

GOVERNMENT COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)

COIMBATORE – 641 013



22CES613 - DESIGN THINKING LABORATORY

RECORD

This is to clarify that this record is Bonafide compilation of work carried out as part of Design Thinking Laboratory by the Class of **Civil B** during the 6th semester of B.E. Civil Engineering Program in the Academic Year 2024 – 2025.

Date:

(Member 1)

(Member 2)

(Member 3)

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Design Thinking Method

Introduction to Design Thinking

Design Thinking is a problem-solving framework that places human needs at the centre of innovation. It combines empathy, creativity, and rationality to meet user expectations and deliver functional, meaningful solutions. Unlike traditional problem-solving approaches that focus primarily on technical feasibility, Design Thinking begins with understanding users' real problems and aspirations.

This approach has gained prominence in diverse fields such as education, healthcare, business, and public policy. By focusing on how users experience problems, Design Thinking helps to develop solutions that are not only innovative but also practical and desirable.

Key Stages of the Design Thinking Process

Design Thinking typically follows five key stages. These stages are not always linear and can often overlap or repeat as needed.

❖ Empathize

This stage focuses on understanding users through observation, interviews, and interaction. The goal is to gain deep insights into their experiences, needs, and pain points.

❖ Define

Collected insights are synthesized to define a clear and actionable problem statement. This step ensures that the problem addressed user-focused and rooted in real needs.

❖ Ideate

Multiple ideas are generated through brainstorming sessions and creative techniques. Quantity is encouraged initially, as diverse solutions often lead to innovative outcomes.

❖ Prototype

Ideas are transformed into simple, tangible representations. These can be sketches, mock-ups, or digital models designed to explore how solutions might work in practice.

❖ Test

Prototypes are tested with users to gather feedback, identify improvements, and refine the solution. This helps ensure the final output is practical, usable, and well-aligned with user expectations.



1. Empathize

The Empathize stage is the first and most crucial step in Design Thinking. Here, the goal is to develop a deep understanding of users — their feelings, needs, and challenges — by seeing the problem through their eyes. This phase helps uncover insights that aren't obvious at first glance.

To gather this understanding, designers use a variety of methods, such as:

- **User Interviews:** Open-ended conversations that reveal personal experiences, frustrations, and desires.
- **Observation:** Watching how users interact with products or environments in their natural settings to spot hidden pain points.
- **Empathy Mapping:** A visual tool organizing what users say, think, feel, and do to build a holistic picture of their mindset.
- **Personas:** Fictional characters representing typical users, helping keep the design focused on real human needs.
- Empathy-building can also include immersive techniques like shadowing users in their natural environments to deeply understand their challenges and behaviours

This phase requires active listening, patience, and the ability to suspend judgment. The richer the empathy developed here, the more effective the solutions in later stages.

2. Define

Once user insights are gathered, the Define phase helps make sense of the information and frame the problem clearly.

Key activities include:

- **Affinity Diagramming:** Grouping user data into themes to identify core issues.
- **Point of View (POV) Statements:** Clear problem definitions that combine user, need, and insight
- **'How Might We' Questions:** Open-ended prompts that encourage creative problem-solving
- A clear problem statement should be framed in a user-centered manner, focusing on *what* needs to be solved rather than *how* to solve it.

The Define stage ensures the team focuses on the right problem, setting a clear direction for brainstorming and prototyping.

3.Ideate

The Ideate phase is where creativity and innovation come alive. After clearly defining the problem, the goal is to generate a wide range of ideas without judgment or limitations. This openness encourages novel solutions that might not have been considered otherwise.

During this stage, common techniques include:

- **Brainstorming:** Teams quickly generate many ideas, aiming for quantity over quality to spark unexpected concepts.
- **Mind Mapping:** Visual diagrams connecting ideas and themes to explore relationships and expand thinking.
- **SCAMPER:** A method that prompts thinking through Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, and Reverse to reinvent existing solutions.
- **Sketching and Storyboarding:** Drawing rough concepts or user journeys to communicate ideas visually and concretely.
- Brainstorming sessions can be enhanced by incorporating methods like SCAMPER or mind mapping to stimulate diverse ideas
- Encouraging 'wild ideas' without judgment allows teams to explore unconventional possibilities that might lead to innovative solutions.

The ideation process benefits from diversity in the team, encouraging different perspectives to foster richer creativity. It's important to create a safe space where all contributions are valued, no matter how unconventional

4.Prototype

Prototyping turns ideas into tangible forms, making abstract concepts real enough to test and improve. These prototypes can be simple or complex depending on the project stage and goals.

Key aspects of prototyping include:

- **Low-Fidelity Prototypes:** Quick, inexpensive models such as paper sketches, wireframes, or mock-ups used to explore ideas and gather early feedback.
- **High-Fidelity Prototypes:** More detailed and functional versions resembling the final product, helpful for in-depth user testing.
- **Iterative Development:** Building, testing, and refining prototypes in cycles to gradually improve based on user responses.
- **Storyboards and Role Play:** Using narratives or acting out scenarios to visualize user interactions and identify pain points.
- Prototypes do not need to be fully functional; low-fidelity models such as paper sketches or role-playing can be just as effective early on.

Prototyping is not about perfection but learning. It encourages experimentation and reveals unforeseen challenges early, saving time and resources in the long run.

5. Test

The Test phase is crucial for validating the effectiveness of the prototype with real users. It involves observing and gathering feedback on how users interact with the prototype, what works well, and where challenges arise. Testing helps identify usability issues, uncover hidden assumptions, and understand whether the solution truly addresses the user's needs.

Common approaches in testing include:

- **Usability Testing:** Watching users perform tasks with the prototype to evaluate ease of use and intuitiveness.
- **Surveys and Interviews:** Collecting qualitative feedback directly from users to understand their experiences and perceptions.
- **A/B Testing:** Comparing two versions of a solution to determine which performs better.
- **Field Testing:** Deploying prototypes in real-life settings for authentic user interaction.
- Testing is not a one-time event but a continuous feedback loop that involves observing user interactions, collecting feedback, and refining accordingly.

Test results provide actionable insights that guide further refinement. It is important to maintain an open mindset, seeing feedback as valuable input rather than criticism

Iteration

Iteration is the process of refining the design based on feedback from testing. Design Thinking is inherently cyclical, encouraging repeated cycles of prototyping, testing, and improving until the solution optimally fits user needs.

Iteration involves:

- **Analyzing Feedback:** Systematically reviewing test data to identify patterns and prioritize improvements.
- **Making Adjustments:** Updating the prototype to address issues, enhance features, or pivot the approach.
- **Retesting:** Validating changes through subsequent rounds of testing to ensure improvements are effective.
- **Continuous Learning:** Embracing a mindset of ongoing development rather than one-time delivery.
- Each cycle of iteration improves the solution incrementally, helping to align it more closely with user needs and practical constraints.

This cycle may repeat several times, as each iteration deepens understanding and hones the solution. Ultimately, iteration helps transform ideas into user-centered products or services that deliver real value.

1. Empathize Phase

To understand the skill gap between college and industry, user research was conducted involving 45 students and 8 working professionals (college seniors). A Google Form was circulated to collect data on user experiences, needs, and expectations. The research also included an analysis of the current college curriculum to identify gaps in real-world applicability.

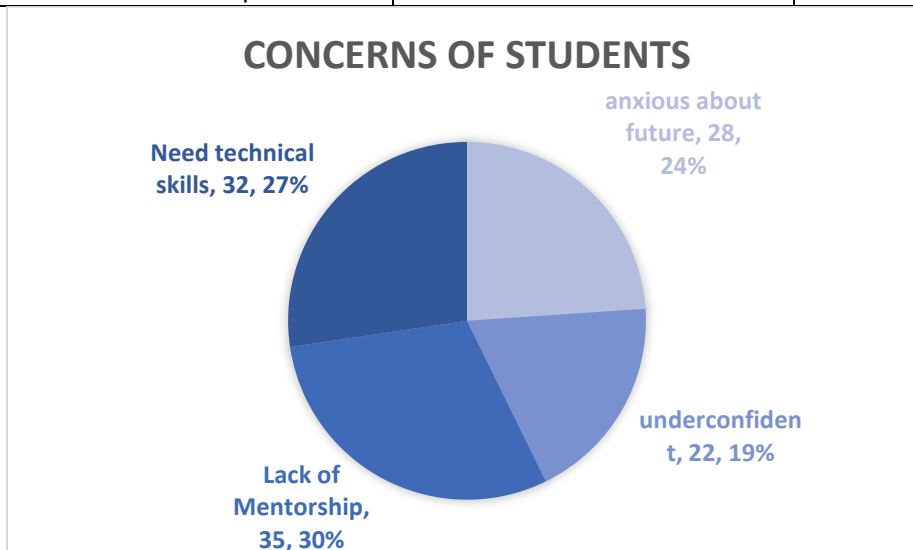
1.1 Methods Used

- Online surveys via Google Forms
- Curriculum analysis
- Experience sharing from recent graduates

1.2 Data Collected

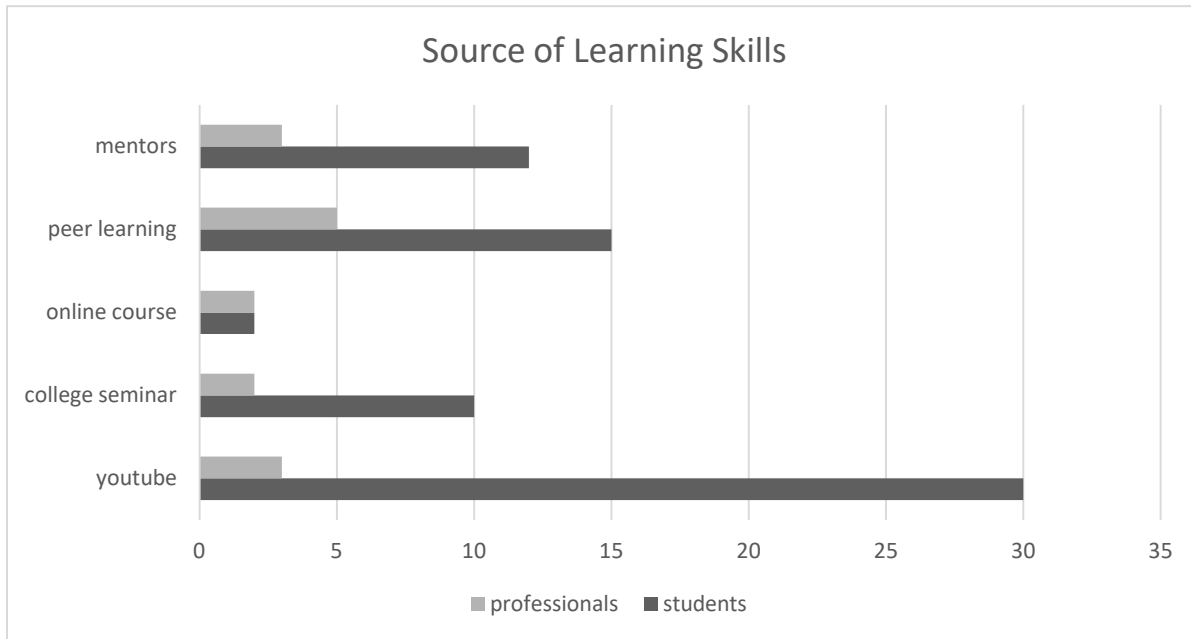
Survey insights based on multiple questions to understand career concerns and mentorship needs.

Concern	Students (45)	Professionals (8)
Anxious about future	25	3
Underconfident	20	2
Lack of mentorship	30	5
Need technical skills	28	4
Lack of industrial exposure	32	6



"Lack of industrial exposure" and "mentorship" emerged as the top concerns. These two needs alone account for more than 50% of total responses.

Source of learning	Students (45)	Professionals (8)
YouTube	30	3
College seminars	10	2
Online courses	2	2
Peer learning/ group work	15	5
mentors	12	3



Students mainly rely on self-learning and peer groups. This highlights the need to improve mentorship and formal guidance for students.

1.3 Key Insights

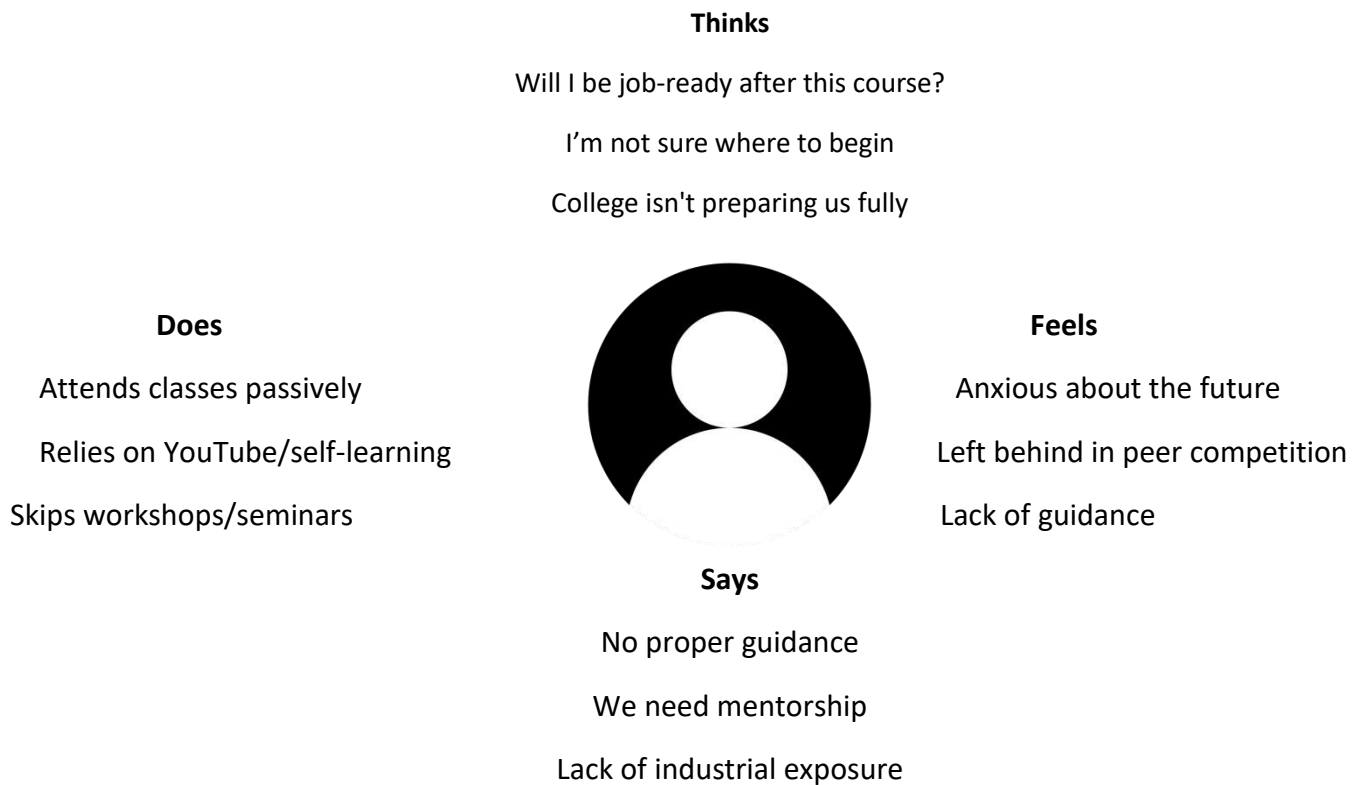
- Emotional Needs: Students feel anxious and underconfident about facing the job market.
- Behavioural Needs: Lack of engagement in skill-building activities due to unclear direction.
- Functional Needs: Desire for structured mentorship, technical upskilling, and real-time exposure to industry practices.

1.4 User Observations

- Most students mentioned "no proper guidance" and "lack of mentorship."
- Professionals stressed the gap between academic learning and real-world work.

1.5 Empathy Mapping

To deepen our understanding of students and professionals, we created an empathy map capturing their thoughts, feelings, behaviours, and pain points. This tool helps visualize the emotional and practical challenges they face in career readiness, guiding us toward targeted solutions that address real user needs.



2. Define Phase

The empathy research revealed that students across different goals — whether preparing for placements, competitive exams, or entrepreneurship — face a common struggle: lack of proper skill direction, mentorship, and real-world exposure. This gap prevents them from confidently preparing for their future.

2.1 User Persona

Name: Civil Engineering Students (3rd Year)

Background: Students with varied career goals — some aim for competitive exams, others seek placements or want to start businesses

Goals:

- Become job-ready through practical learning
- Prepare for government exams with clarity
- Develop entrepreneurial mindset and leadership

2.2 Pain Points:

- “We don’t have proper mentors to guide us.”
- “There’s no clarity on what skills the industry expects.”
- “We rely on seniors or online sources for basic understanding.”

2.3 Point of View (POV) Statement

We met students who are ambitious but confused. They want to succeed — through jobs, exams, or startups — but lack structured mentorship, practical learning, and clear direction. They need a system that bridges classroom learning with real-world skill-building in a guided, consistent way.

2.4 Additional Insight

Many students expressed that their current learning is heavily theory-based, with very limited exposure to hands-on activities or real-time problem-solving. They feel disconnected from industry expectations and uncertain about how to align their skills accordingly. The absence of regular interaction with professionals or structured mentorship programs leaves them directionless and underconfident.

2.5 Problem Statement

Students feel unprepared for life after college due to poor mentorship, outdated academic exposure, and lack of real-time industry interaction. They need a structured, guided approach to skill-building that aligns with their career goals.

3. Ideate Phase

During the brainstorming stage, a total of 20+ unique ideas were generated. The ideation method used was open brainstorming sessions with students allowing free flow of thoughts without judgment. Ideas were noted, grouped, and refined through multiple discussions.

3.1 Key Ideas Generated

- Startup Garage lab
- Skill Hub (club)
- Credit system for startup attempts
- “Problem Wall” – monthly real-world challenges
- Demo Days for student innovations
- Open-access Idea Bank
- Department-level startup initiatives
- Weekly tech sessions with industry
- Reverse internships
- Mentorship wheel (faculty, industry, alumni)
- Monthly founder panels
- Alumni mentor hub
- Lunch & learn with professionals
- Engineer-in-Residence
- Shadow programs

- Failure stories from entrepreneurs
- Innovation points system
- Student-led mini consultancy
- Campus market for student products

Selection Criteria:

The final idea was selected based on feasibility, potential impact, and originality. Concepts that could be realistically implemented within college, drive real skill development, and offer long-term value were prioritized.

3.2 Chosen Concept: Skill Hub

Skill Hub was selected as the most promising solution. It is a dedicated club/lab designed to bridge the gap between academics and industry. It includes elements like mentorship circles, industry challenges, hands-on sessions, and student-led projects. It stood out due to its scalable model, multi-goal alignment, and ability to run continuously with existing college resources.

4. Prototype Phase

To represent the Skill Hub concept, a low-fidelity poster prototype was created using Canva and Photoshop. The poster visually demonstrates how the club operates, outlining its structure, core components, and student flow through various activities.

Tools Used

- Canva – for layout and design elements
- Photoshop – for refining visuals and adding highlights

4.1 Key Features Modelled

- Clear club structure (mentor circle, student groups)
- Weekly 3-hour sessions for hands-on training
- Monthly industry/alumni sessions
- Mini-project flow and student learning path
- Visual icons for mentorship, industry exposure, peer learning
- A simple workflow showing how students progress inside Skill Hub

Note: Attached are the poster prototypes that visually illustrate the Skill Hub concept and its core features.

5. Test Phase

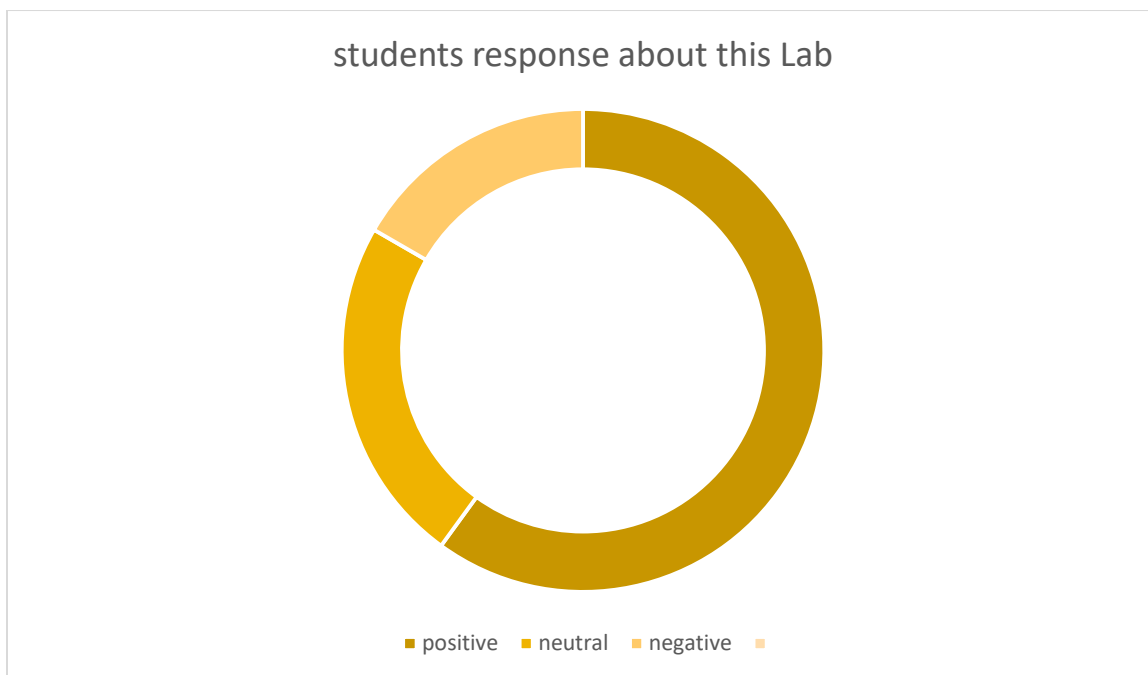
The Skill Hub prototype was informally tested by drawing parallels with the current Design Thinking Lab setup, where students collaboratively solve real-world problems in groups — just like Skill Hub’s core idea. This environment provided a practical context to evaluate how such a model might function in a real academic setting.

