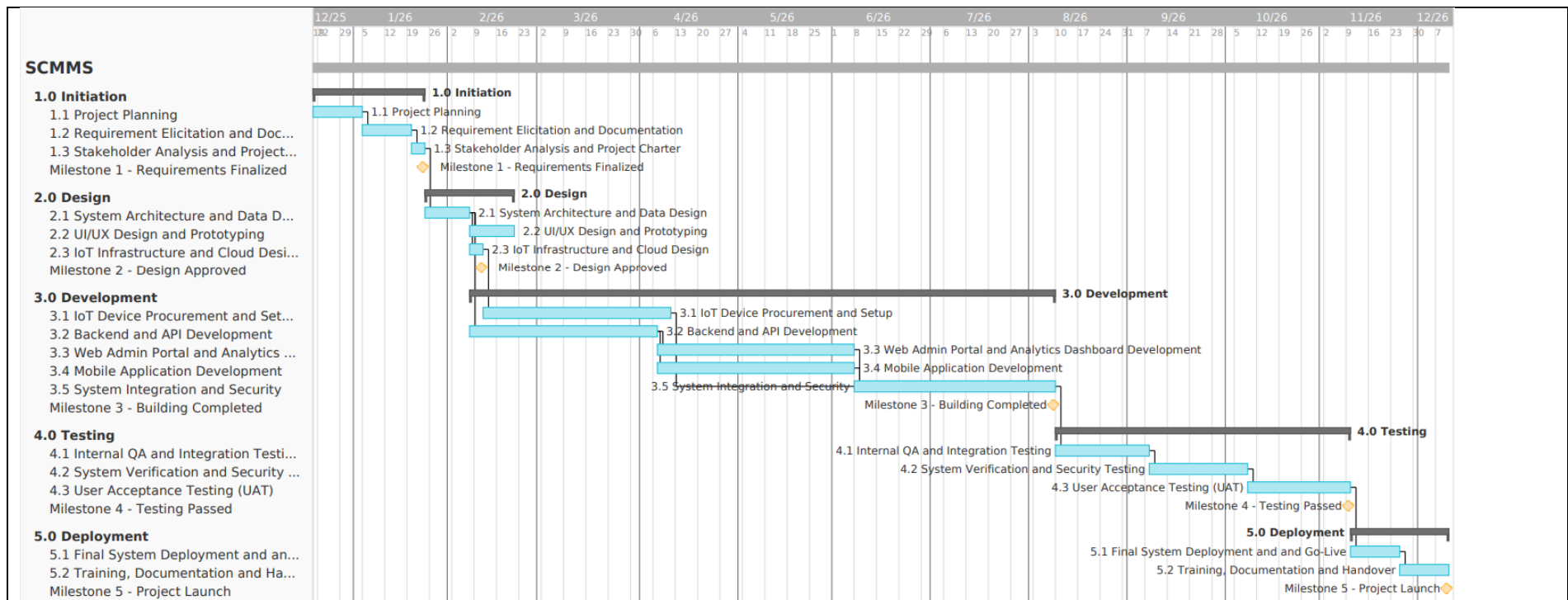


Figure 4.2: The Gantt Chart for Smart Campus Maintenance Management System (SCMMS)

### 4.3 Critical Path Identification

Completion of the project in the specified budget of RM 950,000 and within 11 months will be achieved by focusing on the following tasks on the Critical Path:

- **Requirement Elicitation & Documentation:** Any delays here will result in stalling the start of the technical design.
- **System Architecture & Data Design:** This is the basis for all backend development.
- **Backend and API Development:** This is critical for the mobile and web applications to operate.
- **Mobile Application Development (Flutter):** This is the main interface for students and technicians.
- **User Acceptance Testing (UAT):** This is the last step of the project before it goes live.
- **Final System Deployment:** This is the last task to complete within the 11 months.