5.1 Testing Methodology

- Observation-based testing within the Design Thinking Lab
- Feedback collected from students
- Focus on how students engaged in group tasks, mentorship flow, and response to hands-on learning

5.2 User Feedback

We collected informal feedback through observations and discussions with 60 students participating in the Design Thinking Lab. The following chart summarizes their responses regarding group work, learning methods, and clarity of sessions, providing key insights into the prototype’s effectiveness and areas for improvement.



Based on the informal testing and discussions with peers during the lab sessions, the following observations were made regarding the Skill Hub concept:

What Worked:

- Students were interested in working in group
- Rather than conventional Labs they liked this new approach
- Peer learning and mentor support were seen as motivating and practical

Areas for Improvement:

- Session plans and how students take turns in different roles need to be clearer.

5.3 Insights

The test validated that a Skill Hub-like structure encourages active participation and group ownership. The informal nature of Design Thinking Lab served as a realistic, small-scale testbed for Skill Hub's concept. Feedback will be used to enhance the prototype with better time-based structuring and clearer activity flow.

6. Conclusion

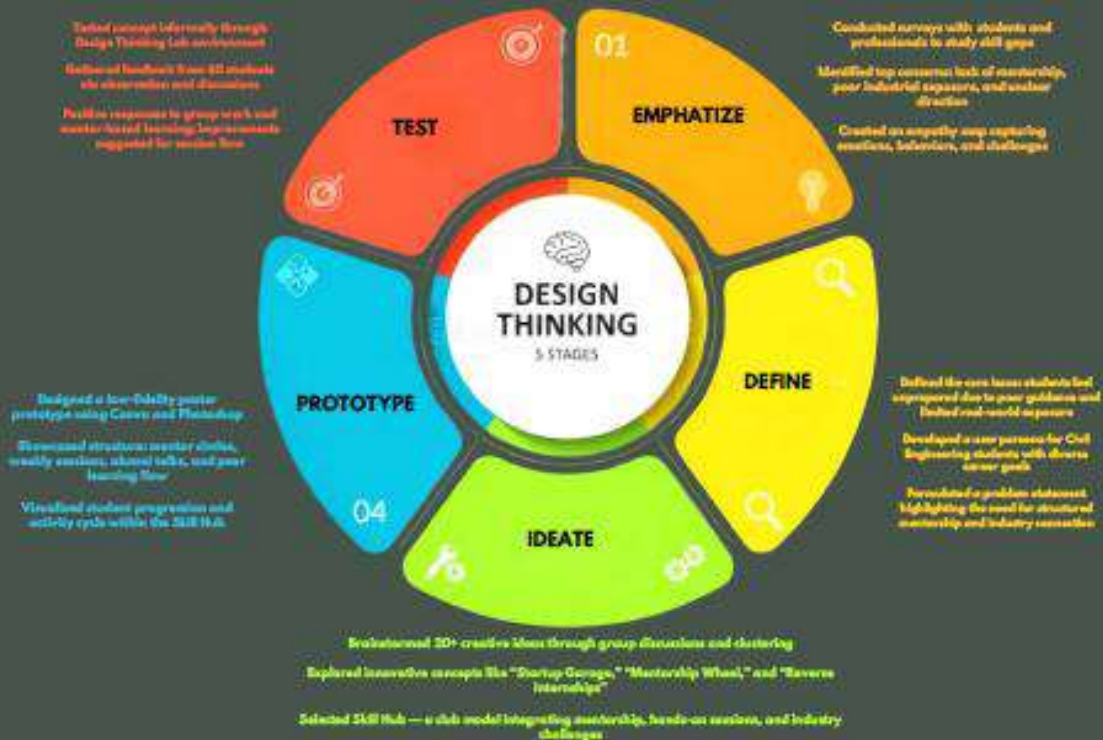
Sustainable Development Goal Achieved: **SDG 4 – Quality Education**

This Initiative aligns with SDG4: Quality Education, by enhancing practical skills, mentorship and preparing students for real world challenges

By repeating this lab model with structured improvements, or launching Skill Hub as a separate club, the initiative can gain more traction.

Refined session planning and clearer role rotation will boost student engagement. Gradually, this model can evolve based on feedback and real-time trials with consistent iterations, we can bridge the gap between academic learning and industry expectations.

PROBLEM ID : 1 BRIDGING THE SKILL GAP BETWEEN INDUSTRY AND INSTITUTION



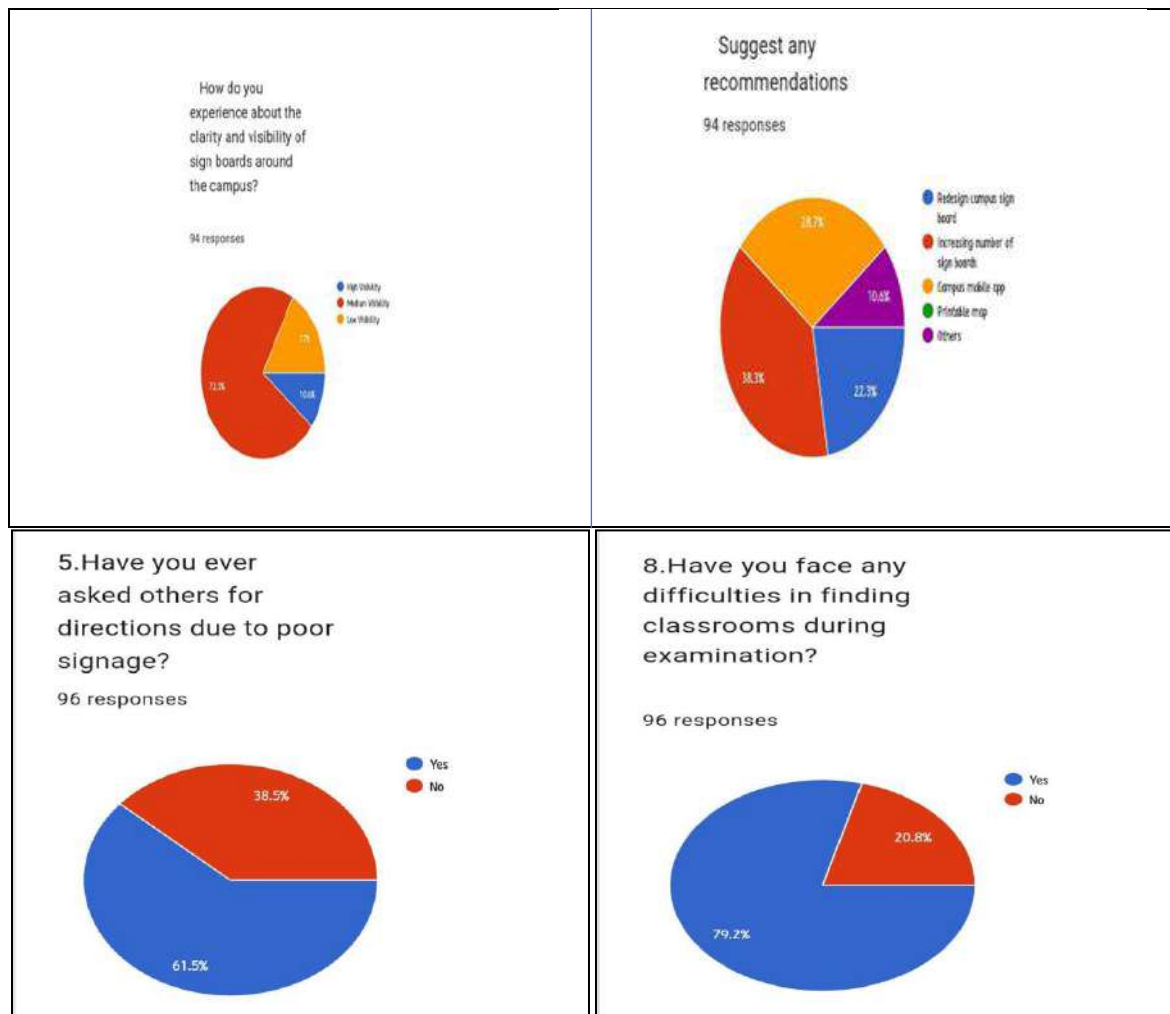
1. EMPATHIZE PHASE:

Understand the current experiences, pain points, and needs of users navigating the campus. Focus on identifying emotional, behavioural, and functional user needs. A Google Form was circulated to collect data on user experience, needs and expectations.

1.1 METHODOLOGY:

- Conducted interviews with students, faculty, visitors, and staff.
- Performed observational walks around campus during peak and off-peak hours.
- Collected feedback via surveys and Google Forms.

SURVEYS COLLECTED FROM THE STUDENTS DURING EMPATHIZE PHASE



1.2 OBSERVATIONS:

- First-time visitors often feel lost or confused.
- Inconsistent signage styles lead to misinterpretation.
- Lack of visibility and clarity, especially at night or in bad weather.
- Digital natives desire mobile-friendly navigation aids.

Decision points in

- wrong places.
- Parking for faculties and students are quite confusing.
- Faded or illegible writings on signs.
- Wayfinding system which is not maintained properly.

1.3 ANALYSIS:

From the analysis of signboards in our college campus ,the following observations were made :

Total Number of Sign Boards in our college campus	36
Number of damaged Sign Boards in our college campus	04
Number of Improper Sign Boards in our college campus	06
Number of Unwanted Sign Boards in our college campus	02

1.4 KEY INSIGHTS:

EMOTIOANAL NEEDS:

People need to feel confident that they are going in the right way, reduced stress and anxiety.

BEHAVIOURAL NEEDS:

Users want to get from a point with minimal confusion that can help them choose a path quickly.

FUNCTIONAL NEEDS:

Easy understandable text and symbols, appropriate font size and placement of sign boards.

1.5 EMPATHY MAPPING:

Empathy mapping is a great tool to understand the users' experience with signage and way findings. Below is an empathy map tailored for this context. It is divided into the typical four quadrants—Says, Thinks, Does, and Feels.

1. SAYS:

"I can't find where I am supposed to go."

"These signs are confusing?"

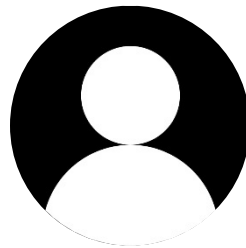
"Why isn't there a map here?"

2. THINKS:

"Will I be late because I can't find it?"

"Why didn't they design this better?"

"Should I ask someone?"



3. DOES:

Frequently stops to look at signs

Ask staff for direction

walks back and forth

4. FEELS:

Anxious, stressed or frustrated.

Embraced or hesitant to ask for help.

Overwhelmed in large and complex environments

2. DEFINE PHASE:

Summarize critical user problems based on empathy findings. To design and implement a clear, consistent and user-centred signage and way finding system that enhances navigation, reduces confusion, supports accessibility, and improves the overall user experience across the space. End with a Point of View (POV) statement that guides ideation.

2.1 POINT OF VIEW STATEMENT:

A first-time visitor navigating a large, unfamiliar campus needs clear, consistent, and inclusive signage because they feel confused, anxious, and disoriented when trying to find their destination without guidance.

2.1.1 ALTERNATE POINT OF VIEW:

A student running late to class needs quick, easily visible directional signs because they don't have time to stop and figure out where to go.

2.2 NEEDS IDENTIFIED:

- Clarity – Information must be easy to read and understand quickly.
- Visibility – Signs should be placed where they are clearly seen (eye level, well-lit).
- Consistency – Uniform design, colours, fonts, and symbols throughout the space.
- Relevance – Information must be accurate and updated regularly.
- Intuitiveness – Signage should guide users naturally without confusion.
- Strategic Placement – Located at decision points, entrances, and exits.
- Emotional Comfort – Reduce stress and build user confidence with reassuring signs.
- Inclusivity – Multilingual and culturally sensitive to accommodate diverse users.
- Durability – Use materials that withstand environmental conditions and wear

2.3 PROBLEM STATEMENT:

The absence of clear and consistent signage and wayfinding on the college campus leads to confusion, delays, and frustration among students, staff, and visitors. It makes navigation difficult, especially for newcomers, negatively impacting the campus experience, accessibility, and overall efficiency. An improved, user-friendly wayfinding system is essential to enhance navigation and create an inclusive, welcoming environment.

3. IDEATE PHASE:

Generate a wide range of creative ideas and solutions to address the user needs and problems defined earlier.

3.1 IDEAS GENERATED DURING BRAINSTORMING:

- Colour coded zones.
- Digital QR scanning.
- Interactive Digital kiosks.
- Mobile app integration.
- Standardized signage design.
- Floor and wall markings.
- Multilingual signs.

- Wayfinding volunteers or help desks.
- Name boards with illumination.
- Map boards at key points.
- Parking and vehicular directional signs.

3.2 KEY ACTIVITIES:

Brainstorming Sessions- Encourage diverse ideas:

- From digital solutions (apps, interactive kiosks) to physical innovations (color-coded zones, 3D signs).
- Use techniques like mind mapping or “How Might We” questions (e.g., “How might we make signage clearer for first-time visitors?”).

Sketching and Concept Development:

- Create rough drafts of layout and placements.

Explore Technology Integration:

- Consider augmented reality way finding via smartphones.
- QR codes linked to maps and real-time directions.

Inclusive Design Ideas:

- Multilingual signs and universal icons.

Selection criteria:

Reason for choosing the ideation model: Due to its wide advantage over other methods. The advantage includes; Cost effective implementation, user-friendly and accessible, space saving, real time information, environment friendly, time saving.

To avoid the difficulties faced by the students in the campus and to reduce the anxiety, the room numbers are placed in individual buildings at the entrance.

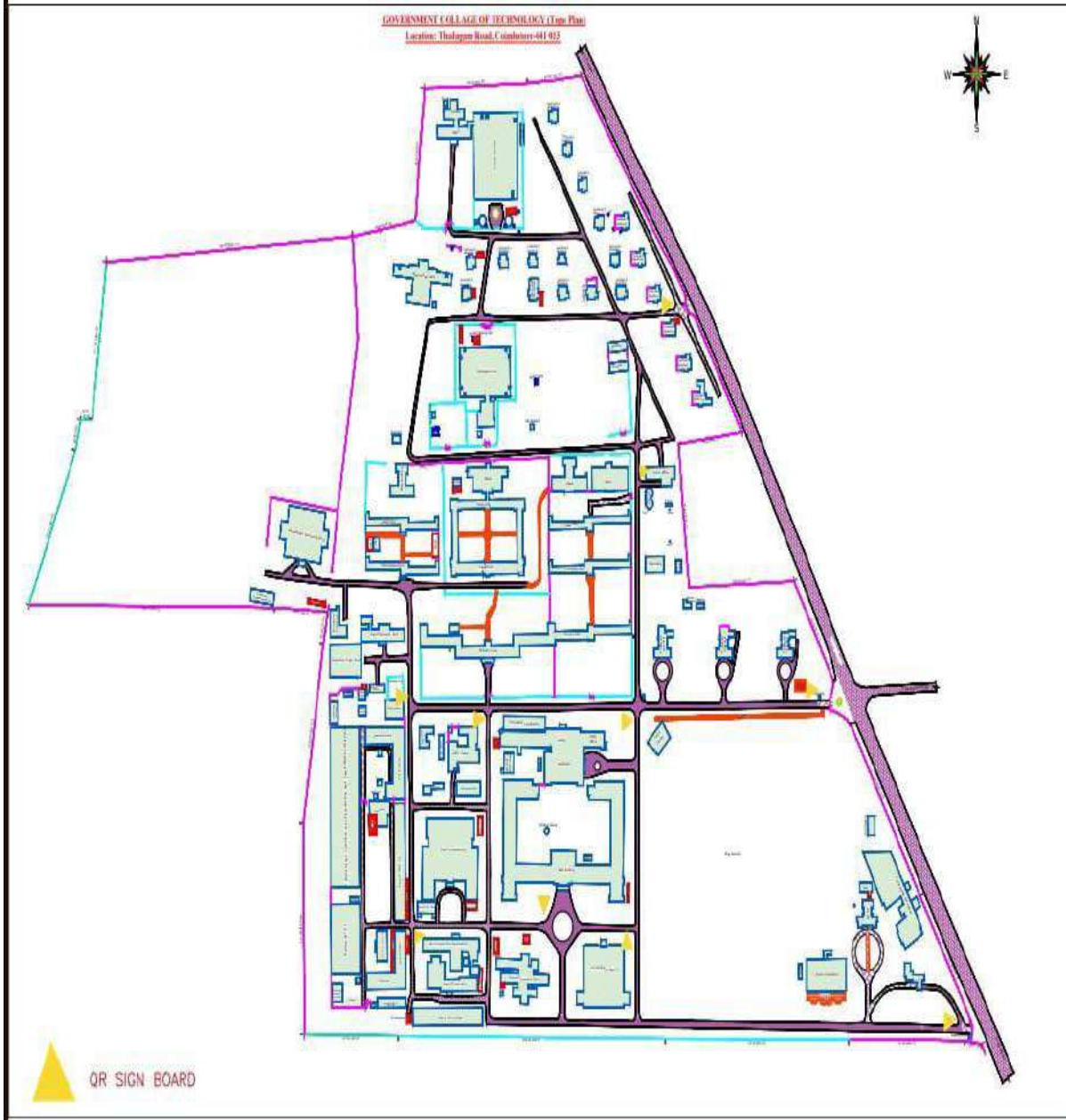
Bilingual languages (Tamil, English) are provided in the signboards for people who find difficulties in reading English, which will also help the parents as well as non-teaching faculties.

4. PROTOTYPE PHASE:

To develop and test a user-friendly, efficient QR code scanning experience that delivers clear, accessible navigation information.

The placement of the sign boards containing the Digital QR Scanning, in the college campus was designed using the AUTOCAD Software and the generation of the QR from the Google maps was done with the URL link.

Also, by providing bilingual languages (Tamil, English) on the sign boards will help the people with lack of English knowledge. By creating room numbers, for the respective departments and blocks in the access points



SIGN BOARDS INSTALLED IN THE COLLEGE LAYOUT

4.1 MATERIALS USED:

Acryl is a popular material owing to its low cost and high durability. It can be colourful or monochrome, transparent or opaque. It is often used as a more convenient and affordable alternative to glass. You can create a QR code and place it on various acrylic surfaces.

4.2 QR CODE RATIO:

A general guideline is to make the QR code 1/10th the size of the expected scanning distance. For example, if people will be scanning from 10 feet away, the QR code should be at least 1 foot square.

4.3 DIGITAL PROTOTYPE:



FOR COLLEGE LOCATION



FOR HOSTEL LOCATION

5. TEST PHASE:

5.1 USER TESTING:

Ask real users to:

- Scan the QR.
- Follow the digital directions to a destination.
- Give feedback on ease, clarity, speed, and any confusion.

5.2 SCANNABILITY TESTING:

- Test QR codes using different smartphones (Android, IOS) and camera apps.
- Ensure they work under various lighting conditions and at different distances.
- Check for issues like glare (especially on acrylic/glossy surfaces).

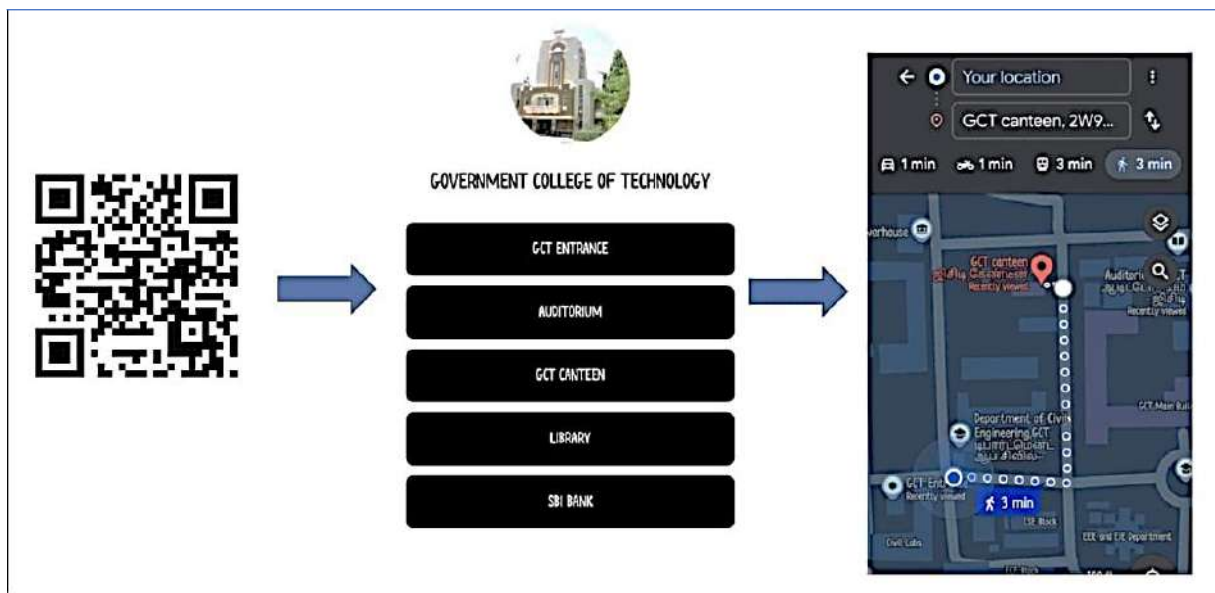
5.3 LINK FUNCTIONALITY:

- Ensure the QR code redirects to the correct location/map page.
- Confirm the URL loads quickly and reliably.

5.4 CONTENT USABILITY:

- Test the landing page.
- Mobile-friendly layout.
- Easy navigation.
- Visual clarity (maps, instructions).

5.5 TESTING OF PROTOTYPE:



SAMPLE TAKEN DURING QR CODE SCANNING

5.6 USER FEEDBACK:

We collected feedback from the students for the QR Codes. They found the directions of the QR was helpful. The QR code worked well on users mobile, they scanned easily and opened up maps that helped them to find ways effectively.

5.7 PARTICIPANTS INCLUDED AND THE TESTING AREAS:

The feedback was collected from the participants includes, 30 students, 5 new visitors and few faculty members.

The testing was conducted in the areas includes,

- Main entrance to academic blocks.
- Library to State Bank of India.
- Hostel to canteen.

5.8 EXPECTED IMPACT:

5.8.1 SUCCESS RATE:

- 95% of participants reached their destination without external help.
- Average navigation time dropped by 30% in test zones.

5.8.2 AREA TO BE IMPROVED:

- Illiterates still find difficulties in navigating the college campus.
- Night Lightings need to be improved in the sign boards.

6.SUSTAINABLE DEVELOPMENT GOALS :

SDG 3 – GOOD HEALTH AND WELL-BEING

Clear signs help students and staff move safely, especially in emergencies or large campuses, reducing anxiety and injuries.

SDG 4 – QUALITY EDUCATION

Easy navigation ensures students, especially newcomers and differently-abled individuals, can access classrooms, labs, and facilities without barriers, promoting inclusive education.

SDG 9 – INDUSTRY, INNOVATION, AND INFRASTRUCTURE

Integrating smart signage (like digital QR codes) reflects innovation in campus infrastructure, improving user experience and operational efficiency.

SDG 10 – REDUCED INEQUALITIES

Multilingual and accessible signs ensure all students and visitors, regardless of language or disability, have equal access to campus resources.

SDG 11 – SUSTAINABLE CITIES AND COMMUNITIES

Well-planned way finding encourages walking and reduces vehicle reliance on campus, contributing to a more sustainable environment.

Smart Navigation System Using QR-Based Wayfinding

FOR COLLEGE

FOR HOSTEL



WAYFINDING
QR CODES

CAMPUS LAYOUT WHERE WE
PLACED QR CODES



STEP 1:



STEP 2:



STEP 3:



THIS IS HOW QR
WORKS

1 EMPATHIZE

- Understand the users' experiences, emotions, and pain points while navigating the campus.
- Conducted interviews with students, faculty, staff, and visitors.

2 DEFINE

- A first-time visitor navigating a large, unfamiliar campus needs clear, consistent, and inclusive signage because they feel confused, anxious, and disoriented without proper guidance.

3 IDEATE

- Generate creative and innovative solutions.
- Color-coded zones.
- QR code-based digital navigation.
- Multilingual and illuminated signboard.

4 PROTOTYPE

- Designed signboard placement using AutoCAD.
- Generated Google Maps QR codes linked to campus locations.
- Created bilingual signs using acrylic boards for durability.

5 TEST

- Evaluate the prototype with real users. Participants: 30 students, 5 new visitors, and staff.
- Tested in main campus, library, and hostel areas.

Results:

- 95% of users reached destinations without external help.
- Navigation time reduced by 30%.

1. EMPATHIZE PHASE

We started with the first stage of design thinking process, this stage was all about empathizing with the user. To understand user challenges, we observed and surveyed students and staff about walkway issues on campus. Many reported difficulties like uneven surfaces, water stagnation, and poor lighting. Users often avoided damaged paths by taking longer routes. These insights helped us define their emotional, functional, and physical pain points clearly.

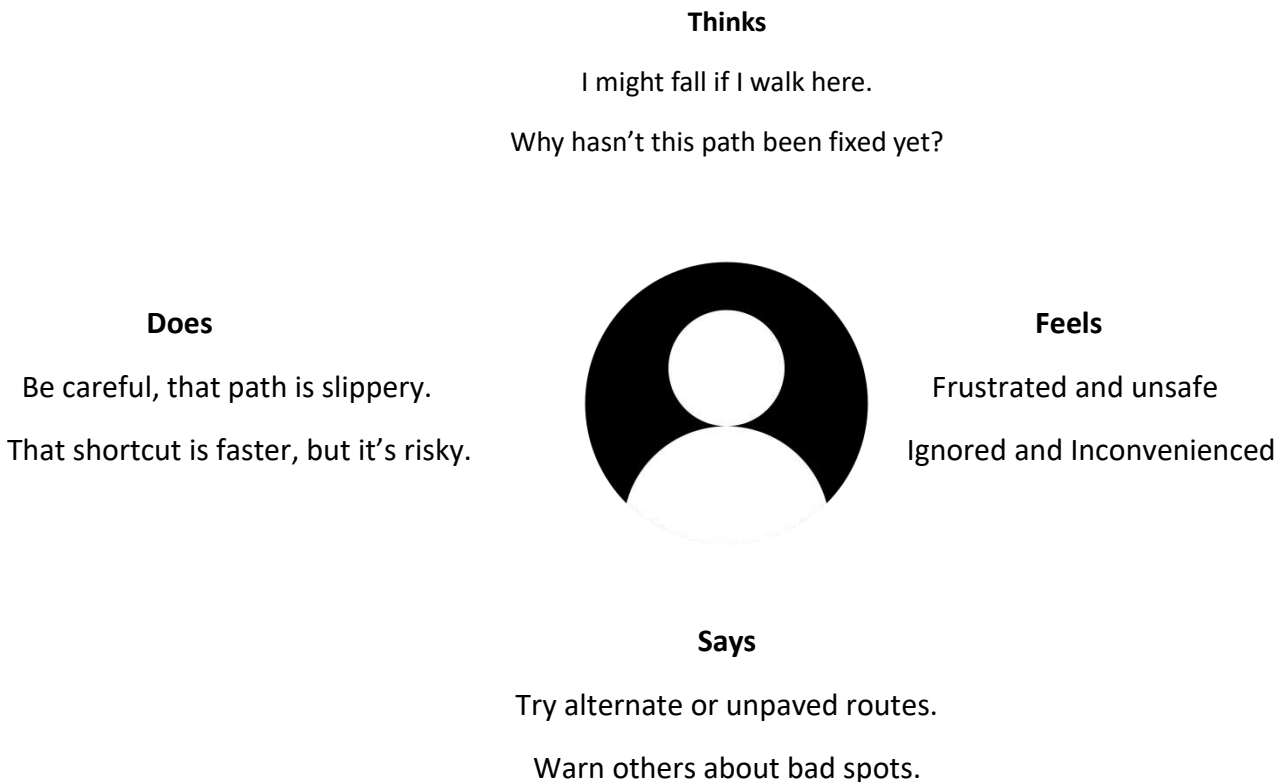
1.1 Research Methods

- Man-to-Man Interviews with students.
- Online Google Form survey.

1.2 Key Insights

- People can easily trip or twist their ankles on uneven pathways.
- Water accumulation in low spots during rain makes walking even harder.
- Faculty and staff moving between buildings take longer due to detours.

Empathy Mapping



1.3 User Observations

- Users often avoid damaged or flooded paths by taking longer, inconvenient routes.
- People with mobility challenges find it difficult to use current walkways due to uneven surfaces and lack of accessibility.



Survey Using G-forms

2.DEFINE PHASE

This stage is where I was stuck for most of my time as I was trying to make sense of all the data collected during the interview. It was tricky since I had to understand problems from the perspective of individual user. Since a well-functioning pathway is essential for safe and secure navigation in college campus.

2.1 Identified Root Cause

- Poor Planning and Design
- Lack of Maintenance and Repair
- Inadequate Signage and Navigation
- Budget constrains
- Environmental and External factors

2.2 User Persona

NAME: 2nd YEAR BOYS

BACKGROUND: Lives in Hostel; uses the pathway for navigational purpose.

2.3 Goals

- Access the Right Support and Guidance
- Ensures safe walkways, reducing accidents and injuries.
- Enhances resilience to weather-related issues like rain and flooding.

2.4 Pain Points

- It creates slippery surface
- ed mobility and accessibility
- Increased stress and fatigue

2.5 Pov statement

A college student who walks to multiple classes across campus needs safe, accessible, and clearly marked pathways because the current paths are often uneven, poorly maintained, and confusing during construction or bad weather, making daily commutes stressful, time-consuming, and sometimes unsafe.

2.6 Problem statement

Students and faculties feels uncomfortable and unsafe while walking on road sides due to inadequate pathways in college campus. They need a safe and secure pathway for navigation.

2.7 Additional insights

Students experiencing an inadequate academic pathway often face a complex mix of emotional, structural, and informational challenges. Exploration, which is crucial in the early college years, is frequently seen as risky because changing majors or paths can feel like falling behind or wasting time and money. Many students operate under a narrow definition of success tied to prestigious or “practical” majors, which can pressure them into pursuing fields that don’t align with their true interests.

3.IDEATE PHASE

Open brainstorming focusing on practical, low-cost, and impactful solutions for inadequate pathway in college campus. Ideas were refined through group discussion and user feedback.

3.1 Brainstormed Ideas

- Raised pathway: Separates pedestrians from vehicles without reducing road width.
- Curved pathway: Define subtle zones without the need for signage or barriers
- Rubberized pathway: Provide a non-slip, impact-absorbing surface to reduce falls and injuries.
- Paints: Use paint to mark lanes (e.g., walking vs. biking).
- Piezoelectric pathway: Designed to harness energy from foot traffic.

3.2 Selection Criteria

The final idea was selected based on feasibility, impact, sustainability and cost effective. The selected idea should fulfil the user needs and it should be better than already existing idea.

3.2 Picked Ideas

- **Raised pathways**

Pedways (short for pedestrian walkways) are elevated or underground walkways, often connecting urban high-rises to each other, other buildings, or the street. They provide quick and comfortable movement from building to building, away from traffic and inclement weather.

- **Curved pathways**

A **curved pathway** refers to a path or route that does **not follow a straight line** but instead **bends or arcs smoothly**. It can curve in one or more directions, forming shapes like arcs, loops, spirals, or sinuous (wavy) lines

4.PROTOTYPE

One of the prototypes created to solve the problem of inadequate pathway and walkways in college campus is shown here. Along with this, we designed a pathway layout in AutoCAD. The prototype focuses on safety navigation in a cost-effective manner.

4.1 Tools used

- Auto Cad – for design layout
- Excel - for estimation and costing.

4.2 Key features

- Raised walkways to prevent water stagnation and separate pedestrian flow from traffic.
- Curved paths designed to naturally guide movement and avoid cutting trees.
- Tactile tiles and ramps to improve accessibility for visually impaired and differently -abled users.
- Solar LED Edges and glow paint for better night-time visibility.
- Rubberized surface finish to reduce slipping and increase walking comfort.



AI Generated image of Raised Pathway

RAISED PATHWAYS

Definition

Raised pathways are elevated walkways constructed above the natural ground level. They are designed to provide safe, dry, and accessible routes for pedestrians, especially in areas prone to flooding, poor drainage, or uneven terrain.

Application

- Urban slums and low-lying residential areas
- Hostel and school campuses (e.g., Bhavani Illam Rehabilitation Project)
- Wetlands and eco-sensitive zone
- Parks, gardens, and public walkways
- Disaster-prone or flood-affected regions



AI Generated image of Curved Pathway

RAISED PATHWAYS

Definition

Curved pathways are pedestrian walkways designed with smooth, flowing curves instead of straight lines. These paths often follow natural contours of the landscape, creating a more aesthetic, relaxed, and human-centered movement through a space.

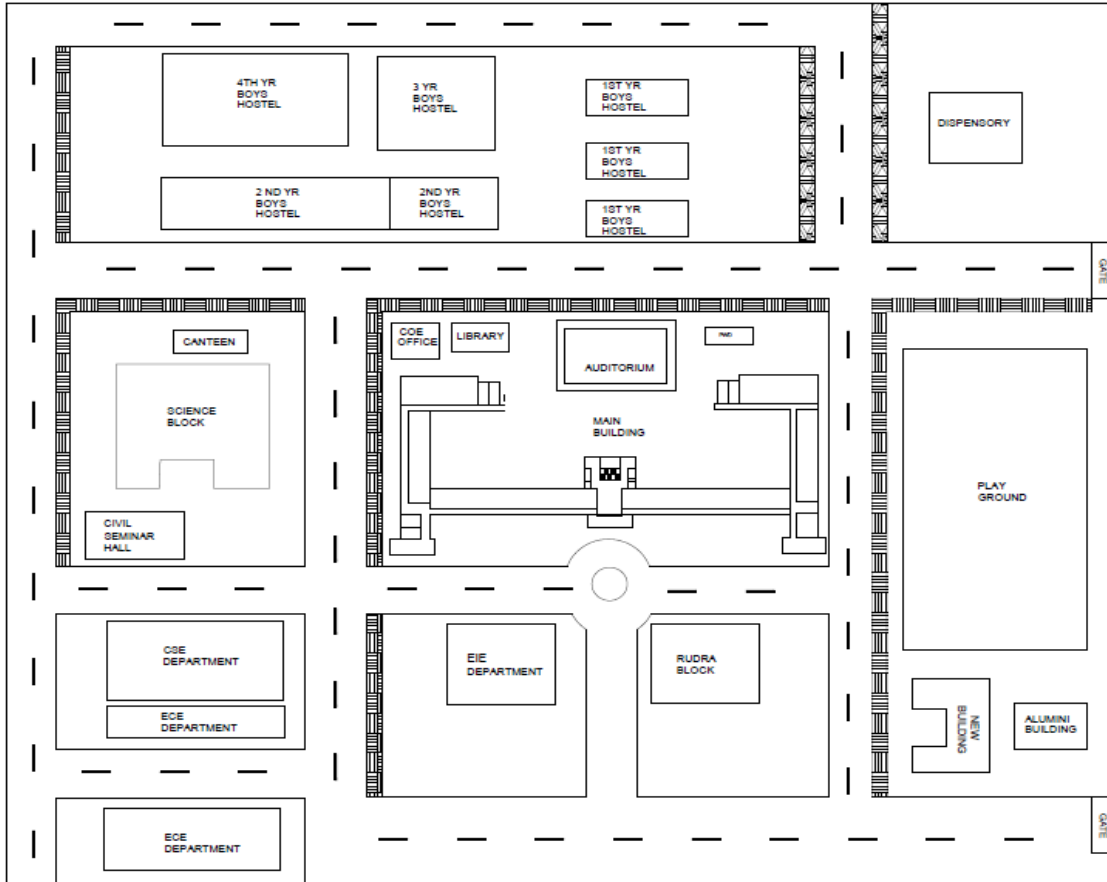
Application

- Parks and gardens – for a peaceful walking experience
- Campus or institutional layouts – to create inviting and calm environments.
- Residential areas – to improve design aesthetics and pedestrian safety.
- Public spaces and plazas – to soften urban landscapes and improve user flow.

Estimation of Pathway

ESTIMATION FOR PATHWAY M ²							
DESCRIPTION	NOS	LENGTH	BREADTH	HEIGHT	QUANTITY	UNITS	RATE (Rs)
SUBGRADE PREPARATION							
EXCAVATION	-	1	2.5	0.6	1.5	M ³	350 -400
SUB BASE	-	1	2.5	0.15	0.37	M ³	75 -100
MATERIALS							
M SAND	30				30	KG	80 - 100
TILES	11	0.3	0.3	-	11	NOS	880 -1000
RAIL	1	-	-	-		KG	285 -300
CEMENT	6	-	-	-	6	KG	45 - 50
LIGHT	1				1	NOS	150-200
PAINT	1				1	LIT	700 - 800
LABOURS COST							
SKILLED LABOUR	1	-	-	-	1	NOS	1000 -1200
SEMI SKILLED LABOUR	1	-	-	-	1	NOS	900 - 1000
UNSKILLED LABOUR	1	-	-	-	1	NOS	700 - 900
GSB LAYING & COMPACTION	-	-	-	-	1	M ²	400 -950
TILES LAYING	11	-	-	-	11	NOS	330 - 440
RAIL INSTALLATION	1	-	-	-	1	M	500 - 550
TRANSPORTION COST							
TILES	1	-	-	-	10	KM	50
M SAND	1	-	-	-	10	KM	100
CEMENT	1	-	-	-	10	KM	100
RAIL	1				10	KM	100
TOTAL							6745 - 8340

Pathway Drawing



5.TEST PHASE

To evaluate the potential effectiveness of the proposed solutions for uneven footpaths and walkways around campus, we conducted a perception-based test using a structured Google Form. Since full-scale implementation was not feasible, this test was designed to gather feedback from students and faculty based on their experiences and expectations.

5.1 Testing Methodology

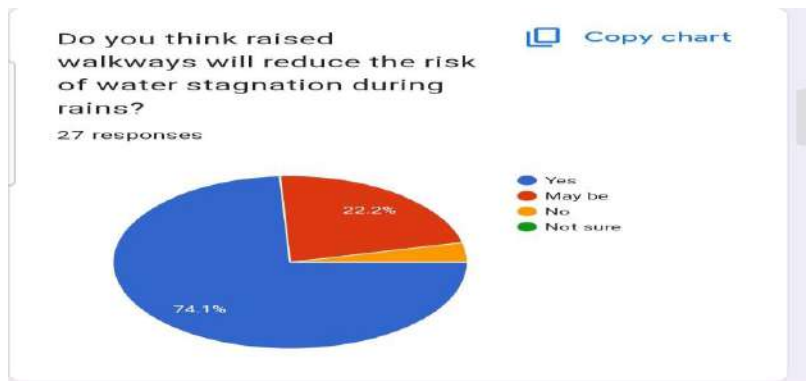
- A Google Form was circulated among students and faculty members.
- The form included 15 structured questions using multiple-choice and checkbox formats.
- The focus was on predicting the effectiveness of features like raised paths, curved walkways, tactile tiles, LED lighting, and rubberized surfaces.
- No physical prototype was implemented; responses were based on user perception of proposed ideas.

5.2 Objectives of the Test

- Understand whether users believe the proposed solutions would solve existing problems.
- Identify the most and least accepted features among the proposed ideas.
- Gather insights into users' expectations and concerns.

5.3 Sample Group

- Total Responses: 50
- Participants: Students from various departments.
- Demographic: Users who walk regularly across different parts of the campus.



SURVEY USING G-FORMS

5.4 Key Findings

- 75% of participants believed that raised pathways would reduce water stagnation and improve safety.
- 60% supported curved paths to improve navigation and preserve trees.
- 75% felt that tactile tiles and LED lighting would enhance nighttime accessibility.
- Many appreciated the idea of using rubberized paths for anti-slip and comfort.
- Common concerns included clarity on session roles, maintenance responsibility, and space constraints.

5.5 Insights

- The majority of students found the ideas logical and feasible in theory.
- Visual aids (like posters or sketches) helped participants better imagine the concepts.
- There is strong user interest and acceptance of innovative walkway features, even without real-world testing.
- Some users expressed concerns about long-term maintenance and funding feasibility, although these were beyond the test scope.

5.6 Areas of Improvement

Users suggested clearer pathway zoning and raised concerns about long-term maintenance and durability of materials.

6. Conclusion

The feedback from the testing phase indicates that the proposed ideas are well-received and considered effective by the users. Even without implementation, the testing helped validate the relevance and usefulness of features like raised paths, LED edges, curved designs, and tactile surfacing. These insights will guide the next iteration of prototype development and help prioritize features based on user trust and acceptance.

SUSTAINABLE DEVELOPMENT GOALS (SDG)

1. SDG 3 – Good Health and Well-Being

- Reduces risk of injuries by improving walkway safety.
- Encourages walking, promoting healthier lifestyles.

2. SDG 9 – Industry, Innovation, and Infrastructure

- Promotes smart, user-focused infrastructure like LED-lit paths and tactile tiles.
- Encourages innovative use of materials such as glow gravel and rubberized surfaces.

3. SDG 11 – Sustainable Cities and Communities

- Enhances accessibility and safety in public campus spaces.
- Creates inclusive and walkable environments for all users, including differently-abled individuals.

4. SDG 12 – Responsible Consumption and Production

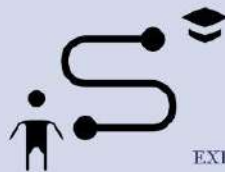
- Encourages the use of recycled and low-maintenance materials in construction.
- Focuses on durable design to reduce frequent repairs and waste.

UNEVEN FOOTPATHS

DON'T TRIP ON THE PROBLEM, DESIGN THE SOLUTION!!!



CAMPUS LAYOUT



EXISTING CONDITION



PROPOSED PATHWAY



EXISTING CONDITION



PROPOSED PATHWAY



PROTOTYPE MODEL



CURVED PATHWAY

Problem ID: 04

Parking Optimization for Students and Staffs

1. Empathize Phase

Our initial step involved engaging with 35 users including 20 students and 15 staff members. The goal was to understand their experiences, needs, and frustrations related to the current parking facilities on campus.

1.1. Methods Used:

- Direct Interviews with staff and students
- Observational studies during peak and off-peak hours
- Google Form survey with structured questions

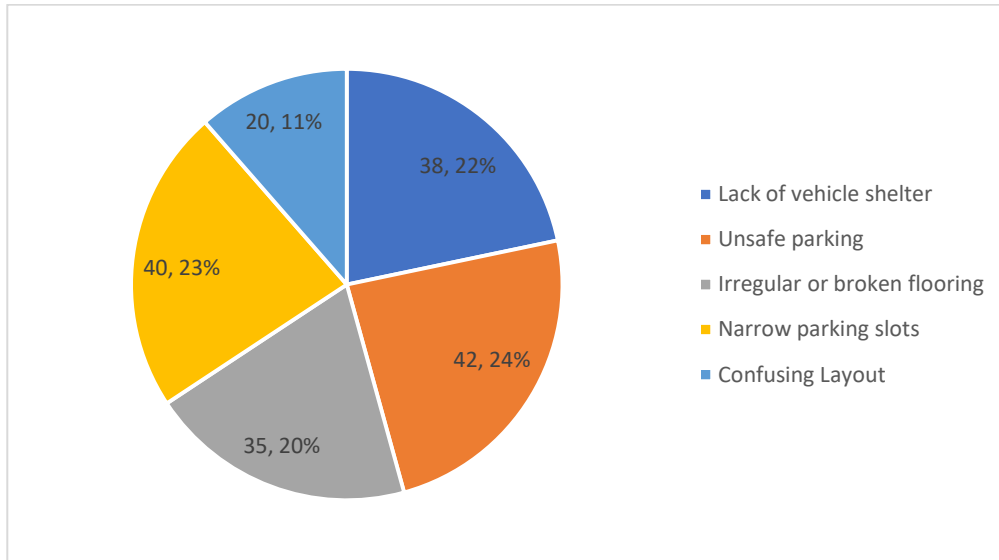
1.2. Key Insights:

- Users expressed significant dissatisfaction with the safety and accessibility of the parking area.
- Students reported fear of theft and damage due to lack of security and surveillance.
- Both groups highlighted the inconvenience of having to park far from their departments.
- Lack of shelter caused discomfort, especially during rain or intense heat.
- The existing flooring posed a risk of slipping and difficulty in maneuvering.