### 4.4 Resource Mapping

This table maps the NexTech technical team to the major WBS phases to ensure clear accountability for each deliverable:

WBS Phase	Primary Resources Responsible	Deliverable Alignment
1.0 Initiation	Project Manager, System Analyst	Project Charter & Requirements Document
2.0 Design	System Analyst, UI/UX Designer	System Architecture & Wireframes
3.0 Development	Backend/Mobile Developers, IoT Engineer	Core SCMMS Source Code & IoT Setup
4.0 Testing	QA/Test Engineer, System Admin	Bug Reports & UAT Approval
5.0 Deployment	Cloud Engineer,	Live System & User

	Trainer/Technical Writer	Manuals
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## 5.0 Risk Management

### 5.1 WAN NOOR DINA BINTI MEOR AHMAD SHUKRI (CB22001)

#### 5.1.1 Risk Assessment Matrix

Risk Factor = Probability x Impact

Risk ID	Risk Description	Category	P	I	Risk Factor
R001	IoT integration failure due to MQTT communication timeouts or sensor disconnections	Technical	3	5	15
R002	Data security breach caused by unauthorized system access	Security	2	5	10
R003	Cloud service downtime affecting IoT platform availability	Technical	2	4	8
R004	Inaccurate sensor data leading to false	Data Quality	4	4	16

	maintenance alerts				
R005	Project cost overruns exceeding the RM 950,000 budget	Financial	3	5	15

### 5.1.2 Risk Ownership and Response

Risk ID	Risk Owner	Risk Trigger	Response Strategy
R001	IoT Engineer	More than 10% data packet loss detected in system logs	<b>Mitigate:</b> Deploy redundant MQTT brokers and enable local data buffering
R002	Project Manager	Security audit reports high-severity vulnerabilities or unauthorized access attempts	<b>Avoid:</b> Implement HTTPS encryption, RBAC, and multi-factor authentication
R003	System Administrator	Cloud provider dashboard indicates regional service outage	<b>Contingency:</b> Enable multi-region failover and offline data caching
R004	IoT Engineer	Sensor readings differ from manual inspection by more than 10%	<b>Mitigate:</b> Conduct quarterly sensor calibration and validation

R005	Project Manager	Monthly burn rate exceeds planned budget by more than 15%	<b>Mitigate:</b> Use contingency funds and strengthen cost monitoring
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## 5.2 MUHAMMAD HARIZ HAIKAL BIN NORISMAN (CB23130)

### Cost Risk Management Plan

#### Identification

The cost risk management is aimed at identifying, analyzing and managing risks that can lead to the project exceeding its approved budget. As per the content of the course, cost risks are evaluated during the entire project lifecycle through probability and impact analysis and relevant risk response plans are implemented to reduce financial impact. Cost risk management is not a one time activity but rather a process.

Based on the project scope and the cost categories as outlined in the cost breakdown, the following risks associated with the costs have been identified:

- i. Increase in development effort due to requirement changes.
- ii. Unexpected IoT hardware replacement costs.
- iii. Extended maintenance and support effort.
- iv. Higher usage of cloud services than expected.

#### Analysis Method

The cost risks will be analyzed using the qualitative risk analysis as each cost is evaluated based on:

- i. **Probability (P)**: Likelihood of the cost risk occur (scale 1-10)
- ii. **Impact (I)**: Financial impact on the project budget (scale 1-10)

$$\text{Risk Factor} = \text{Probability} \times \text{Impact}$$

Risk levels are classified as:

- i. High Risk:  $\geq 40$
- ii. Medium Risk: 30-39
- iii. Low Risk:  $\leq 29$
- iv. Resolved Risk: 0

### Analysis and Control Table

<b>Risk ID</b>	<b>Cost Risk Description</b>	<b>P</b>	<b>I</b>	<b>Risk Factor</b>	<b>Risk Level</b>	<b>Risk Response Strategy</b>	<b>Risk Owner</b>
CR1	Cost increase due to frequent requirement changes	6	8	48	High	Mitigate	Project Manager
CR2	Higher cloud hosting cost due to increased data usage	5	7	35	Medium	Mitigate	Cloud Engineer
CR3	Additional cost from IoT device damage or replacement	4	7	28	Low	Accept	IoT Engineer
CR4	Increased testing and bug-fixing effort	5	6	30	Medium	Mitigate	QA Lead
CR5	Increased maintenance cost during warranty period	4	6	24	Low	Accept	Support Manager

## Response Strategies

Risk ID	Response Strategies	Action
CR1	Mitigate	Implement strict change control and assess cost impact before approval
CR2	Mitigate	Monitor cloud usage monthly and optimize resource allocation
CR3	Accept	Use contingency budget and rely on vendor warranty
CR4	Mitigate	Allocate buffer time and prioritize critical defect fixes
CR5	Accept	Monitor support effort and adjust maintenance scheduling.