1.3. Data Collected:

Concern	Students (60)	Staff (30)
Lack of vehicle shelter	38	25
Unsafe parking (no CCTV/security)	42	20
Irregular or broken flooring	35	18
Narrow parking slots	40	22
Confusing layout or no clear marking	45	20

"No shelter" and "Unsafe zones" were the most mentioned issues across both user groups.



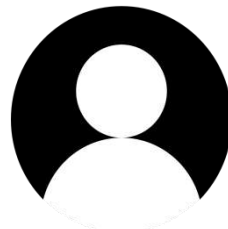
1.4. Empathy Map Summary:

Thinks

- "I wish I could park closer and under shade."
- "My vehicle might get scratched in that tight space."

Feels

Chooses alternate, unauthorized spots to park for convenience
Often parks hurriedly in unsafe conditions



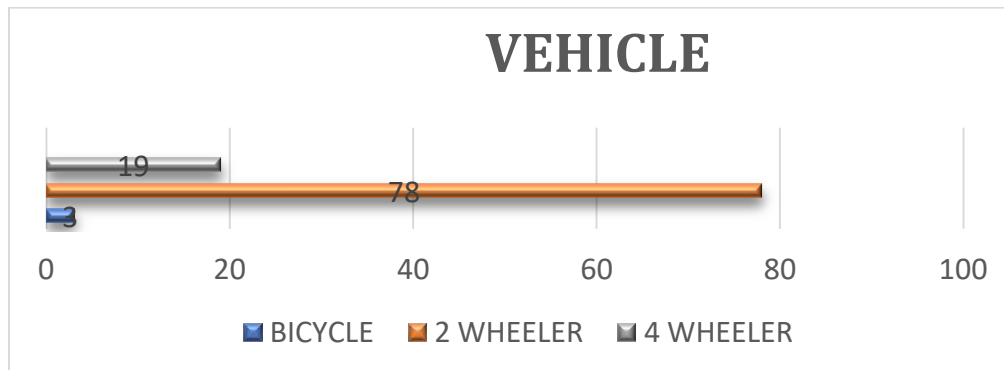
Does

Anxious about vehicle damage.
Uncomfortable during bad weather
Frustrated with current parking conditions

Says

- "There's no proper space to park near my block."
- "The floor is so uneven, it's risky."

1.5.Vehicle Users in our College Campus:



2.Define Phase

Based on our empathy findings, we formulated a clear understanding of the core user issues, which allowed us to build user personas and define the design challenge effectively.

2.1.User Persona:

Name: Faculty from IBT Department

Role: Assistant Professor, GCT

Needs: Safe, shaded, and nearby parking

Pain Points: Distance from the block, exposure to sun/rain, poor flooring, and safety concerns



2.2.Point of View (POV) Statement:

Faculty and students at GCT need a structured, safe, and weather-protected parking solution close to their academic departments because the existing parking system leads to discomfort, delays, and exposes their vehicles to damage and theft.

2.3.Additional Insight:



Additionally, we gathered information about the current parking facilities available to passengers on our college campus. As shown in the interview pictures above, the data includes responses from undergraduate and postgraduate students from the Civil and IBT departments, as well as technical and non-technical staff from the Civil Department. We also interviewed staff and students from other departments to gain a broader understanding of the parking-related issues.

2.4.Problem Statement:

From the student/staff, they want their vehicle to be parked in a shaded and secure area so that it remains safe and unaffected by weather and they need a properly maintained surface to avoid slipping or damaging their vehicle and also they want clearly marked and spacious parking slots to avoid confusion or collisions.

3.Ideate Phase

Using the insights gathered from users, our team engaged in a series of structured ideation activities. We conducted multiple brainstorming sessions using the Mind Mapping and SCAMPER techniques. A total of 14 feasible ideas were generated and evaluated on the basis of impact, cost, scalability, and sustainability.

3.1.Some key ideas included:

- Installing solar-panel shelters over parking slots
- Introducing zonal parking areas for staff, students, and visitors
- Implementing RFID-based smart access gates
- Laying interlocking tiles with proper drainage
- Adding dedicated spaces for bicycles and EVs
- Integrating CCTV systems with smart surveillance features



Multi level parking



Hydraulic parking



Parking deck



CCTV



Solar Panel



Bitumen flooring

3.2.Final Idea Selected:

A dual-zonal smart parking system:

- Zone A: On-campus parking for staff and students with secure, shaded infrastructure.
- Zone B: Newly allocated visitor parking inside the main gate, equipped with guidance systems and future provision for expansion.

This solution was chosen for its practicality, user-centric focus, and integration of sustainable technology.

4.Prototype Phase

4.1.Prototype: Smart Zonal Parking Facility

4.2.Fidelity: Low to Medium

4.3.Tools and Materials Used:

- Cardboard and chart models for layout visualization
- Figma and SketchUp for digital zoning and concept design

4.4.Zone A – Staff and Student Parking:

- Flooring with interlocking tiles and 1–2% slope for effective water drainage
- Clearly marked parking slots for vehicle organization
- Solar-powered shelters to provide both energy and weather protection
- 24/7 CCTV with night vision and motion detection for security
- Anti-rust mesh fencing around the area with RFID-based gate access
- Safety signage and emergency contact boards



Main Parking Area in our college campus

4.5.Zone B – Visitor/Public Parking:

- Dedicated zone across from the main gate for external visitors
- Open layout with guiding boards and wayfinding maps
- Shelter and CCTV similar to Zone A for uniform safety standards
- Wheelchair accessibility and provision for helpdesk



Play Ground near main entrance

4.6.Future Enhancements:

- Mobile app for real-time slot tracking and access permissions
- Bicycle zone with covered storage racks
- Landscaping using vertical gardens and eco-friendly features

This prototype holistically addresses major user concerns while remaining scalable and eco-conscious.

5.Test Phase

Testing involved 15 participants including 10 students and 5 faculty members who reviewed the prototype through a physical walk-through and digital mock-up presentation. Feedback was collected via open-ended questions and Likert-scale ratings.

5.1.Feedback Summary:

5.1.1.Positive Responses:

- Participants appreciated the structured zoning and shelter designs.

- The use of solar energy was highly valued for sustainability.
- The security elements like surveillance and RFID access were considered vital.

5.1.2.Concerns Raised:

- Some lanes appeared too narrow for safe turning.
- More directional signage was suggested.
- Students requested dedicated space for bicycles.

5.1.3.Action Taken:

- Adjusted prototype to widen lanes slightly.
- Added separate bicycle parking with roofing.
- Proposed additional visual wayfinding aids.

5.2.Conclusion:

The prototype received strong validation from users, and adjustments made post-feedback significantly improved the model's comprehensiveness.

6.Iteration Summary & Expected Impact

Post-feedback iterations included expanding lane width, designating dedicated zones for bicycles, and optimizing the layout for better guidance.

6.1.Expected Impact:

6.1.1.Short-term:

- Streamlined access and reduced traffic congestion
- Improved comfort due to shading and protection from weather
- Enhanced safety and peace of mind through surveillance

6.1.2.Long-term:

- Reduced energy consumption via solar-powered infrastructure
- Promotion of eco-friendly transport (bicycles and EVs)
- Scalable model for implementation in other campuses or public institutions

This design solution not only solves the existing problems but also establishes a future-ready system that aligns with smart and sustainable campus goals.

Sustainable development Goals

Sustainable Development Goal Achieved: SDG 11 – Sustainable Cities & Communities

This project promotes inclusive and sustainable infrastructure, encourages renewable energy usage, and supports safer public spaces.



Multi level parking



Hydraulic parking



Parking deck



CCTV



Solar Panel



Bitumen flooring

PARKING OPTIMIZATION FOR STUDENTS & STAFFS

A SMART DESIGN THINKING APPROACH



OUTCOME

- ✓ Reduced congestion
- ✓ Easy parking access
- ✓ Enhanced safety & satisfaction
- ✓ Refine solutions based on real-time data
- ✓ Reserved safety & satisfaction

Problem ID: 5

Water Conservation and Scarcity in College Laboratories and Restrooms

1 Empathize Phase

To develop effective solutions for water conservation and scarcity in college laboratories and restrooms, we need to understand the needs and problems of our users. so we made various methods of survey to gather information.

1.1 Methods used

- We interviewed the user to understand the user's problem.
- Observations are made after the interview.
- Data are collected through surveying.

1.2 Information gathered from the user

The user are Lab Assistants, Faculty Advisors, Assistant Engineer and Students.

Information gathered from lab Assistants are given below

- In geotechnical lab and Concrete lab, they said that they were suffering from lack of water during the time when the pipe got broken due to the unnecessary digging and they felt that if there is an overhead tank, it would be helpful during the time of scarcity.
- In hydraulics lab, unavailability of required sump capacity had leads to water stagnation in entire lab due to the overflow of rainwater from the sump during heavy rainfall, so they asked us to give an effective solution to conserve the stagnating rainwater.

Information gathered from Faculty Advisors are given below

- Prof. Ravathi Mam - In Environmental lab, there is a storage tank in which they are often facing an overflow from the tank and there is a leakage problem due to improper fixtures. For the requirement of distilled water, they were installed RO system in which $\frac{1}{3}^{\text{rd}}$ of water gets wasted.
- Dr. S. Periyasamy, Associate Professor and Head of Water Distribution at our college, shared that sometimes water is not available in the source, resulting in an irregular water supply from the source (Krishnampathi Lake). Additionally, the branches are connected to the main pipeline, which is controlled by a single valve connected to the main pipe.



Periyasamy sir (water distribution head)

Information gathered from Assistant Engineer are given below

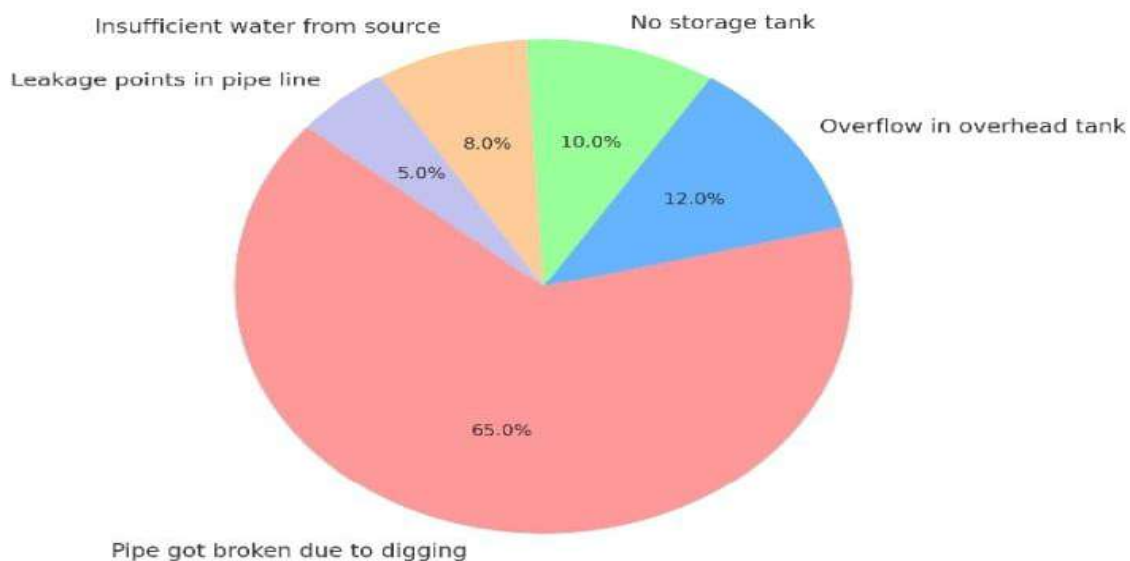
- Actual capacity of overhead tank in pump house is not sufficient for the daily demand, even though it is loaded 4 times a day. Sometimes source itself did not have enough water to supply and he said that there is no record of already existing pipe network, so that unnecessary digging will leads to damage in pipe line and also if the running time of motor exceeds the limit (> 10 hours) it will reduce the efficiency of motor and get repaired.



Assistant engineer (Government College of Technology, Coimbatore)

Information gathered from students are given below

- There are some leakage points and improper fixtures. Due to less maintenance the fittings were damaged more so that water get wasted. In boy's restroom, unwanted activities done by the students leads to damage in pipe fittings.



This pie chart represents the overall problems of the user

Empathy Map



2 Define Phase

Here we clarify and focus the problem statement based on insights gained during the “empathize” phase. According to our user point of view the major problem are briefly listed below:

2.1 scarcity is considered as major problem

- pipe get broken due to unnecessary digging around the campus
- There is no any report and photos of pipe layouts laid in our campus.
- Till now the pipe laid in our college is not replaced (it's been 50+ years) and the pipe material is made of CI (cast iron).
- In some restroom, pipes are directly connected to the source (pump house) so ,if there is no water in the source or main pipe get broken, the supply of water to the restroom get affected.
- Since the Depth of Main pipe and branches are at same level, the separation of branches into sub-branches will leads to unnecessary damage in the main pipe line.

2.2 Lack of water from the source

We're exploring an alternate source of water, a borewell installed at the Thenpennai hostel, with an alternate connection provided. However, we've identified some issues with the current water supply system:

- The actual capacity of the overhead tank in the pump house is insufficient to meet daily demand, despite being loaded four times a day.
- Prolonged motor operation (> 10 hours) can reduce efficiency and lead to repairs.

We have two motors:

1. A 25 HP motor
2. A motor with a capacity less than 25 HP

2.3 Water Wastage and Overflow Issues

- Insufficient sump capacity: During heavy rainfall, the sump's capacity is inadequate to store rainwater, causing water to enter the lab and leading to stagnation until it's drained.
- RO system inefficiency: In the Environmental Lab, the RO system used to treat saltwater for experiments wastes 2/3rd of the water.
- Overflow in restrooms: Storage tanks are not properly monitored, fixtures are not well-maintained, and leakage points have been detected.

2.4 Problem statement

Our college faces water scarcity due to a dead-end distribution system with a single valve, causing total shutdowns during repairs. Some labs lack storage tanks, while overflow from overhead tanks and poor bathroom fittings lead to wastage. These issues demand urgent improvements in water management and conservation across campus.

3 Ideate Phase

We generated a wide range of ideas to address the challenge of water conservation and scarcity in college restrooms and laboratories through a brainstorming session, where we freely discussed and noted down ideas without worrying about their feasibility or final results. These ideas were then refined through multiple discussions, allowing for a free flow of thoughts and further development.

3.1 Smart fixtures and technology

- This include replacing old fixtures with water-efficient one. We used PVC pipe wrap tape instead of thread to reduce the leakages in pipes



Thread sealed pipe



PVC pipe wrap tape

- Faucet aerators: These device mix air into the water stream, reducing water flow without affecting pressure.
- Dual-flush toilets: These toilets offer the option of using less water for liquid waste disposal.

3.2 CONSERVATION IN HYDRAULICS LAB

- The major problem in the Hydraulics Lab is rainwater stagnation due to the insufficient capacity of the underground sump. Sometimes, leaves and debris clog the channel connected to the sump, obstructing the flow of rainwater.
- Installing traps and screens can help remove debris and smaller particles from entering the storage system. However, during heavy rainfall, the rainwater overflows into the lab due to the sump's insufficient capacity.
- To address this issue, we suggest installing a well on the backside of the Hydraulics Lab to collect the rainwater that overflows from the sump. This would help to mitigate the stagnation problem and potentially provide a useful source of collected rainwater.

3.3 CONSERVATION IN OVERHEAD TANK

- The water supply to the overhead tank is pumped from an underground sump tank using a motorized pump, which is typically operated manually via a switch. However, this manual operation can lead to issues if someone forgets to switch off the pump, resulting in water overflowing from the overhead tank. To address this problem, we propose an easy-to-install, DIY IoT system that includes:
- Tank sensors to monitor water levels
- A Wi-Fi controlled switch connected to the pump
- A mobile app interface that provides users with real-time control and insights into their water consumption behavior

With this system, users can:

- Monitor the current water level in the tanks remotely
- Turn the pump on/off remotely, eliminating the risk of overflow
- Gain valuable insights into their water consumption patterns

This solution offers a convenient, efficient, and smart way to manage water supply and reduce waste.

3.4 INFRASTRUCTURE AND DESIGN INNOVATIONS

- Redesign the entire water distribution system in our college campus.
- If complete redesign process is not possible, we have to maintain the already existing pipe material. Pipe relining is a quick way to fix cracked, leaky, or old pipes. The glue material used for this process are PVC glue and CPVC glue.
- Pipe relining is a quick way to fix cracked, leaky, or old pipes.
- The glue material used for this process are PVC glue and CPVC glue.

Selection Criteria:

- The final ideas for each problem were selected based on feasibility, potential impact, originality, desirability, viability, Impact and ease of prototyping. Each idea was rated or discussed against the above criteria in group sessions. The most promising solutions were selected.

Chosen Concepts:

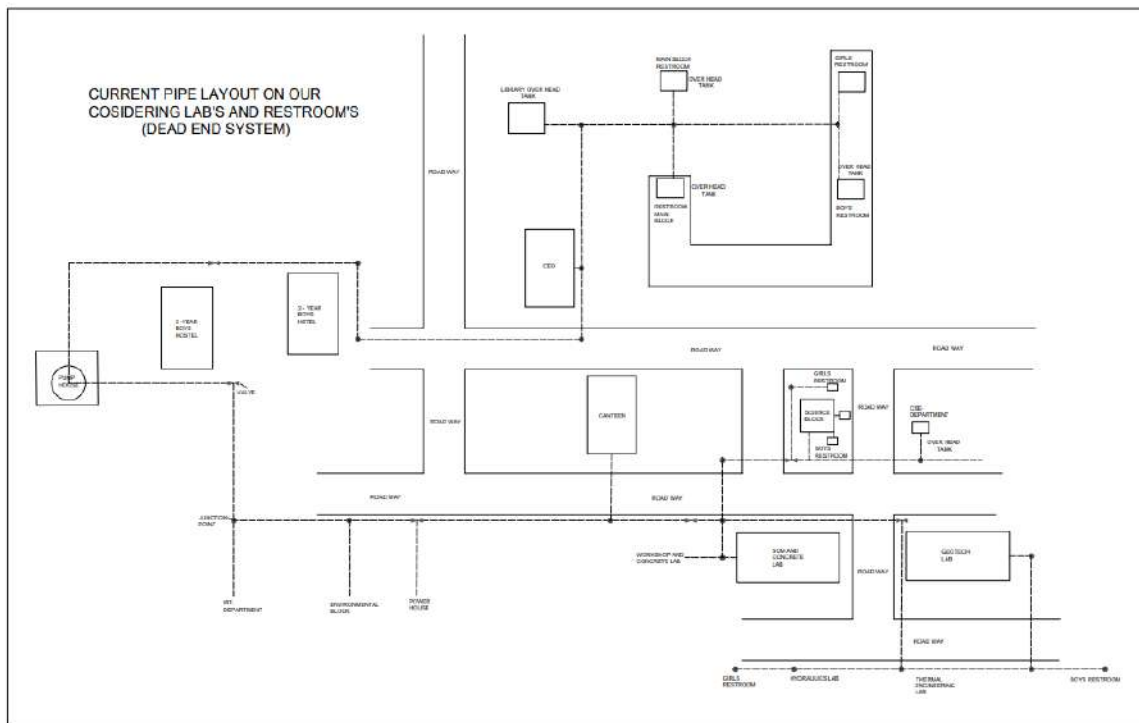
Redesign Of already existing water distribution system

4. Prototype Phase

4.1 Redesign Of already existing water distribution system

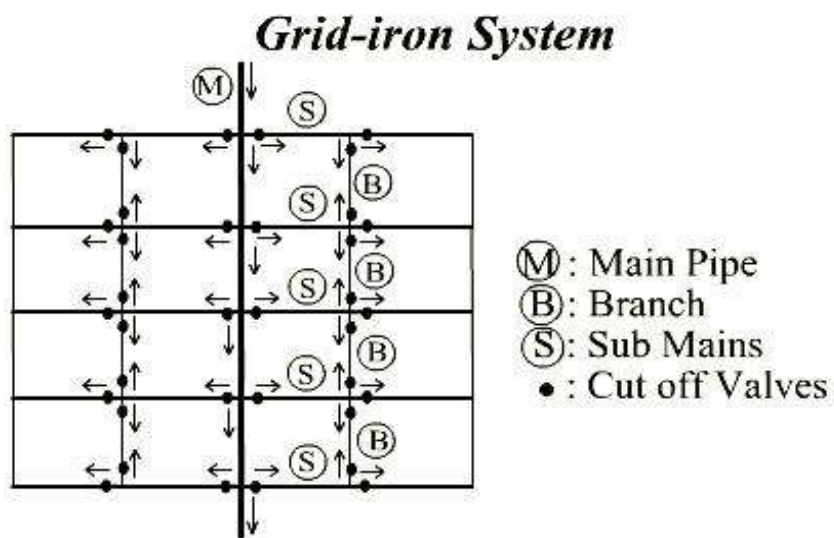
The reason why we choose this idea?

- The main problem in water scarcity is damage of already existing pipe line due to unnecessary digging.
- Already existing pipe layout was installed 70 years before.
- There is no proper record for already existing water distribution layout.
- The redesigning of already existing system will not interrupt the continuous flow of water.
- So, we thought that this solution will be more effective as compared to other solution.



The already existing pipe layout network in our college

The redesigned Water distribution Network is designed based on Grid-Iron System.



4.2 Advantages of a Grid System:

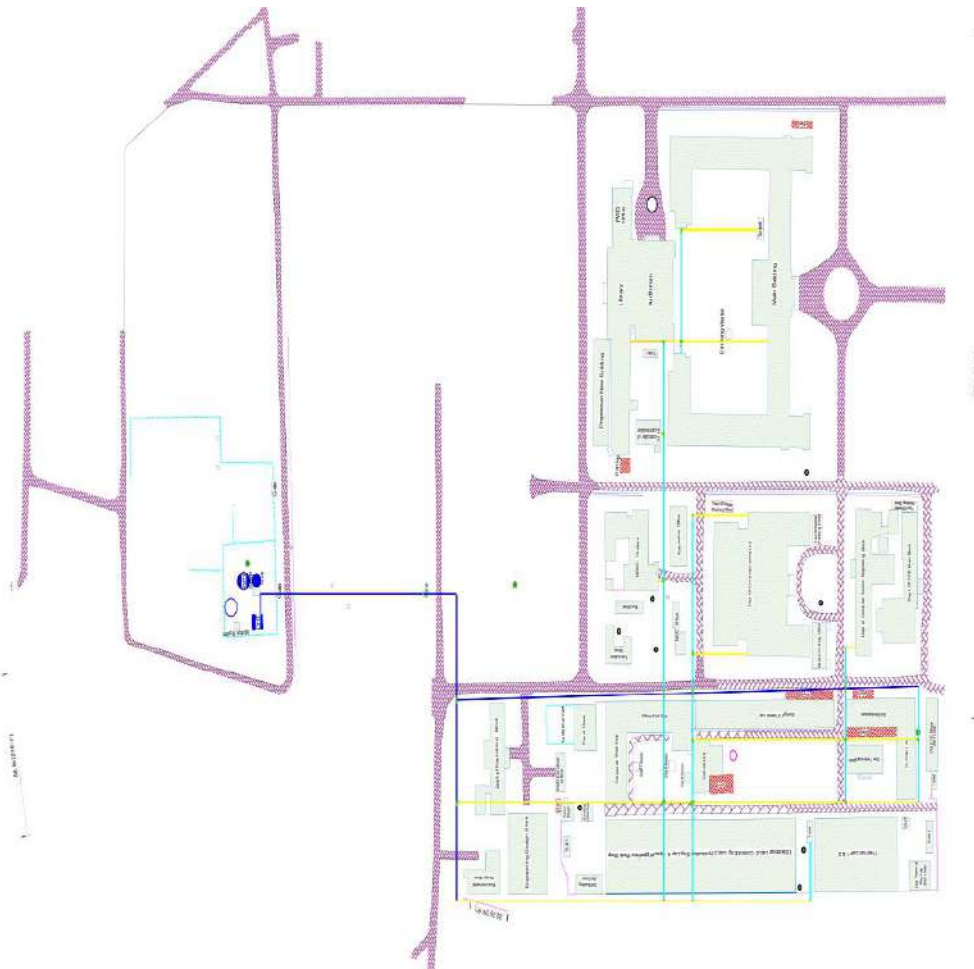
1. No dead ends and continuous circulation: Water can flow in multiple directions, reducing stagnation and ensuring continuous circulation.
2. Reliable water supply: The grid system provides a reliable water supply, as water can be sourced from multiple directions.
3. Minimal head loss: The grid system is designed to minimize head loss, ensuring that water pressure remains consistent throughout the network.
4. Sufficient water for firefighting: The grid system can provide sufficient water for firefighting purposes, making it a critical component of urban infrastructure.
5. Ease of maintenance: The grid system is relatively easy to maintain, as valves and pipes can be isolated and repaired without disrupting the entire network.
6. Suitable for well-planned cities: The grid system is well-suited for cities with a planned infrastructure, where roads and utilities are carefully designed and laid out.

4.3 Water distribution system layout

We are not designed the layout for entire college we preferred our problem concern areas like civil engineering laboratory and restroom in our college.

We have redesigned the water distribution system for our college with a focus on improving reliability and water conservation, especially in laboratories. The new layout follows a grid iron system, where pipelines are interconnected in a loop rather than ending in a single direction, unlike the previous dead-end system. This design ensures continuous water flow during maintenance or pipe repair, as water can be rerouted from multiple paths.

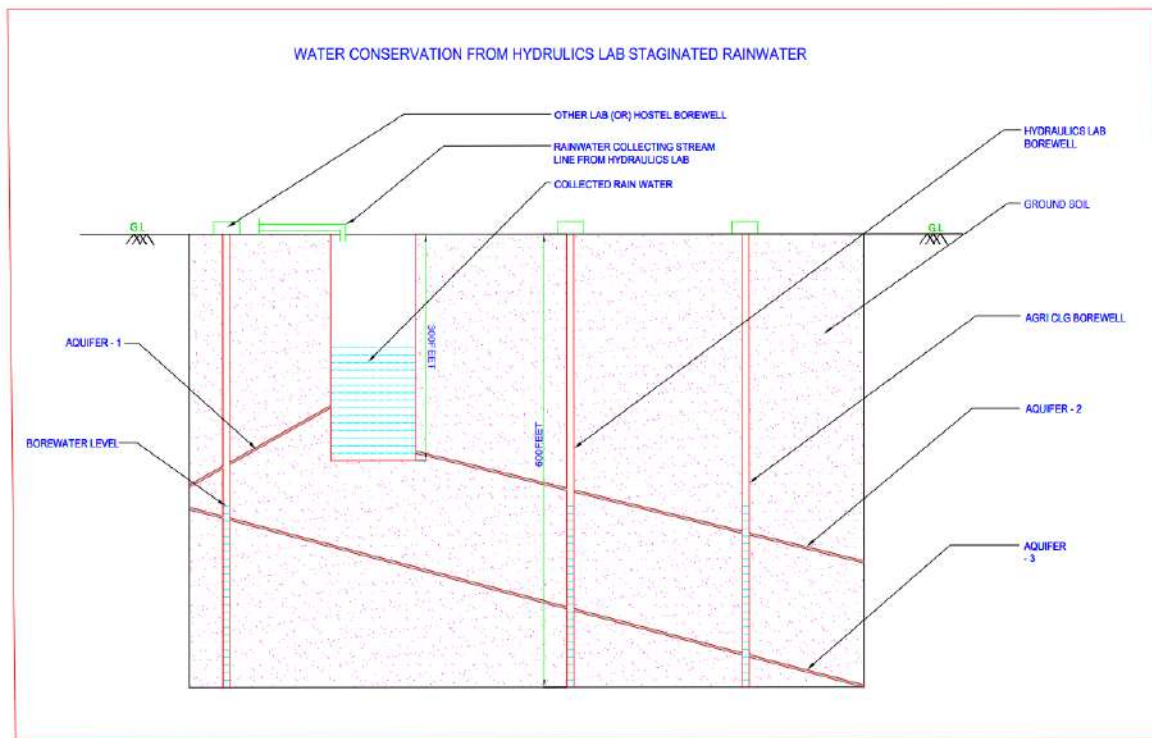
We have strategically placed valves throughout the network, allowing isolation of specific sections for repair without disrupting the supply to laboratories. This enhances operational flexibility and minimizes downtime. The redesigned system is dedicated to laboratories only, addressing their critical need for an uninterrupted water supply.



Water distribution layout

Alternate solution:

- The major problem in the Hydraulics Lab is rainwater stagnation due to the insufficient capacity of the underground sump. Sometimes, leaves and debris clog the channel connected to the sump, obstructing the flow of rainwater.
- To address this issue, we suggest installing a well on the backside of the Hydraulics Lab to collect the rainwater that overflows from the sump. This would help to mitigate the stagnation problem and potentially provide a useful source of collected rainwater.



5. Test Phase

The prototypes ideas were discussed with class students, assistant engineer, and the respective staffs. The above two solutions received positive feedback:

- The given layout was appreciated by it's convenient and continuous flow of water.
- Also received a good opinion about the solution among the student side
- A layout had already been prepared and proposed to the government, but the proposal was not sanctioned due to a lack of funds.
- The provided alternate solution also received good opinion and told that would be effective.

5.1 Area to be improved

To enhance system efficiency, sensors were added for real-time leakage detection, enabling automated monitoring and predictive maintenance. This reduces water wastage, minimizes manual checks, and ensures a continuous, reliable water supply to laboratories and restrooms.

5.2 Expected Impact

- Benefits: Our water distribution system offers continuous flow, low head loss, efficient distribution, easy maintenance, and environmental sustainability, increasing groundwater levels.
- Short-term advantages include reliable supply, reduced energy costs, and minimized waste.
- Long-term applications promote sustainable water management, increased water security, and environmental benefits. Our system addresses pain points like water scarcity, inefficient distribution, and environmental concerns, providing a reliable and sustainable solution. By optimizing water usage and reducing waste, our system ensures a steady supply for communities while promoting environmental sustainability and contributing to a healthier water table.

6.Conclusion

Sustainable Development Goal Achieved: **SDG 6- Clean Water and Sanitation**

The project's focus on water conservation and addressing scarcity in college washrooms and laboratories directly contributes to ensuring availability and sustainable management of water and sanitation for all.

The test phase validated that our proposed design effectively addresses the key issues in the existing water distribution system. While our solution is currently based on ideas, suggestions, and preliminary observations, it demonstrates strong potential for improving water reliability and conservation. The integration of features like the grid iron layout and leakage detection sensors reflects thoughtful planning. Further refinement and real-world implementation will confirm its practical effectiveness.

1. EMPATHIZE PHASE

To understand issues related to inadequate laundry and water heating systems in the hostel, user research was conducted with 111 students and the hostel superintendent, Caretaker and cleaners. Data was collected through a Google Form survey and direct observations to identify problems such as limited access to functional laundry facilities, insufficient hot water supply, and scheduling conflicts. The study also reviewed the existing infrastructure and utility provisions to determine the root causes of these deficiencies and their impact on student hygiene and comfort.

1.1. Research Methods Used

- a) Man-to-Man Interviews with hostel students.
- b) Online Google Form survey.
- c) Interview with hostel caretaker.

1.2. Key Insights

- a) Lack of washing machines leads to time-consuming and unhygienic manual washing.
- b) Boiling water manually is unsafe and inefficient.
- c) Seasonal issues exacerbate the problems (e.g., cold water in winter)

1.3. User Observation

1. Laundry Facilities:

- a. Students reported long waiting times due to a limited number of washing machines.
- b. Spotted clogging problems that leads to several health issues.
- c. Lack of Proper maintenance.

2. Water Heating System:

- a. Many students complained about having to take cold showers during winter.
- b. The existing geysers/boilers were either too few in number or too old to meet the current demand.

1.4. Empathy Mapping

The empathy map reflects real feedback and behavioral patterns observed during interviews and surveys with hostel students. It is divided into four quadrants: Says, Thinks, Does, and Feels.

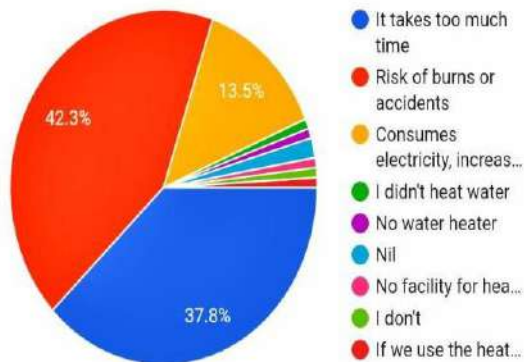


PIE CHARTS

What is the most inconvenient part of heating water manually?

[Copy chart](#)

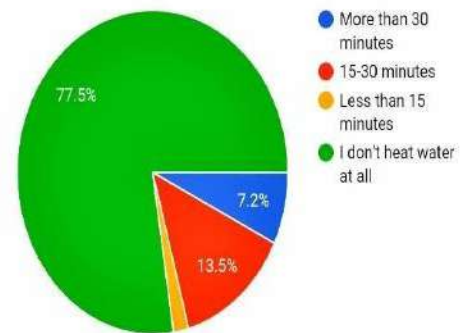
111 responses



How much time do you spend daily on heating water for bathing?

[Copy chart](#)

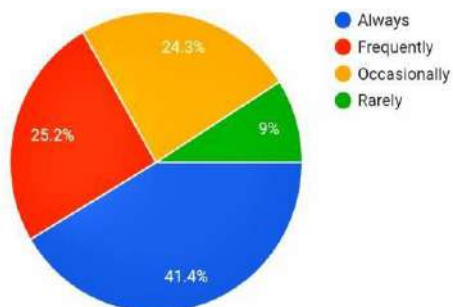
111 responses



How often do you face difficulty washing clothes due to time constraints or inconvenience?

[Copy chart](#)

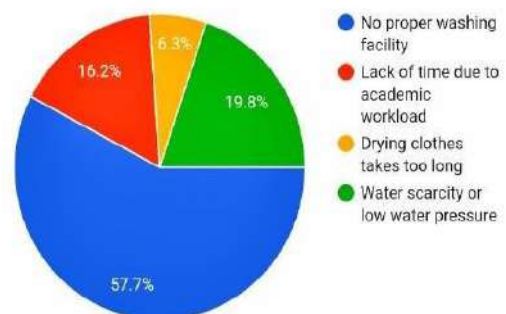
111 responses



What is the biggest challenge you face while washing clothes in the hostel?

[Copy chart](#)

111 responses



2. DEFINE PHASE

The empathy research revealed that students and staff, regardless of their daily routines—be it studying, relaxing, or managing hostel operations—face ongoing challenges with insufficient laundry and water heating facilities. Limited access to functional washing stones and inconsistent hot water supply disrupt daily comfort, hygiene practices, negatively impacting overall hostel living conditions.

2.1. Problem Statement

Hostel residents feel uncomfortable and frustrated due to inadequate laundry facilities and an unreliable water heating system. They need accessible, functional laundry services and a consistent hot water supply to maintain hygiene, comfort, and support their daily routines effectively.

2.2. User Persona

Name: Hostel Residents

Background:

Hostel residents depend on shared laundry and water heating systems for hygiene and daily routines.

Goals:

To have access to a functional, hygienic, and time-efficient laundry and water heating system.

Pain Points:

Long wait times, unsafe manual water heating, and breakdown of geysers add unnecessary stress to her day.

2.3. POV Statement

“Students in our government college hostel need a reliable, efficient, and safe laundry and water heating system because the current setup wastes time, energy, and fails to meet their daily needs.”

2.4. Key Problems Identified

- a) Frequent equipment breakdowns.
- b) Water clogging and bad odour.
- c) Insufficient hot water and power fluctuation issues.

3. IDEATE PHASE

Ideas for improving laundry and hot water facilities in the hostel were generated through open discussions focused on cost-effective, practical solutions. These ideas were further shaped by group input and resident feedback.

3.1. Brainstormed Solutions

- a) Retrofitted common laundry room using unused space
 - ✓ Unused hostel space was converted into a centralized laundry room for better utility and organization.
 - ✓ This improves access to machines and reduces congestion in individual rooms.
- b) Extension of plumbing with GI/UPVC lines and gully traps
 - ✓ Durable GI/UPVC lines and gully traps were added to support proper water flow and drainage.
 - ✓ This upgrade ensures hygiene and reduces maintenance issues.
- c) Greywater reuse via sand-gravel filtration
 - ✓ Filtered greywater from laundry is reused for non-potable purposes like gardening.
 - ✓ This promotes water conservation and sustainable hostel practices.
- d) Lint interceptors to reduce clogging
 - ✓ Lint interceptors trap fabric particles before they enter the drainage system.
 - ✓ They help prevent clogs and extend the lifespan of plumbing.
- e) Digital slot booking system for laundry machine usage
 - ✓ A mobile-based system lets students book laundry machine time slots.
 - ✓ This reduces waiting times and avoids overcrowding.
- f) Voltage stabilizers for geyser protection
 - ✓ Stabilizers protect geysers from voltage fluctuations and ensure safe operation.
 - ✓ They enhance reliability and extend appliance life.
- g) Finalized: Centralized Heat Pump Water Heating System and Lint Management
 - ✓ An energy-efficient heat pump system was chosen for consistent hot water supply.
 - ✓ Lint management was also integrated to support smooth operation.

3.2. Selection Criteria

The ideas were evaluated based on

- a) Feasibility: Ease of implementation and compatibility with existing hostel plumbing and electrical systems.
- b) Impact: Potential to enhance convenience, hygiene, and daily comfort for residents.

- c) Cost-effectiveness: Preference for low-cost solutions requiring minimal infrastructure upgrades.
- d) Sustainability: Focus on energy-efficient systems and water-saving methods to reduce environmental impact.

3.3. Picked Ideas

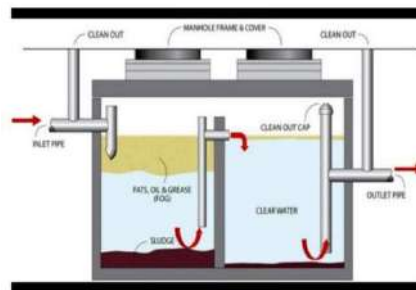
- a) Lint Interceptors.
- b) Improved layout for some hostels.
- c) Centralized Heat Pump Water Heating System
- d) water stabilizer installation along with PR Valves (Water Heating Solution)

4. PROTOTYPE PHASE

The prototype was conceptualized to address the core issues identified during user research. Two major solutions were developed:

4.1. Lint Interceptor System + improved layout for some hostels (Laundry Solution)

A physical model of a lint interceptor was proposed, showing a two-chamber unit with primary and secondary filtration. The prototype emphasized the importance of removing lint, threads, and other solid waste before it enters the main drainage system. The unit includes baffles, a filter mesh, and sludge settlement zone.



. Diagram: Lint Interceptor System

4.2. Centralized Heat Pump Water Heating System and water stabilizer installation along with PR Valves (Water Heating Solution)

This prototype concept focuses on a centralized unit capable of supplying 6000 liters of hot water daily. It consists of a heat pump, storage tank, control unit, and heat exchanger. The design ensures energy efficiency through a refrigeration cycle, consuming approximately 60 kWh/day asaving over 4000 kWh monthly compared to electric heaters

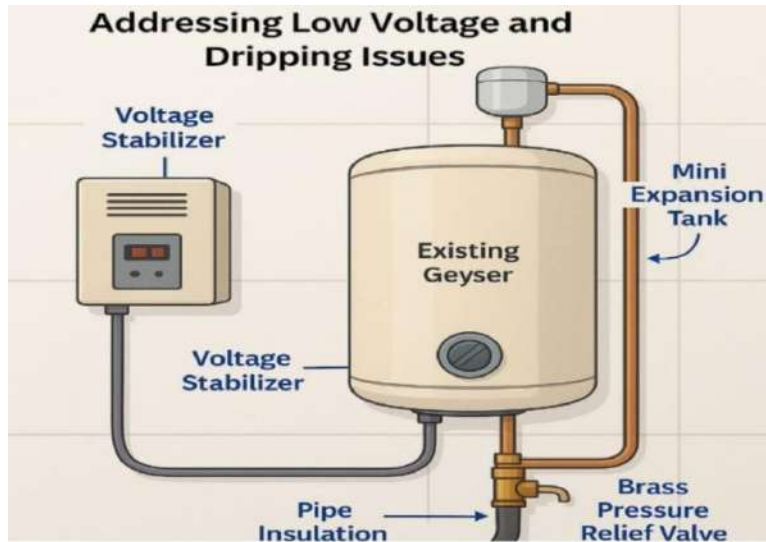
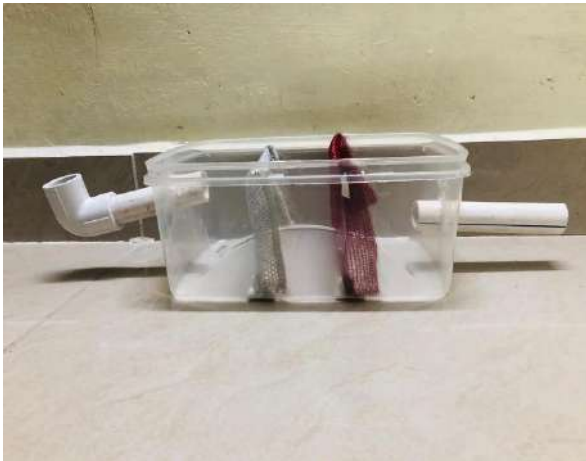


Diagram: Voltage Stabilizer + Geyser System

5. TEST PHASE

To evaluate the proposed solutions, a simulated walkthrough and feedback session were conducted with 10 students and 2 staff members. Participants reviewed diagrams and conceptual explanations.



5.1. Feedback Summary

- a) Students found the lint interceptor practical and easy to maintain, though they suggested a defined cleaning schedule.



Diagram: Centralized Heat Pump Water Heater

- b) The heat pump system was praised for energy efficiency and consistency, but installation cost was a concern.
- c) Caretakers appreciated the long-term maintenance benefits of both systems.

5.2. Iteration Summary

Based on feedback, the following refinements were suggested:

1. Include removable filter trays in the lint interceptor for easy cleaning.
2. Propose a monthly maintenance schedule to hostel authorities.
3. Add a phased implementation plan for the heat pump system to reduce upfront costs.

These changes increased the clarity, usability, and feasibility of the proposed solutions.

5.3. Expected Impact

Short-Term Impact

- a) Improved hygiene and convenience in daily laundry routines.
- b) Safe and consistent hot water access during all seasons.
- c) Reduced complaints and workload for maintenance staff.

Long-Term Impact

- a) Energy savings of up to 70% in water heating.
- b) Reduced clogging and waterlogging issues through lint filtering.
- c) Scalable and sustainable model for other hostels or institutions.

Overall, these solutions effectively address the core problem of inadequate laundry and water heating systems using a user-centered, sustainable, and technically feasible approach.

6.CONCLUSION

Sustainable Development Goals Achieved:

SDG 3 – Good Health and

Well-Being SDG 6 – Clean

Water and Sanitation Code

Statement:

Initiative Name: Hostel Hygiene & Comfort Enhancement (HHCE)

This initiative supports SDG 3 and SDG 6 by improving hostel sanitation infrastructure, specifically through modernized laundry and water heating systems. It ensures hygienic living conditions, reduces student stress, and minimizes health risks related to poor sanitation and lack of hot water.

By introducing centralized heating systems, greywater filtration, and energy-efficient appliances, the project enhances day-to-day hygiene while promoting resource conservation. Student-led feedback cycles, slot-booking systems, and operational audits will guide continuous upgrades, making this model adaptable and scalable to other institutions.

Sustainable Laundry and Water Heating Solutions for Energy-Efficient Hostel Management

CIVIL ENGINEERING PERSPECTIVE

GOVERNMENT COLLEGE OF
TECHNOLOGY COIMBATORE-
641013

EMPATHIZE

- Man-to man interviews
- Hostel caretaker interview
- Google Forms survey

Key findings

- Water heating unsafe and unreliable
- Time loss impacts

DEFINE

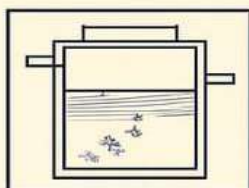
POV: Students need a reliable, efficient laundry and water heating system because the current setup wastes time and energy

HMW

- How might we reduce laundry wait times?
- How might we provide safe, energy efficient hot wa-

PROTOTYPE

- Designed Lint Interceptor System to effectively trap lint and debris; preventing pipe blockage and promoting clean water reuse



Prototype:
Lint Interceptor System

OUTCOME

Achieved energy savings of ₹91,000/month through heat pump system



Prototype:
Heat Pump System

1. Empathize Phase:

To understand ventilation issues in the hostel, user research was conducted with 250 students and the hostel superintendent. A Google Form survey and direct observations were used to collect data on discomfort, Odors, and pest problems. The study also reviewed hostel infrastructure to identify causes of poor ventilation and living conditions.