## Monitoring and Control

Cost Risk Area	Monitoring Activity	Monitoring Frequency	Control Action	Responsible Owner
Change requests	Evaluate cost impact before approval	As required	Approve, defer, or reject change	Project Manager
Cloud service cost	Monitor cloud usage and billing	Monthly	Optimize resources and usage limits	Cloud Engineer
IoT hardware expenses	Track device inventory and replacement	Quarterly	Use warranty or contingency reserve	IoT Engineer
Testing and rework cost	Monitor defect rate and rework effort	During testing phase	Prioritize critical fixes	QA Lead
Maintenance cost	Review support effort and incident	Quarterly	Adjust maintenance plan	Support Manager

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## 5.3 KEH BAN NING (CB23137)

### 5.3.1 Risk Management Governance Structure

Risk Management Committee Structure:

Role	Responsibility	Frequency	Escalation Point
Chair - Project Manager	Overall risk coordination and management	Weekly	Steering Committee
System Analyst	Technical risk assessment and mitigation	Weekly	Project Manager
University Coordinator	University-specific risk management	Weekly	Project Manager
University IT Liaison	Infrastructure and security risk oversight	Weekly	Project Manager

### 5.3.2 Risk Assessment Matrix

Impact and Probability Levels:

Level	Score	Impact Criteria	Description
Low	1	Minor delay <1 week	Resource adjustment <5% budget
Medium	2	Significant impact 1-4 weeks	Budget impact 5-10%
High	3	Major milestone impact >1 month	Budget impact 10-20%
Critical	4	Project success threatened >3 months	Budget impact >20%

Risk Score Matrix (Impact × Probability):

Risk Level	Score Range	Action Required	Response Time
Low Risk	1-4	Accept with monitoring	Weekly Review
Medium Risk	5-8	Active mitigation required	72 hours
High Risk	9-12	Immediate mitigation + escalation	24 hours
Critical Risk	13-16	Emergency response + executive intervention	Immediate

### 5.3.3 Key Organizational Risk Categories

Risk Category	Impact Level	Probability	Risk Score	Mitigation Strategy
Key personnel unavailability	High (3)	Possible (2)	6	Cross-training, backup resources
Communication breakdown	Medium (2)	Likely (3)	6	Structured protocols, regular touchpoints
Decision-making delays	High (3)	Possible (2)	6	Deputy authority, emergency protocols
Skill gap risks	High (3)	Possible (2)	6	External experts, training programs
Stakeholder	Medium (2)	Likely (3)	6	Regular

misalignment				validation, workshops
Policy compliance	Critical (4)	Unlikely (1)	4	Regular audits, compliance training

## 5.4 BAGABER ABDULRAHEEM (CB22016)

Risk management should be effective to guarantee the successful implementation of the Smart Campus Maintenance Management System, comprising of the IoT hardware integration, cloud environment, and sensitive information processing. This risk management plan pinpoints the most crucial risks in the project, their likelihood of occurrence, and impact of the project, and it has incorporated the continuous checks and balances through monitoring and visible ownership of risks in project lifecycle to control active risks.

### 5.4.1 Key Risk Assessment

Risk ID	Risk Description	Probability (1–5)	Impact (1–5)	Risk Score	Risk Level	Risk Owner
R1	Malfunctioning of Arduino sensors or MQTT communication problems resulted in IoT hardware integration failure.	3	5	15	High	IoT Engineer
R2	Unauthorized access to maintenance data or vulnerabilities of IoT network leading to data security breach.	3	5	15	High	System Administrator

### 5.4.2 Risk Mitigation Strategy

#### R1 – IoT Hardware Integration Failure

Phased deployment of IoT, testing compatibility of sensors, MQTT stress testing and backup devices maintenance are some of the mitigation actions. These will minimize the system disruption during the stages of integration and pilot testing

#### R2 – Data Security Breach

To safeguard system and IoT network data, mitigation measures encompass the role-based access control, encryption of HTTPS, secure authentication tools, and periodic security audit.

### 5.4.3 Continuous Monitoring and Ownership Tracking

In line with the need to have continuous monitoring and ownership tracking, risk management is inculcated into the project governance structure as:

- Every risk identified has a specific risk owner in charge of the risk monitoring, execution of the mitigation, and reporting.
- Risk reviews are performed at weekly intervals during the development and the integration of IoT in order to revise the probability and impact levels.
- Phase-end risk checkpoints are done following significant milestones (IoT Integration, Pilot Testing, and Deployment).
- A risk log that will be kept by the Project Manager will record risk status (Open, Mitigated, Escalated, Closed).
- Risks associated with the High category automatically escalate to the Project Manager to be corrected and the resources adjusted.

This is a formalised process to make sure that risks are not only discovered but are constantly monitored, actively mitigated and their ownership well defined in fact to enable timely decision making as well as safeguard the aims of the project.

## 6.0 Project Status Review Plan

### 6.1 WAN NOOR DINA BINTI MEOR AHMAD SHUKRI (CB22001)

#### 6.1.1 Project Status Review Schedule

Review Type	Frequency	Progress Indicators (KPIs)	Review Tool	Responsible Role
Technical Stand-up	Weekly	Task completion rate, feature delivery progress	Jira / Slack	Development Team
Project Status Review (PSR)	Bi-Weekly	Milestones achieved, actual cost vs. budget	Status Report / Gantt Chart	Project Manager
IoT System Health Review	Weekly	Sensor uptime, $\geq 90\%$ detection accuracy	IoT Monitoring Dashboard	IoT Engineer
Management Progress Review	Monthly	Customer satisfaction, scope or requirement changes	Executive Presentation	University Management

### 6.1.2 Decision Control Points

To ensure quality and scope validation, the project will pass through "Quality Gates" at each major milestone.

<b>Control Point</b>	<b>Purpose</b>	<b>Decision Authority</b>	<b>Outcome</b>
Design Approval	Confirm system architecture and UI design	Project Manager	Proceed to Development
IoT Integration Gate	Verify sensor stability and MQTT data accuracy	IoT Engineer	Fix Issues or Proceed
Pilot Acceptance	Evaluate system performance and user feedback	System Admin	Approve Final Deployment
Go-Live Approval	Confirm system readiness and security compliance	University Management	Official Launch

## 6.2 MUHAMMAD HARIZ HAIKAL BIN NORISMAN (CB23130)

The Project Status Review Plan is set to monitor project performance in a systematic way and make sure that it is against approved scope, schedule, cost, quality, and risk baselines. Consistent reviews of status are made to measure actual performance against scheduled goals, determine variances and facilitate corrective and preventive responses in time. The review process enhances transparency, accountability, and informed decision making, through defining progress indicators, review tools, responsibilities, and control points all through the lifecycle of the project.

### Review Frequency

Review Type	Frequency	Purpose
Weekly Review	Weekly	Track task progress and issues
Monthly Review	Monthly	Review schedule and cost performance
Phase Review	End of each phase	Approve deliverables and next phase
Pilot Review	Pilot phase	Validate system readiness
Deployment Review	Post-deployment	Confirm system stability

### Project Status Monitoring Table

Review Area	Progress Indicator (KPI)	Review Tool	Responsible Role	Control Action
Schedule	Planned vs actual milestones	Gantt Chart	Project Manager	Adjust timeline
Cost	Budget vs actual cost	Cost Report	Project Manager	Apply cost control
Development	Feature completion rate	Project Dashboard	Team Leads	Reprioritize tasks
Quality	Number of defects	Defect Log	QA Lead	Fix critical issues

IoT Performance	Device uptime	IoT Monitoring Tool	IoT Engineer	Replace / recalibrate
Training	Training completion rate	Attendance Record	Training Coordinator	Schedule additional sessions

The Project Manager will check general progress of the project by reviewing the schedule and cost performance, it will ensure that milestones are met within deadlines and budgets and take corrective actions in terms of timeline modification or cost control. Team Leads will monitor the progress of development by measuring the rates of features delivered and rescheduling the tasks to ensure that the project goals are met. The QA Lead will be responsible to control the quality of the products by tracking defects and making sure that the most important problems are managed in time. The IoT Engineer will make sure that device performance is monitored by checking system uptime and taking appropriate remedial measures including changing and recalibrating devices where needed. The Training Coordinator oversees the training progress and makes the users ready by checking the attendance records and planning further training sessions when necessary.