1.1 Methods Used:

- Online surveys via Google Forms
- Interviews
- Direct observations
- Photographic documentation

1.2 Key Insights:

- Residents experience discomfort due to poor ventilation, leading to dampness, foul odors, and increased insect entry.
- Overcrowding and blocked airflow are common.
- Maintenance issues (broken windows, faulty drainage) exacerbate the problem.

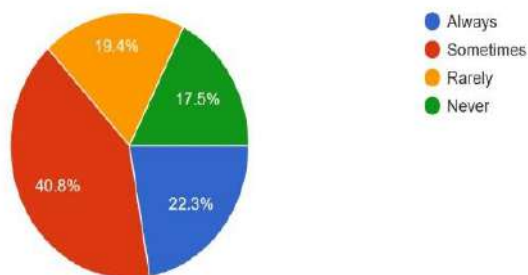
1.3 User Observations:

- Accumulation of moisture on walls and ceilings.
- Damaged or missing window screens.
- Stagnant water and overgrown vegetation near the building.
- Windows closed due to the entry of mosquitoes, bugs, and sometimes snakes.

1.4 Concerns of students:

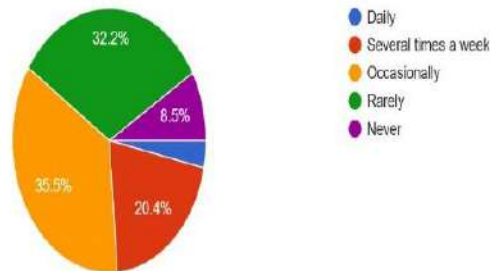
How often do you open your windows for ventilation?

211 responses



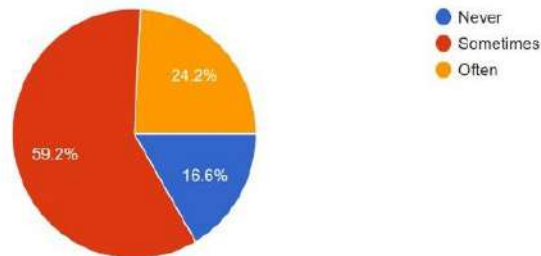
How often do you experience headaches, fatigue, or respiratory issues that you think might be related to poor ventilation in your room?

211 responses



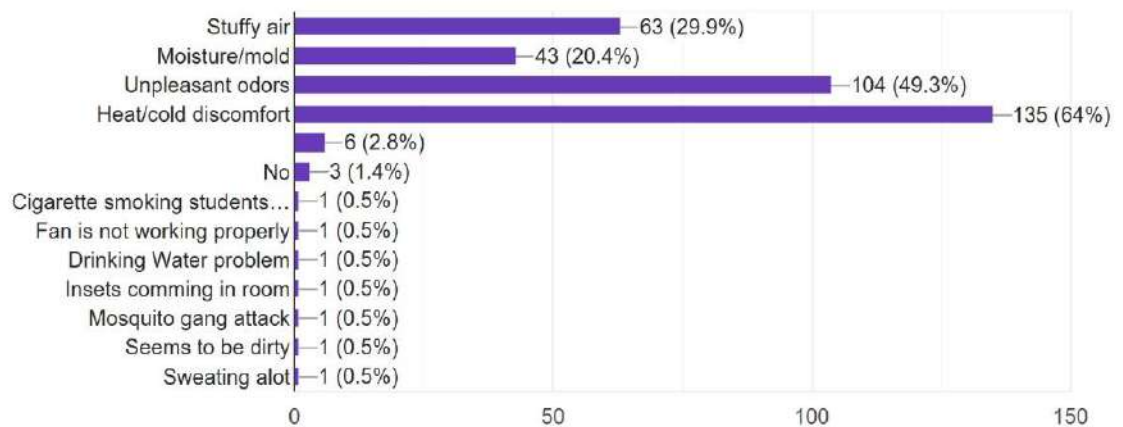
Do you feel suffocated or uncomfortable due to lack of ventilation?

211 responses



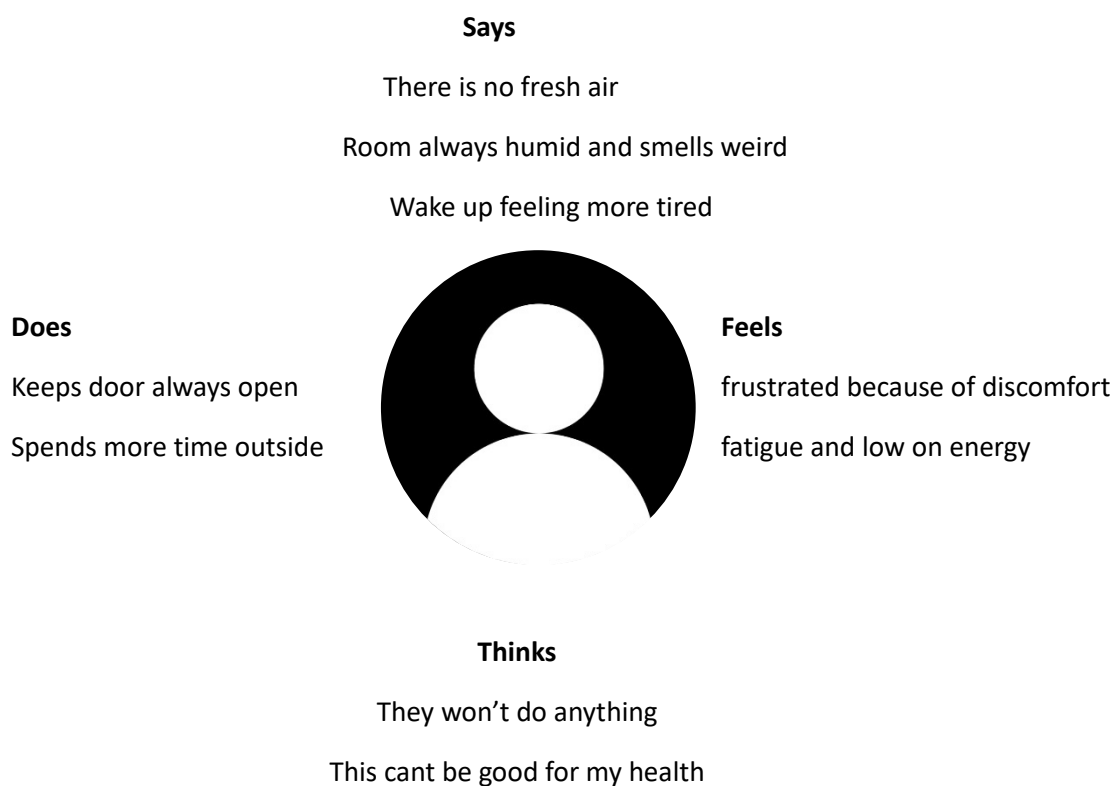
Have you experienced any of the following issues in your hostel room due to poor ventilation? (Select all that apply)

211 responses



1.5 Empathy Map:

To better understand the lived experiences of hostel residents, we developed an empathy map focusing on the issue of poor ventilation and airflow in hostel rooms. This tool captures students' thoughts, feelings, behaviours, and challenges, offering a human-centered perspective on how inadequate airflow impacts their daily life, health, comfort, and academic performance. By identifying these insights, we aim to guide the development of practical, student-informed solutions that improve hostel living conditions.



2. Define Phase:

The empathy research revealed that students and staff across different routines—whether studying, resting, or socializing—face a common struggle: poor ventilation, frequent pest entry, and persistent foul odours in the hostel rooms. These issues disrupt comfort, health, and the ability to use shared spaces effectively.

2.1 User Persona:

Name: Hostel Residents

Background: Lives in Hostel; uses the hostel for studying, group activities, and relaxation.

Goals:

- Study and socialize comfortably in the hostel rooms.
- Stay healthy and avoid respiratory or allergy issues.
- Feel safe from pests and environmental hazards.

2.2 Pain Points:

- “The air feels heavy and stuffy.”
- “I have to keep windows closed because of mosquitoes and sometimes snakes.”
- “The smell from outside makes it hard to concentrate or relax.”

2.3 Point of View (POV) Statement

We met hostel residents who want to use the hostel rooms for learning and leisure but are forced to avoid it due to poor air quality, pest entry, and unpleasant odors. They need a safe, ventilated, and clean space that allows them to focus, socialize, and rest without discomfort or health concerns.

2.4 Additional Insight

Many residents shared that the current living environment is damp and often smells bad, especially after rain or when the drainage is blocked. The lack of proper ventilation and pest control makes them keep windows closed, which worsens the air quality. Students feel that these issues are ignored and that regular maintenance or upgrades are urgently needed to improve their daily life and well-being.

2.5 Problem Statement

Hostel residents face discomfort and health issues due to poor ventilation and inadequate airflow, leading to stuffiness, high humidity, and reduced comfort. A structured, sustainable approach is needed to improve airflow and ensure a healthy living environment.

3. Ideate Phase:

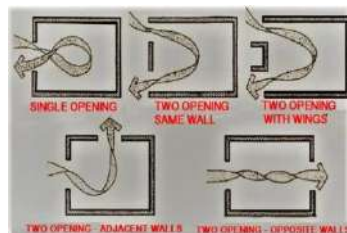
Open brainstorming focusing on practical, low-cost, and impactful solutions for hostel ventilation problems. Ideas were refined through group discussion and user feedback.

3.1 Ingenious Ideas Generated:

1. Cross Ventilation:
 - Natural method using openings on opposite/adjacent sides to enable airflow.
2. Exhaust Fans:
 - Remove stale, moist air from common halls and bring in fresh air.
3. Ventilation Pipes:
 - Allow air into plumbing pipes for proper drainage system operation.
4. Window Grills and Nets:
 - Provide security, insect/dust protection, and allow ventilation.
5. Indoor Plants:
 - Improve air quality, regulate humidity, and enhance mental well-being.
6. Air Walls:
 - Control airflow, separate areas, and manage temperature with air curtains or structures.
7. Energy Recovery Ventilation (ERV):
 - Exchanges heat and moisture between indoor and outdoor air, improving efficiency.
8. Heat Recovery Ventilation (HRV):
 - Recovers energy by transferring heat between two air sources, reducing energy demands.
9. Dr. Fixit sheet shield paints:
 - Applying this paint on hostel rooftops can improve poor ventilation by reflecting heat, reducing indoor temperature, and creating a cooler, more comfortable environment

3.2 Picked Ideas:

- Cross Ventilation



- Window Grills & Nets



- Indoor Plants



- Portable Exhaust Fan



- Dr. Fixit sheet shield paints.



3.3 Selection Criteria:

The ideas were evaluated based on:

- **Feasibility:** Ease of installation and maintenance within existing hostel infrastructure.
- **Impact:** Ability to improve air quality, comfort, and health for students.
- **Cost-effectiveness:** Preference for solutions that require minimal investment or structural changes.

- **Sustainability:** Solutions that are energy-efficient and environmentally friendly.

4. Prototype Phase:

One of the prototypes created to solve the problem of poor ventilation and airflow in hostels is shown here. Along with this, we designed a hostel layout in AutoCAD, which includes features such as cross ventilation and exhaust fans to enhance airflow. The prototype focuses on improving air circulation using cooling paint and ventilation mesh in a cost-effective manner.

4.1 Tools Used:

AutoCAD – Utilized for creating the hostel layout and visualizing ventilation enhancements.

4.2 Key Features of the Prototype

- Cost Estimation for Cooling Paint and Ventilation Mesh.
- Paint Estimation for Hostel Rooms: Includes number of rooms, area per room, total paintable surface.
- Paint Selection and Cost Breakdown.
- Labor Cost Estimation.
- Steel Mesh and Fiberglass Mesh Estimation: Size, quantity, rate, and total cost.
- Visual References: Mesh installation examples before and after improvement.

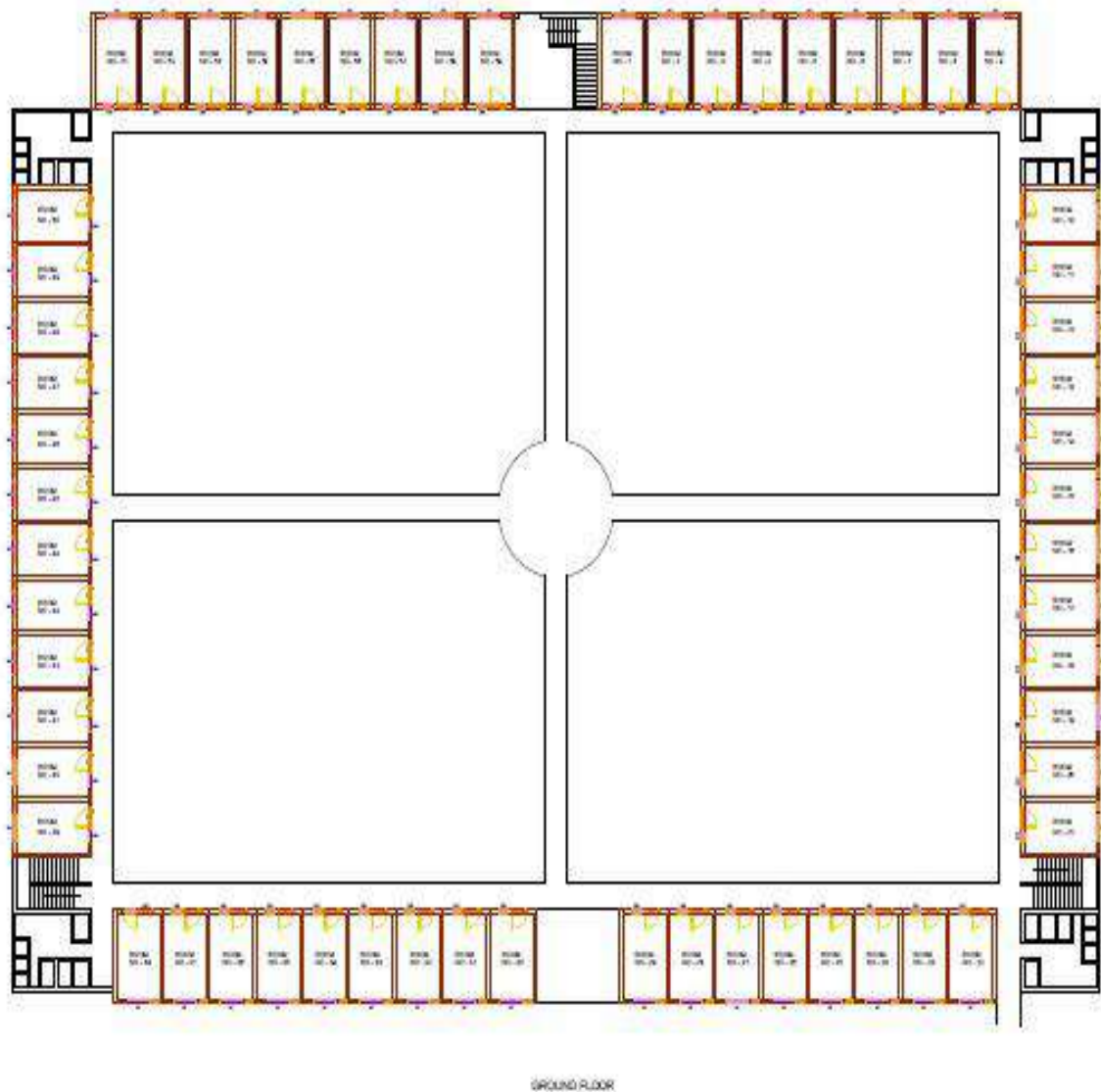
Vaigai Illam – 3D View of a room





Prototype: Vaigai Illam – Front view of a room





Vaigai Illam – Top View

5.Test Phase:

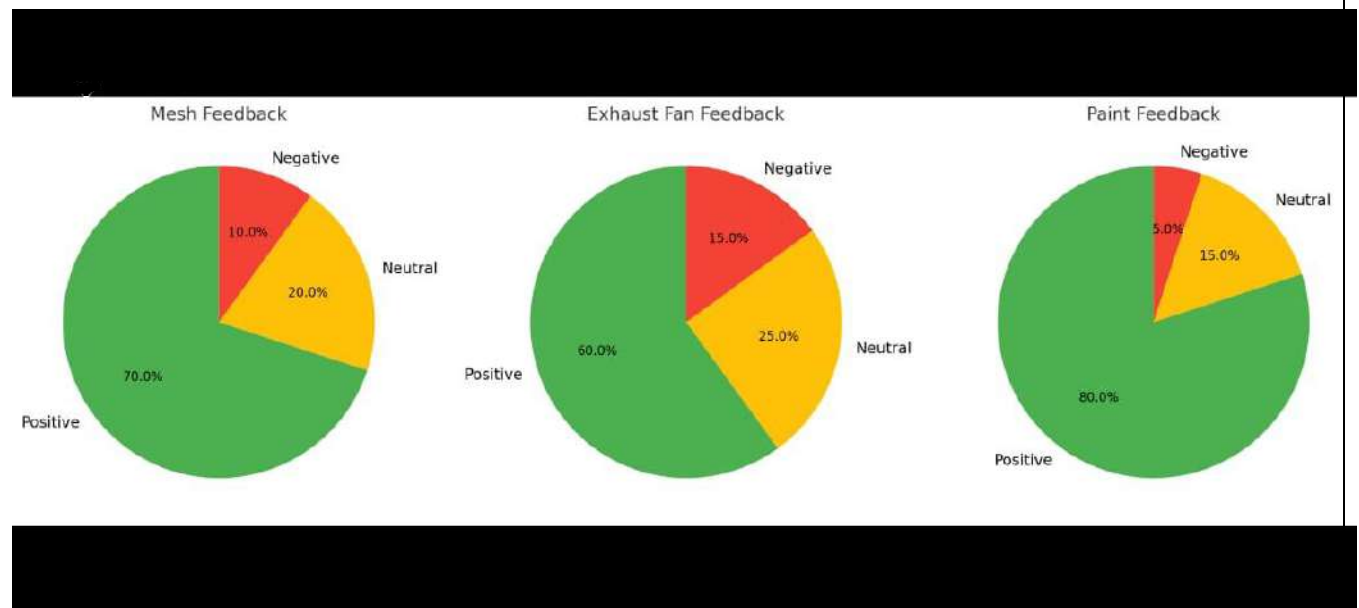
The ventilation prototype was tested by comparing it with real hostel conditions, where students face poor airflow and heat issues. This helped us evaluate ideas like cross ventilation, exhaust fans, cooling paint, and ventilation mesh. An AutoCAD layout supported the concept visually.

5.1 Testing Methodology

- Observation-based analysis of ventilation in hostel rooms and common areas.
- Informal survey through Google Forms with 30+ hostel residents.
- Focus on comfort levels, awareness, and response to proposed solutions.

5.2 User Feedback:

Informal feedback was collected through Google Forms responses from over 30 students residing in hostels. Their input provided valuable insights into the real impact of poor ventilation and highlighted areas for design improvement. The chart below summarizes student responses on room temperature, airflow comfort, and awareness of ventilation systems.



What Worked (with proposed solutions):

- Students appreciated the idea of cross ventilation and were open to structural layout improvements.
- The cooling paint and ventilation mesh prototype was received positively for its low cost and practicality.
- The idea of adding exhaust fans was considered effective and well-received by students for improving airflow.

Areas for Improvement:

- Cost estimation and feasibility for large-scale hostel implementation need further detailing.
- Even if funds are raised through government or alumni support, the actual implementation process is expected to take significant time.

5.3 Insights

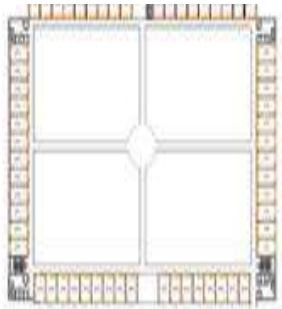
The test showed that solutions like cross ventilation, cooling paint, ventilation mesh, and exhaust fans are practical and well-received. Real hostel conditions helped validate their relevance. Feedback will guide improvements in design clarity, cost planning, and awareness.

6. Conclusion:

Sustainable Development Goal Achieved: **SDG 3 – “Good Health and Well-being”**

This initiative aligns with SDG3 by aiming to improve students' living conditions, health, and overall well-being through better ventilation solutions in hostels. With proper funding, clearer design, phased implementation, and regular feedback, the model can be scaled effectively. Continued refinement will help enhance student well-being across campuses. Investment in these improvements is essential to create healthier, more comfortable living spaces for all students.

Optimizing Ventilation and Airflow for Comfortable and Healthy Hostel Living



Improved Layout



Insect free Airflow



From limited airflow to comfort living

1. Empathize Phase

Understand the users and their needs through observation, engagement and immersing yourself in their experiences.

1.1. Methods Used

- Online surveys via Google Forms
- Interviews
- Direct observations
- Photographic documentation

1.2. Key insight:

- Existing drainage is either insufficient or clogged.
- Black cotton soil in the area retains, worsening stagnation.
- Poor road conditions can lead to slippery and safety hazards.
- Slope variations along the college surroundings.

1.3. User Observations:

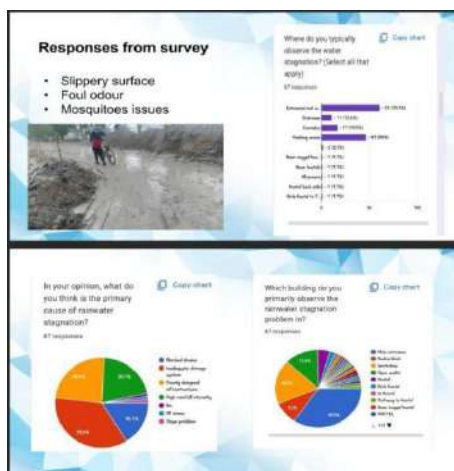
- Slippery surfaces cause students to walk cautiously or take alternate paths.
- Nearby drains are often blocked with leaves and trash and water pools near the main entrance.
- Low-lying areas that collect water.
- Insufficient slope in pavements and walkways.
- Lead to damage to buildings , infrastructure and landscaping.