## Control Points

<b>Control Point</b>	<b>Purpose</b>	<b>Decision Outcome</b>
Requirements Sign-off	Validate user requirements and scope	Proceed to design
Design Approval	Confirm system architecture and UI design	Proceed to development
Development Review	Verify feature completeness and quality	Continue or rework
Pilot Acceptance	Evaluate system performance and user feedback	Approve deployment
Go-Live Approval	Confirm system readiness	Official system launch

### **6.3 KEH BAN NING (CB23137)**

## 6.4 BAGABER ABDULRAHEEM (CB22016)

### 6.4.1 Progress Indicators (KPIs)

KPI Category	Progress Indicator	How It's Measured	Target / Trigger
Schedule	Milestone completion rate	tasks completed vs planned (WBS/Gantt)	Trigger if behind plan by >10%
Cost	Budget variance	Actual spend vs planned budget	Trigger if overrun risk appears
Quality	Defect density & closure rate	defects found, closed per week	Trigger if defect backlog increases
Technical Readiness	Module completion status	Student app, technician app, admin portal, IoT, cloud readiness	Trigger if any critical module slips
User Readiness	Pilot feedback & training completion	UAT results + users trained	Trigger if acceptance issues recur

### 6.4.2 Review Tools and Evidence

Review Area	Tool / Method	Evidence Output
Schedule Tracking	WBS + Gantt chart	Updated timeline, milestone status
Task Progress	Weekly progress updates from owners	Weekly progress report
Issues / Bugs	Issue & defect tracking log	Bug list, severity, resolution status
Testing Readiness	Test reports (unit/integration/UAT)	Test summary + pass/fail metrics
Deployment Readiness	Deployment checklist + environment verification	Go-live readiness report

### 6.4.3 Responsibilities and Accountability

Role	Review Responsibilities	Reporting To
Project Manager	Chairs reviews, approves actions, escalates high issues	Client/University Management
System Analyst	Confirms requirements coverage and scope compliance	Project Manager
IoT Engineer	Reports sensor/MQTT integration status and hardware readiness	Project Manager
Development Team	Reports development progress, defects, and fixes	System Analyst / Project Manager
System Administrator	Validates operational readiness, access control, stability for go-live	Project Manager

#### 6.4.4 Control Points

<b>Control Point</b>	<b>Project Phase</b>	<b>Key Checks (Evidence Reviewed)</b>	<b>Decision Authority</b>	<b>Decision Outcome</b>
Requirements Approval Gate	End of Phase 1	Approved requirements, UI/UX designs, scope baseline	Project Manager, Client Rep	Proceed / Rework
IoT Integration Gate	End of Phase 2	Sensor installation results, MQTT stability tests, data accuracy checks	Project Manager, IoT Engineer	Proceed / Fix Issues
Development Completion Gate	End of Phase 3	Feature completion, integration tests, defect status	Project Manager, System Analyst	Proceed / Extend Dev
Pilot Acceptance Gate	End of Phase 4	UAT results, user feedback, resolved critical issues	Project Manager, System Admin	Proceed / Extend Pilot
Deployment Readiness Gate	Start of Phase 5	Security checks, training completion, documentation readiness	Project Manager, University Mgmt	Go-Live / Delay

## 7.0 Project Reporting Plan

### 7.1 WAN NOOR DINA BINTI MEOR AHMAD SHUKRI (CB22001)

#### 7.1.1 Stakeholder Reporting Matrix

Each report is tailored to the specific information needs and technical level of the recipient.

Stakeholder	Report Type	Format	Frequency	Target Audience	Escalation Channel
Project Sponsor	Executive Status Report	PDF / Presentation	Monthly	Overall project progress, budget status (RM950,000), and high-level risks	Steering Committee
University Management	Management Progress Report	Dashboard	Monthly	Milestones achieved, schedule status, and key deliverables	Project Manager
Development & IoT Teams	Technical Progress Report	Task Board	Weekly	Task status, technical issues, and bug trends	Technical Lead
System Administrator	Issue and Risk Log	Shared Online Dashboard	Real-time	Issue description, impact, severity, and	Project Manager

				assigned owner	
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### 7.1.2 Integrated Change Control

All changes, corrective actions, and defect repairs are evaluated across all knowledge areas to ensure they are realistic and beneficial to the university.

- **Change Requests:** Any modification to the scope, schedule, or budget must be formally submitted and evaluated for impact before approval.
- **Escalation Protocol:** Issues are resolved at the lowest possible level. If an issue impacts the 11-month timeline or RM 950,000 budget, it is escalated to the Project Sponsor or Steering Committee.
- **Issue Management:** All identified project issues are recorded in the Issue Log and assigned a responsible owner for resolution.

## **7.2 MUHAMMAD HARIZ HAIKAL BIN NORISMAN (CB23130)**

The project reporting plan establishes the way the project information is relayed to the various project stakeholders to foster transparency, decision making, and control during the project lifecycle. Reporting is based on the needs of the stakeholders and relates to the specific performance indicators, including progress, cost, quality, risks, and system readiness.

Key Stakeholders for this project: -

- i. Client Management
- ii. Project Sponsor
- iii. Project Manager
- iv. Development and IoT teams
- v. Quality Assurance Team
- vi. Campus Administrators and Technicians.

### Stakeholders-Specific Reporting Plan

<b>Stakeholder</b>	<b>Report Type</b>	<b>Report Format</b>	<b>Content Summary</b>	<b>Frequency</b>	<b>Escalation Channel</b>
Project Sponsor	Executive Status Report	Summary document	Overall progress, major risks, budget status	Monthly	Escalate to steering committee
Client Management	Management Progress Report	Dashboard with brief report	Schedule, cost, risks, milestones	Monthly	Escalate via Project Manager
Project Manager	Detailed Project Report	Detailed report	Task status, issues, risks, changes	Weekly	Escalate to sponsor if required
Development Team	Technical Progress Report	Task board with sprint report	Feature completion, blockers	Weekly	Escalate to Project Manager
IoT Engineer	IoT Performance Report	Monitoring dashboard	Device uptime, sensor issues	Weekly	Escalate to technical lead
QA Team	Quality Report	Defect log	Defect trends, test results	Weekly	Escalate critical issues immediately
Campus Users	Deployment & Training Update	Email or briefing	Deployment status, training info	As required	Escalate via helpdesk

## Reporting Frequency Summary

Frequency	Purpose
Weekly	Track operational progress and issues
Monthly	Review performance, risks, and budget
Phase-End	Approve deliverables and milestones
Ad-hoc	Address critical issues or risks

## Escalation Channels

The project escalation channels are organized in such a way that the issues and risks are resolved at the right level of authority depending on their magnitude, magnitude, and the urgency. The escalation is graded and thus allows a rapid solution without disrupting the upper management unnecessarily.

## Escalation Levels and Channels

Escalation Level	Issue Type	Trigger Condition	Escalation Channel	Decision Authority
Team Level	Minor operational issues	No impact on schedule or cost	Team meetings or Task board	Team Lead
Project Level	Schedule delays, moderate cost variance	Risk of milestone slippage or budget deviation	Weekly status report or Direct meeting	Project Manager
Management Level	High-impact risks, scope or budget changes	Cost overrun, critical risk exposure	Management report or Escalation email	Project Sponsor
Steering Committee	Critical project threats	Project objectives at risk	Emergency meeting or Formal briefing	Steering Committee



### 7.3 KEH BAN NING (CB23137)

### 7.4 BAGABER ABDULRAHEEM (CB22016)

A structured project reporting plan is established to ensure timely, accurate, and role-specific communication throughout the Smart Campus Maintenance Management System project. Reports are tailored to stakeholder needs, delivered at defined frequencies, and supported by clear escalation channels to address issues promptly and effectively.

#### Stakeholder-Specific Reporting Plan

Stakeholder	Report Type	Format	Frequency	Delivered By
University Management	Executive Project Status Report	Summary dashboard + brief report	Monthly	Project Manager
Project Manager	Integrated Project Status Report	Detailed report (schedule, cost, risk)	Weekly	Team Leads
System Analyst	Requirements & Scope Compliance Report	Checklist + change log	Phase-end	Development Team
IoT Engineer	IoT Integration & Performance Report	Technical report + logs	Bi-weekly (Phase 2)	IoT Engineer
Development Team	Development Progress & Defect Report	Issue tracker + summary	Weekly	Development Team Lead
System Administrator	Deployment & Operational Readiness Report	Readiness checklist	Phase-end	System Administrator
QA / Testers	Testing & Quality Report	Test summary + defect metrics	Per test cycle	QA Lead

#### Escalation Channels

Issue Severity	Escalation Path	Response Time
Low (minor delay, cosmetic defects)	Team Lead → Project Manager	Within 3 working days
Medium (schedule risk, recurring defects)	Project Manager → Client Representative	Within 2 working days
High (security risk, major delay, system failure)	Project Manager → University Management	Immediate (within 24 hours)

#### Reporting Governance

- All reports follow approved templates to ensure consistency.
- Reporting accuracy is validated by the Project Manager before distribution.

- Historical reports are archived for audit and reference purposes.
- Reporting effectiveness is reviewed periodically and refined if required.