1.4. Empathy mapping:



1.5. Data collected during empathize phase:

This survey collected feedback from 87 respondents on issues related to rainwater stagnation. Key concerns identified include slippery surfaces, foul odour, and mosquito problems. Participants indicated where they typically observe water stagnation, the primary causes they believe contribute to the issue, and the specific buildings most affected. The survey results are presented with bar and pie charts, highlighting the distribution of responses and the most affected areas. The findings aim to inform targeted interventions to address rainwater stagnation and its associated problems within the community



Survey analysis for rainwater stagnation



rainwater stagnation near main road

2. Define phase:

Clearly articulate the problem based on insights gathered in the empathize stage.

2.1. Impacts:

- Creates safety hazards due to slippery surfaces
- Leads to waterlogging, causing inconvenience to students and faculty
- Weakens building foundations over time.
- Encourages mosquito breeding, leading to health risks.
- Affects the overall campus aesthetics and cleanliness.

2.2. Additional insights :

- Existing drainage is either insufficient or clogged
- Black cotton soil in the area retains, worsening stagnation
- Poor road conditions can lead to slippery and safety hazards
- Slope variations along the college surroundings

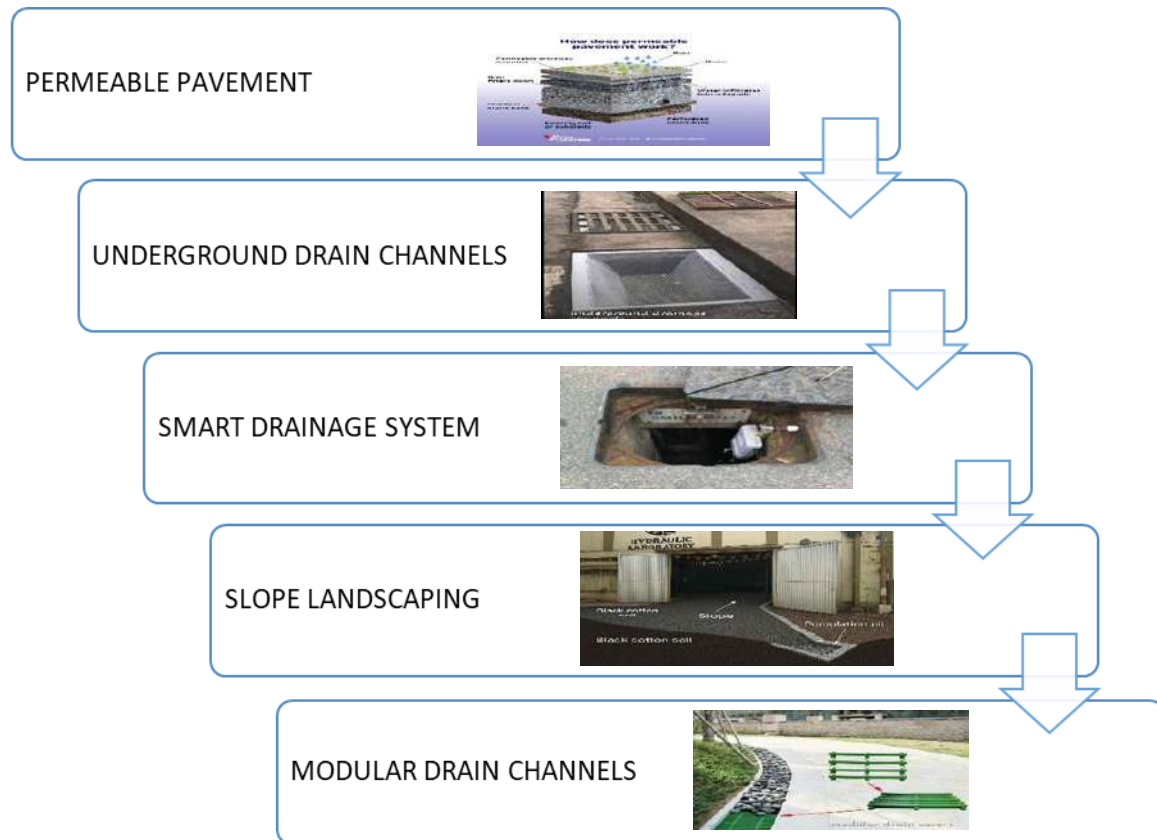
2.3. Problem statement :

Rainwater stagnation occurs due to soil characteristics like low permeability, high water-holding capacity, and shrink-swell behaviour, along with uneven land slopes. These factors prevent proper drainage, causing water to accumulate. This leads to slippery surface, infrastructure damage, and health risks, necessitating effective soil and terrain-based water management solutions.

3. Ideate phase:

Generate diverse and innovative solutions to eliminate or reduce rainwater stagnation around the college building, enhancing accessibility, safety, and environmental sustainability.

3.1. Key Ideas Generated



3.2. Picked solutions

1. Permeable pavement-recommended for black cotton soil and reduces the rain water stagnation, reduces slippery surfaces
2. Modular drains-reduces clogging in drains but requires regular maintenance
3. Sloped landscaping-avoids flooding in hydraulics laboratory

4. Prototype phase

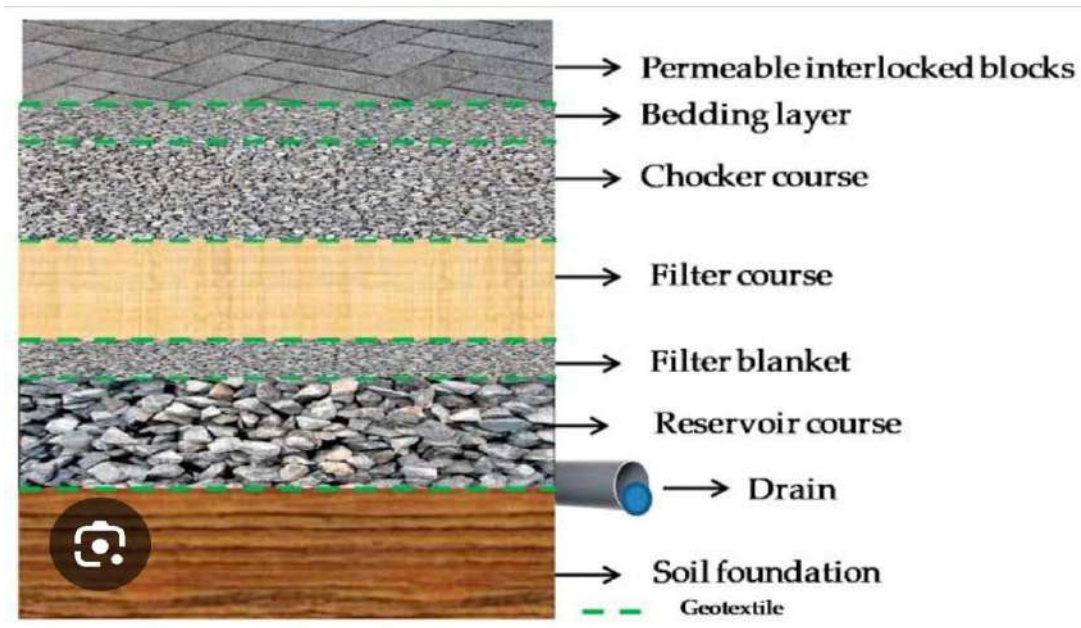
To address rainwater stagnation, a prototype of permeable pavement has been developed. This pavement allows water to pass through its surface, promoting natural infiltration into the ground. Made with porous materials like pervious concrete, porous asphalt, or interlocking pavers, it reduces surface runoff and prevents waterlogging.

4.1. Permeable pavement

The prototype (permeable pavements) includes layers,

- Surface layer (porous concrete/asphalt)
- Gravel base (for water storage and filtration)
- Geotextile fabric (to prevent soil clogging)
- Drainage layer (optional, depending on soil)

This system not only reduces stagnation but also recharges groundwater, supports sustainable drainage, and is ideal for urban pathways, parking lots, and walkways.



Layers in permeable pavement



Modified layout for permeable pavements

4.2. Modular Drains

Prototype Description: A modular drain segment will be installed, incorporating removable components for easy maintenance.

Purpose: To examine how well the modular design prevents clogging and facilitates routine cleaning



Current drain provided

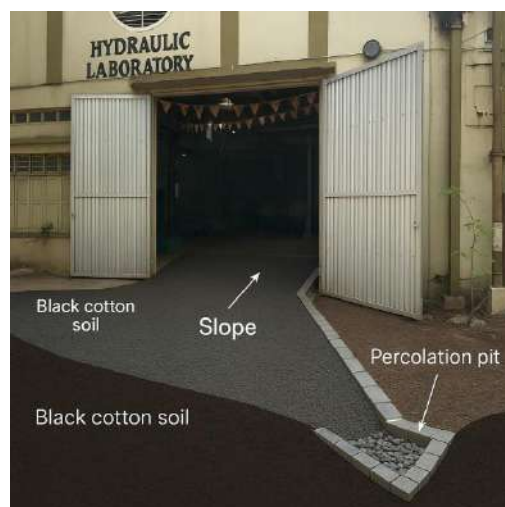


modular drain cover

4.3. Slope Landscaping

Prototype Description: A scaled or actual landscaping model will be created with a designed gradient leading water away from the hydraulics laboratory.

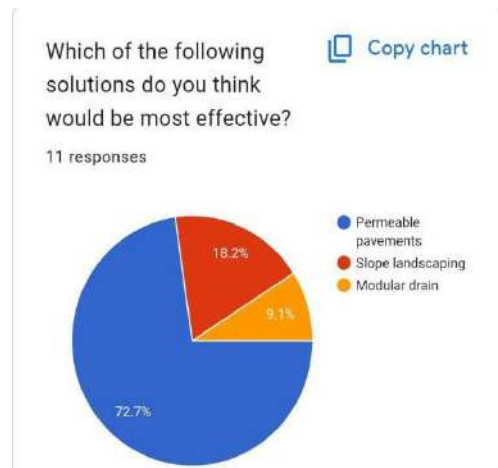
Purpose: To test if the slope design effectively channels water away, preventing flooding.



Slope landscaping

5. Testing phase:

The prototype idea was tested by taking surveys among various students of other departments, non-teaching and teaching staffs. The responses are attached below.



Where do you observe rainwater stagnation near the college building?

9 responses

In parkings and labs near the workshops.

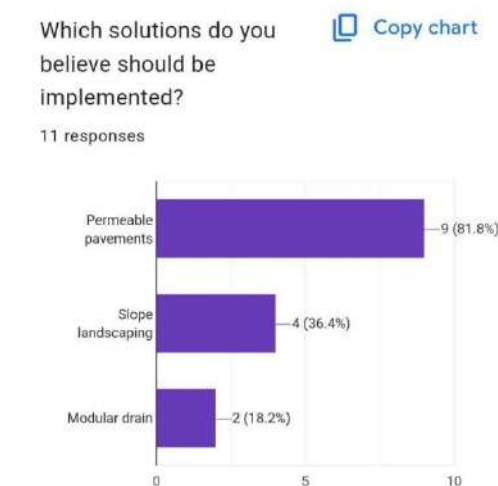
Near 1 st gate

hostel road

Way to hostel

Auditorium

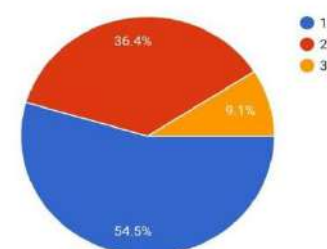
Yes



Please rank the following solutions based on their effectiveness1.

Permeable pavements, 2.
Slope landscaping,3.
Modular drain

11 responses



Survey taken for possible solutions

6.Conclusion

In conclusion, this design thinking process followed a cyclic, iterative approach—empathizing with users, defining the problem, ideating solutions, prototyping, and testing. Each phase informed the next, allowing for continuous refinement based on feedback. Solutions like permeable pavements, modular drains, and slope landscaping were developed and tested for effectiveness. This ongoing cycle ensures adaptive, user-centered improvements that address rainwater stagnation sustainably and practically, aligning with broader environmental and development goals.

Sustainable Development Goals (SDG):

6.1. Permeable Pavement

SDG 6: Enhances groundwater recharge, filters pollutants.

SDG 11: Reduces urban flooding, supports sustainable design.

SDG 13: Manages rainfall, reduces heat islands.

SDG 15: Prevents soil erosion and habitat loss.

6.2. Slope Landscaping

SDG 13: Stabilizes slopes, buffers climate extremes.

SDG 15: Prevents erosion, restores degraded land.

SDG 2: Supports sustainable hillside farming.

SDG 11: Improves slope safety and aesthetics.

6.3. Modular Drains

SDG 6: Improves stormwater and sanitation management.

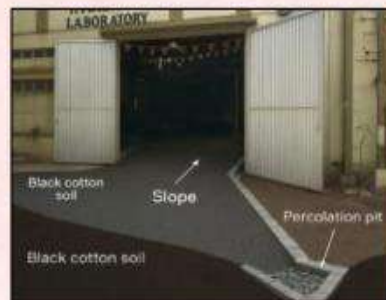
SDG 9: Enables resilient, modular infrastructure.

SDG 11: Reduces urban waterlogging and improves hygiene.

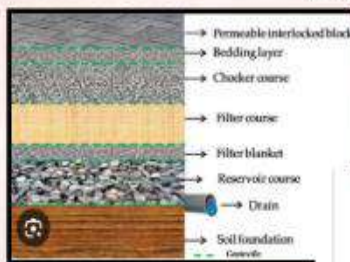
Design of Modular Drain and Permeable Pavement for Effective Water Management



MODULAR DRAIN



SLOPE LANDSCAPING



PERMEABLE PAVEMENT

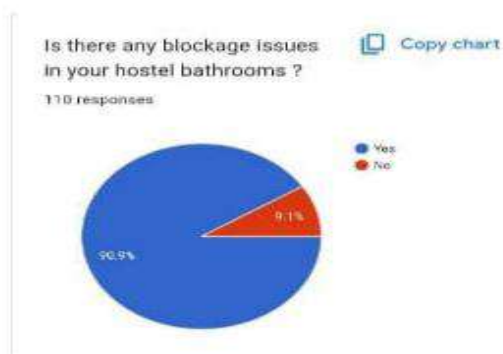
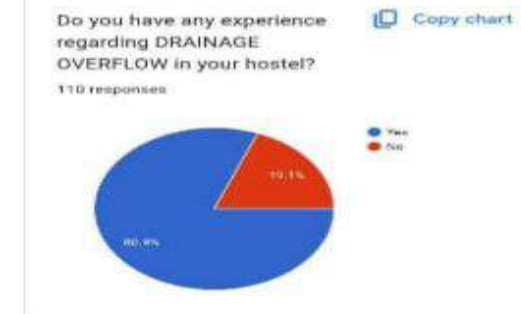
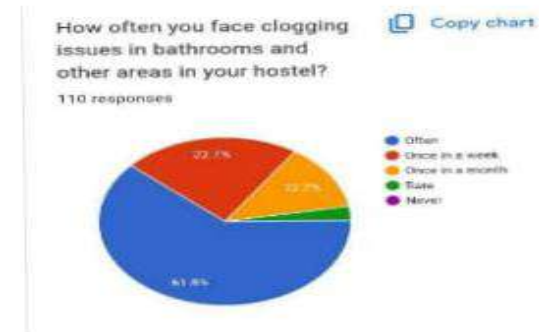
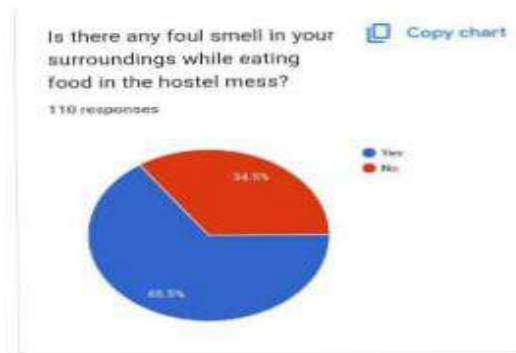
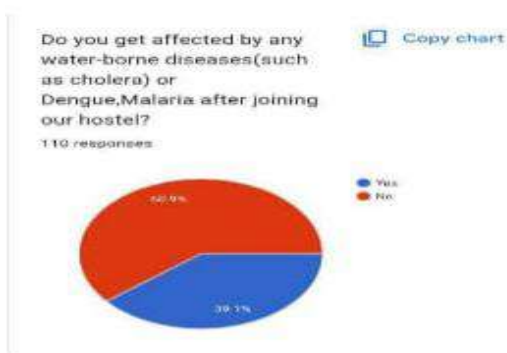


MODEL

1. Empathize Phase:

1.1 User Research:

To understand the drainage problems in the hostel and canteen areas, we conducted interviews and observations involving students, canteen workers, hostel residents, and cleaning staff. Key findings revealed emotional distress, health concerns, and functional issues due to poorly maintained and improperly designed drainage systems. We conducted a survey and 110 students have registered their feedback.



1.2 Key Insights:

1. Overflow in bathrooms and toilets is a frequent complaint.
2. Persistent foul odors impact student's ability to rest or enjoy meals.
3. Staff struggle with blocked pipes and unhygienic working conditions.
4. Frustration due to lack of timely maintenance and awareness among users.

Empathy Map:



2. Define Phase:

A well-functioning drainage system is essential for hygiene and comfort in hostels and canteens. However, we found several systematic issues that led to severe drainage problems impacting the daily life and well-being of students and staff.

2.1 Identified Root Causes:

1. Improper Design and Planning
2. Poor Construction Quality
3. Clogging Due to Waste Accumulation
4. Lack of Regular Maintenance
5. Aged or Outdated Infrastructure
6. Poor Waste Management Practices

- 7. Inadequate Drainage Capacity
- 8. Inadequate Slope or Gradient.
- 9. Environmental and External Factors
- 10. Lack of Awareness Among Residents

2.2 POV Statement:

“Students need a reliable and hygienic drainage system in their hostel that ensures safety, cleanliness, and comfort because the current conditions disrupt his daily routine and pose health risks.”



AFFECTED PIPE SYSTEM



WORKERS WE HAVE DISCUSSED

2.3 PROBLEM STATEMENT:

As far we have discussed, we concluded the major issues as Clogging of water in bathrooms and toilets. Also, due to lack of proper drainage system, the overflow of drainage water affects them a lot. Hence, We decided to implement some of our ideas.

3. Ideate Phase:

It includes assessing the Current System's Layout (problematic areas, usage patterns etc,), Determining the Hydraulic Capacity, rates and future expansion, analysing Topography and Layout (i.e: Proper slope and drainage pathways), Checking Soil Conditions (i.e: Permeability and water table level) and also selecting suitable Materials (Durable materials like HDPE and PVC).

3.1 Ideas:

1. Introducing permeable pavements
2. Regrading paths and courtyards to slope away from buildings
3. Installing surface channels and gratings
4. Introduction of Automatic Strappers with the help of Sensors.
5. Separate wastewater lines (greywater and blackwater).
6. Smart drainage systems with IoT sensors and AI.
7. Hydrodynamic separators for stormwater.
8. Slope-optimized piping (as per IS:1742).
9. Two-pipe system for segregation and efficiency.

3.2 Selected Solution

➤ **AUTOMATIC STRAPPERS (PRIMARY):**

Without reconstructing the overall layout of drainage system, the simple idea which is taken for the execution is AUTOMATIC STRAPPERS. The further working principle and other materials needed is elaborately given below.

➤ **Separate Drainage Systems (SECONDARY):**

After analysing various options, the best solution for increase in population in my hostel, the another chosen solution is the implementation of separate drainage systems. Segregating greywater and blackwater can effectively prevent overflow, backflow, clogging, and pipe corrosion, and improve ease of maintenance.

4. Prototype Phase:

4.1 PRIMARY SOLUTION (AUTOMATIC STRAPPERS):

➤ **Working Principle:**

The strapper will stay idle when the floor is dry. When water starts collecting (e.g., during a bath), the mechanism is triggered. It starts moving in and out (like a gentle sweeping or poking motion) with a 1-second period. This motion helps push floating sachets away from the outlet, keeping the drain area clear. Once the water drains, the motion stops automatically.

➤ **Components Used:**

1. Water Level Sensor / Float Sensor (detects water presence)
2. Strapper Arm (plastic or stainless-steel rod)
3. Small DC Motor / Servo Motor (for in-out motion)

4. Controller (optional) – e.g., Arduino Nano or timer circuit (for motion control)
5. Frame / Mount (to attach strapper near outlet)
6. Power Source – rechargeable battery or DC adapter

➤ **Technical Details Parameters:**

1. Specification Movement- In and Out (Linear Motion).
2. Period- 1 Second (0.5s in, 0.5s out).
3. Trigger Mechanism- Water presence.
4. Presence Material: Waterproof Plastic.
5. Metal Range of Motion: 3–5 cm.
6. Power: 5V or 12V DC.



AI GENERATED IMAGE OF AUTOMATIC STRAPPERS

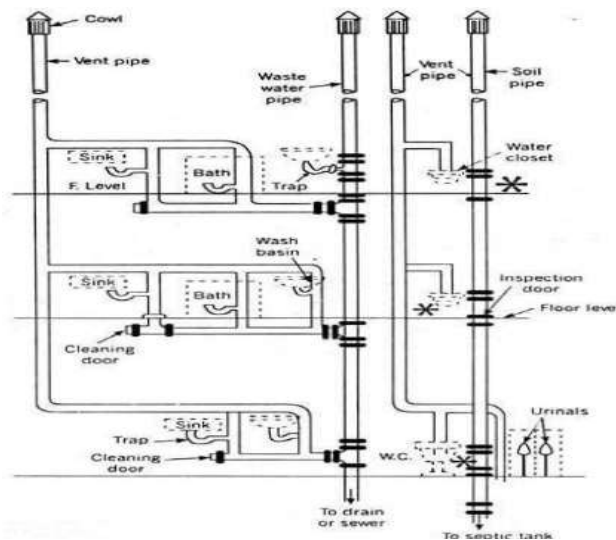
4.2 SECONDARY SOLUTION (Two-Pipe System):

A two-pipe system consist of two main pipes and two vent pipes. It uses Soil pipe to Carry discharge from toilets and urinals. Waste Pipe is used to discharge waste from bathrooms, basins. Vent Pipe are provided separate for both main pipes for air circulation.



COMPONENTS:

Soil Pipe, Waste Pipe, Vent Pipe, Traps and, Inspection chambers, Manholes fittings.



➤ **Working Mechanism:**

As the design discharge is more, Toilets and urinals discharge into soil pipe and Sinks, showers discharge into waste pipe. Separate vertical and horizontal lines are provided to prevent mixing. Common drain connection is provided at ground level. Vent pipes are provided to maintain pressure and prevent siphoning.

Future Population	Future Population	With 20% Buffer
446	447	42.82 m ³ /day
446	447	85.63 m ³ /day

DESIGN DISCHARE OF HOSTEL BUILDING(Considering Future Expansion)

➤ **Application in Hostel:**

1. Vertical stack per floor
2. Separate lines for toilet and bathroom
3. Efficient distribution across floors

➤ **Why Use in Hostels?**

One-pipe systems are inefficient for high flow. Two-pipe systems reduce problems, ease septic tank maintenance, and ensure hygiene.

➤ **Solutions in Canteen:**

SAME SOLUTIONS CAN BE APPLIED AS THE PROBLEMS ARE SIMILAR.

ESTIMATION FOR TWO PIPE SYSTEM					
PARTS	TYPE	QUANTITY	COST	TOTAL COST	31456
PIPE	main	16	1150(12 cm dia @ 6m length)	18400	
	vent	16	816(12 cm dia @ 6m length)	13056	
FIXTURES AN JOINTS	pvc tee	16	125	2000	4320
	pvc elbow	16	80	1280	
	pvc coupling	16	65	1040	
TRANSPORT	loading /unloading	300			1500
	handling	100			
	hiring mini truck	1000			
	packaging	100			
LABOUR	fitting	7000-10000(Avg:8500)			8500
		OVERALL COST			45776

ESTIMATION FOR TWO PIPE SYSTEM

5. Testing Phase:

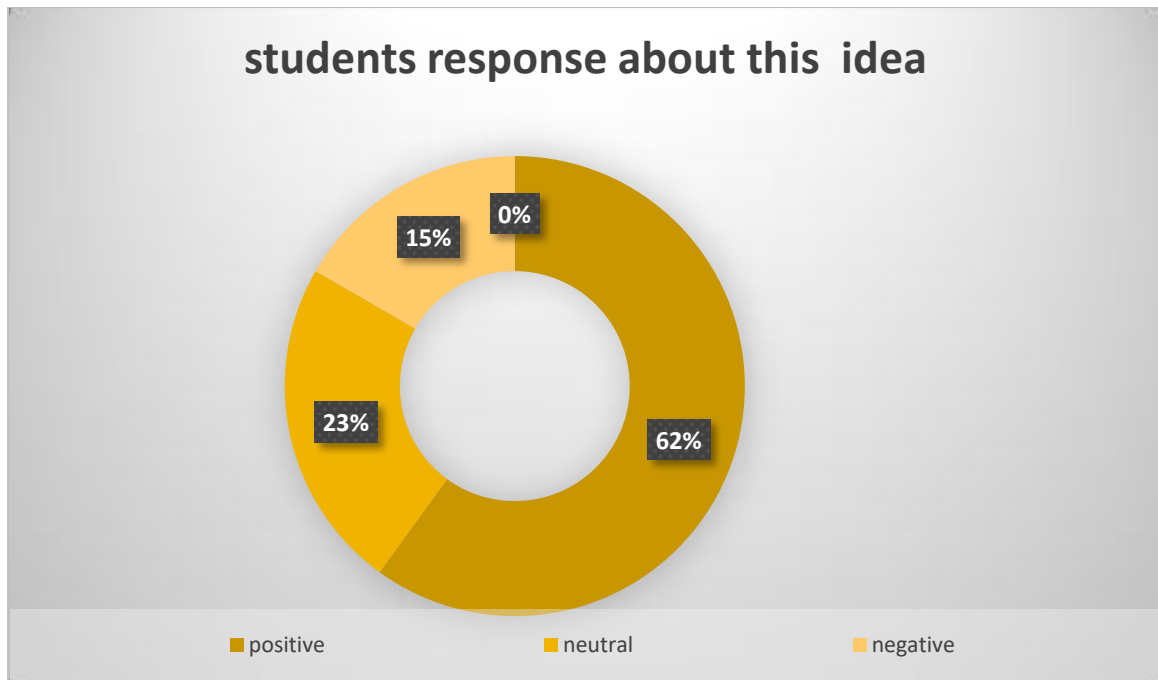
The Skill Hub prototype was informally tested by drawing parallels with the current Design Thinking Lab setup, where students collaboratively solve real-world problems in groups — just like Skill Hub’s core idea. This environment provided a practical context to evaluate how such a model might function in a real academic setting.

5.1 Testing Methodology:

- Observation-based testing within the Design Thinking Lab
- Feedback collected from students
- Focus on how students engaged in group tasks, mentorship flow, and response to hands-on learning

5.2 User Feedback:

We collected informal feedback through observations and discussions with 170 students participating in the Design Thinking Lab. The following chart summarizes their responses regarding group work, learning methods, and clarity of sessions, providing key insights into the prototype’s effectiveness and areas for improvement.



Based on the informal testing and discussions with peers during the lab sessions, the following observations were made regarding the Automatic Strappers

➤ **What Worked:**

Students were interested in this Automatic Strappers installation. Rather than certain students, who feel that installation of automatic strappers may be inefficient in this problem scenario, majority of students feel that it may reduce the clogging due to plastic covers, shampoo packets, hair blocks etc, ...

➤ **Areas for Improvement:**

Many students suggested on making the setup compact so that it does not interfere with their day-to-day activities such as bathing, cleaning works etc, Also, Students want the strappers to be frequently cleaned and maintained in order to work effectively

5.3 Insights:

The test validated that the idea of installing automatic strappers is mostly welcomed and also believe that it prevents the clogging of drainage pipes... Feedback will be used to enhance the prototype with better time-based structuring and clearer activity flow.

6 Conclusion:

➤ Sustainable Development Goal Achieved:

SDG3: Good Health and Well-being – Reduces the spread of water-borne and vector-borne diseases, improving the overall health of students and staff.

SDG6: Clean Water and Sanitation – Ensures proper wastewater management and reduces contamination risks, contributing to a cleaner and healthier environment for residents and food preparation areas.

1. Empathize Phase

In the empathize phase, we focused on understanding the real experiences, emotions, and needs of the hostel residents. The goal was to gather deep insights into the problems they face-not just what's visible, but how it affects their daily lives.

1.1 Methods Used

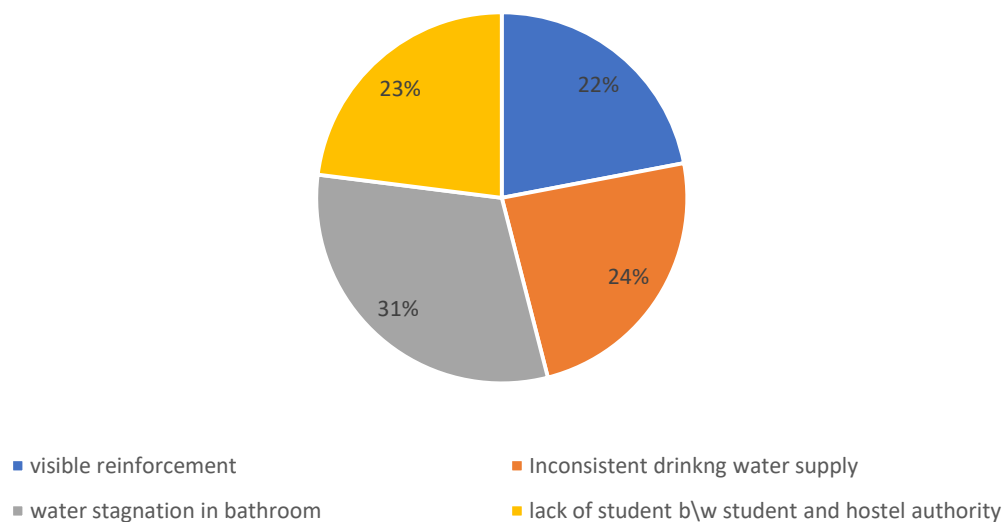
- Student Survey via Google Form
- Observation and Visual Documentation
- Interaction with Hostel Warden

1.2 Data Collected

Survey insights based on multiple questions to understand major issues in Bhavani Illam

Issue Identified from the survey	Students (56)
Visible reinforcement\water seepage	12
Inconsistent drinking water supply	13
Lack of communication b\w students and hostel authority	12
Water stagnation in bathroom	19

Google form survey response



1.3 Key Insights

- Water stagnation causes delays, illness, and discomfort.
- Students often miss morning classes or skip bathing.
- Poor maintenance and coordination are recurring concerns.
- There's frustration due to lack of action on complaints.
- Hygiene, safety, and access to basic needs are compromised.

1.4 Empathy Mapping

As part of the Empathize phase in the Design Thinking process, we conducted surveys, interviews, and visual observations to understand the daily experiences of students living in the 2nd-year GCT hostel (Bhavani Illam). The goal was to go beyond surface-level complaints and uncover the real emotions, behaviours, and thoughts students have regarding the hostel's infrastructure issues. The Empathy Map helps us visualize these findings by organizing them into what the students say, think, do, and feel, giving us a clearer understanding of their needs, frustrations, and motivations. This insight forms the foundation for accurately defining the core problems and designing meaningful solutions.



2. Define Phase

Define Stage is the second step in the Design Thinking process is to clearly identify the core problems based on user insights and data. It helps guide the next steps toward creating relevant, user-focused solutions.

2.1 User Persona

Name: Vijaykumar K

Background: Lives in the hostel during the academic year, comes from a small town and depends entirely on hostel facilities

Needs and Goals:

- Clean and functional bathrooms and toilets
- Continuous access to clean drinking water
- A safe and well-lit hostel environment
- A way to easily raise complaints and receive timely updates

2.2 Pain Points:

- Often finds bathrooms wet, clogged, or unusable
- Has to wake up very early to avoid queues
- No clear way to communicate problems to hostel authorities
- Feels ignored and disrespected due to poor maintenance

2.3 Problem Statement

Bhavani Illam hostel faces major issues like non-functional bathrooms and toilets, visible reinforcement, water seepage, poor lighting, and lack of dustbins-impacting hygiene and safety. Inadequate drinking water and a communication gap between students and hostel authorities further worsen the living conditions and delay problem resolution.

3. Ideate Phase

In the Ideate phase, we applied a variety of creative techniques to generate innovative solutions for the problems identified. Brainstorming encouraged free-flowing, judgment-free idea generation, while SCAMPER helped us modify existing concepts by prompting us to Substitute, Combine, Adapt, and more. We used the "Worst Possible Idea" method to think in reverse—intentionally generating bad solutions and then flipping them into useful ones. Analogous Inspiration allowed us to draw ideas from nature and other industries, such as using gecko-inspired grips or car wash drainage systems. Sketch Storming enabled rapid visual exploration of ideas, helping us imagine practical implementations like foldable privacy screens or modular fixtures. By combining these diverse methods, we were able to develop and shortlist practical, cost-effective, and sustainable solutions tailored to the real needs of students.

For each of the five key issues-structural damage, lightning and hygiene, bathroom shortages, water supply failures and communication gaps-multiple potential solutions were developed.

3.1 Ideas generated:

Structural Issues:

- Replace corroded metal reinforcements with fiber-reinforced polymers (FRP) (lighter, corrosion-resistant).
- Use waterproof coatings + modular drainage panels (like car wash floors) to redirect water.
- Borrow “green roof” techniques (vegetation layers) to absorb rainwater and reduce seepage.
- Remove damaged sections and install pre-fabricated wall panels for quick repairs. Instead of fixing leaks, redirect water into a harvesting system (e.g., rooftop collection).

Bathroom and water shortages:

- Replace broken taps with sensor-based faucets (like airports) to reduce water wastage.
- Staggered shower schedules via a hostel app to manage peak hours.
- Foldable privacy screens for broken doors (like Japanese partition curtains).
- “Adopt-a-Bathroom” program Student groups maintain one bathroom each.

Inconsistent Drinking water supply:

- Use UV water purifiers (like camping gear) for instant clean water.
- Replace damaged pipes with flexible PVC pipes (easier to repair).
- Collaborate with water NGOs to install RO dispensers at key points.

Communication Gap:

- Digital complaint portal (simple Google Form → auto-alerts to management).
- Anonymous suggestion boxes + public response board (like Reddit’s “AMA”).
- WhatsApp broadcast group for urgent issues (e.g., “Pipe burst in Block A!”).
- Student “fix-it” ambassadors (liaisons who escalate issues weekly).

Selection Criteria:

The final ideas for each problem were selected based on feasibility, potential impact, originality, desirability, viability, impact and ease of prototyping. Each idea was rated or discussed against the above criteria in group sessions. The most promising solutions were selected.

3.2 Chosen Concepts:

Structural deterioration-concrete jacketing

Bathroom water stagnation-optimized drainage layout

Inconsistent drinking water supply-sustainable water ATM system

Communication Gap solution-Hostel feedback and complaint form

4. Prototype Phase

1.STRUCTURAL DETORINATION/VISIBLE REINFORCEMENT:

- Concrete jacketing, also known as retrofitting, is a method of strengthening existing concrete structures, like columns and beams, by adding a new layer of concrete around the existing member. This additional concrete is typically reinforced with steel or other materials, increasing the overall strength and load-bearing capacity of the structure.
- FRP Jacketing: Using Fiber Reinforced Polymer (FRP) materials, such as carbon fiber, to strengthen the concrete.

2.BATHROOM WATER STAGNATION:

Improved floor trap layout

Dimensions:

Area: 1.5 m (width) x 2.0 m (length)

Two floor traps are positioned strategically.

Each trap is covered with SS304 grating (stainless steel - corrosion resistant).

Key Features:

Floor Slope 1:50:

Ensures that water naturally flows toward the traps due to gravity.

For every 1 meter, the floor drops by 2 cm.

PVC Pipe Network:

50 mm diameter PVC pipes collect greywater from each trap.

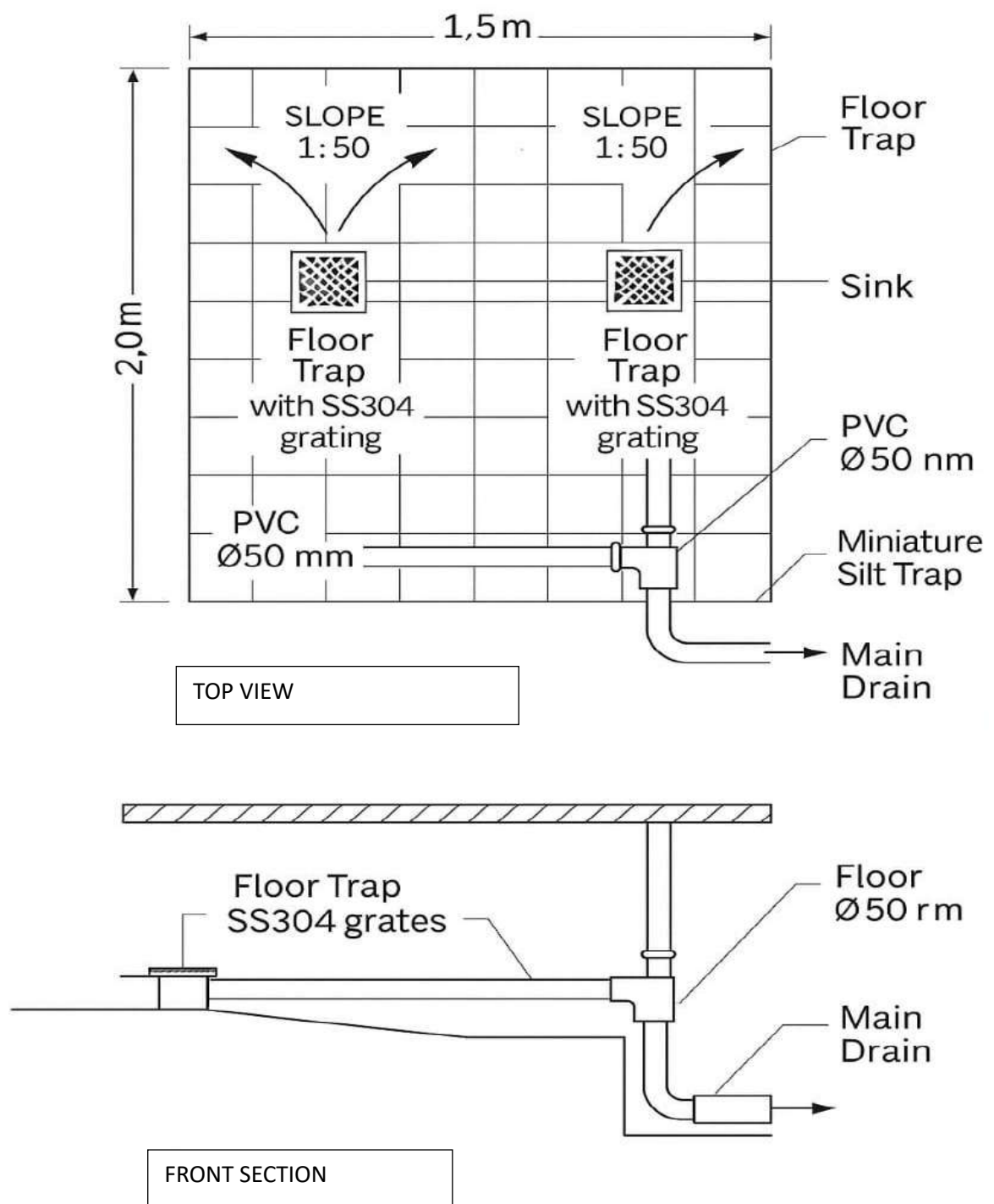
3.COMMUNICATION GAP:

A structured digital google form for students to raise issues, reduces miscommunication and ensures direct tracking by hostel authorities.

4.INCONSISTENT DRINKING WATER SUPPLY:

Sustainable water ATM system:

Integrates rainwater harvesting, clean water is stored and dispensed via a controlled water ATM. Ensures continuous drinking water supply to students.



Bathroom floor drainage layout with floor traps and miniature silt trap

10:35

Register Complaint

Roll Number

Complaint Category

Select ▼

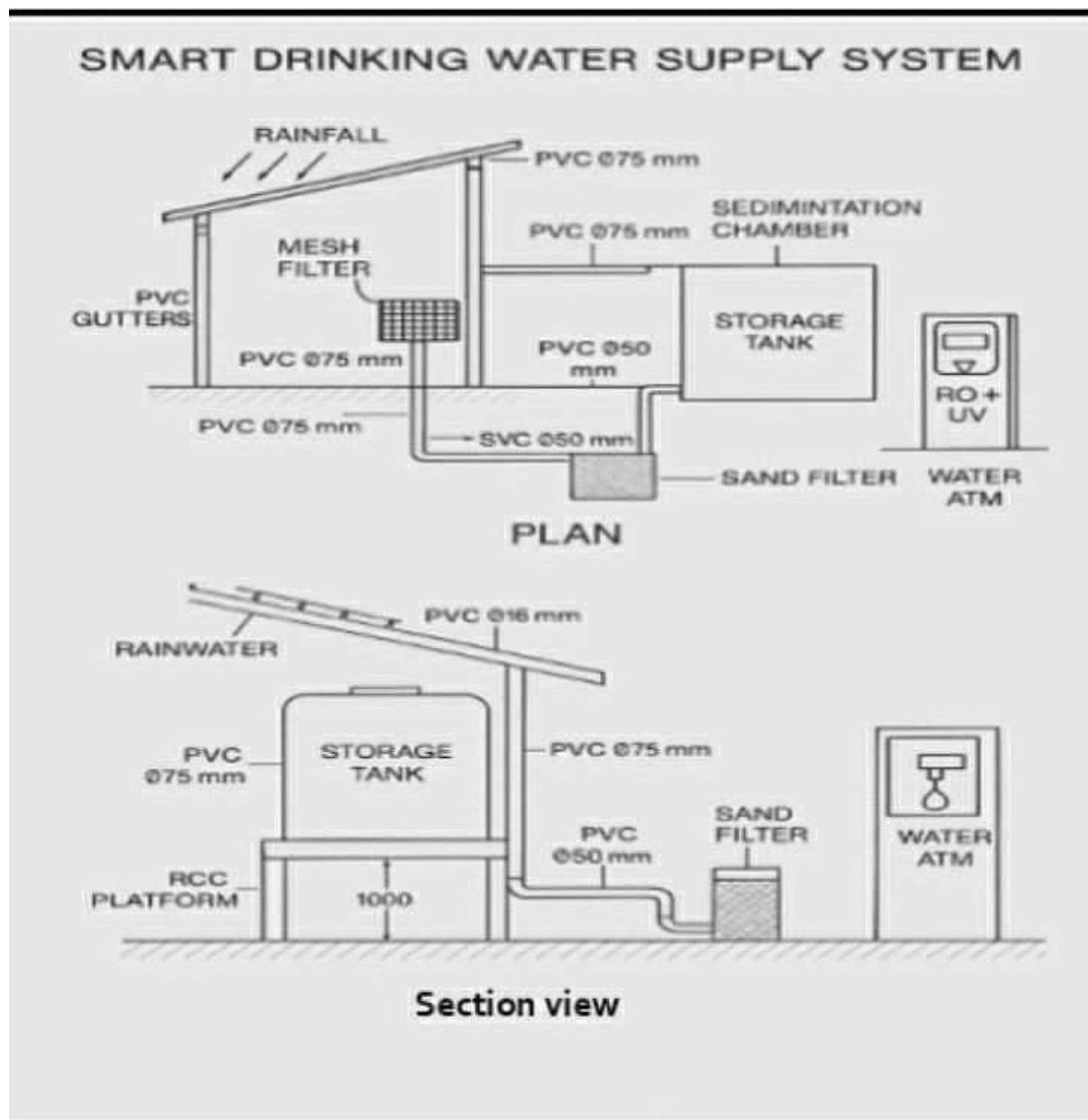
Description

+ Upload Photo

Submit

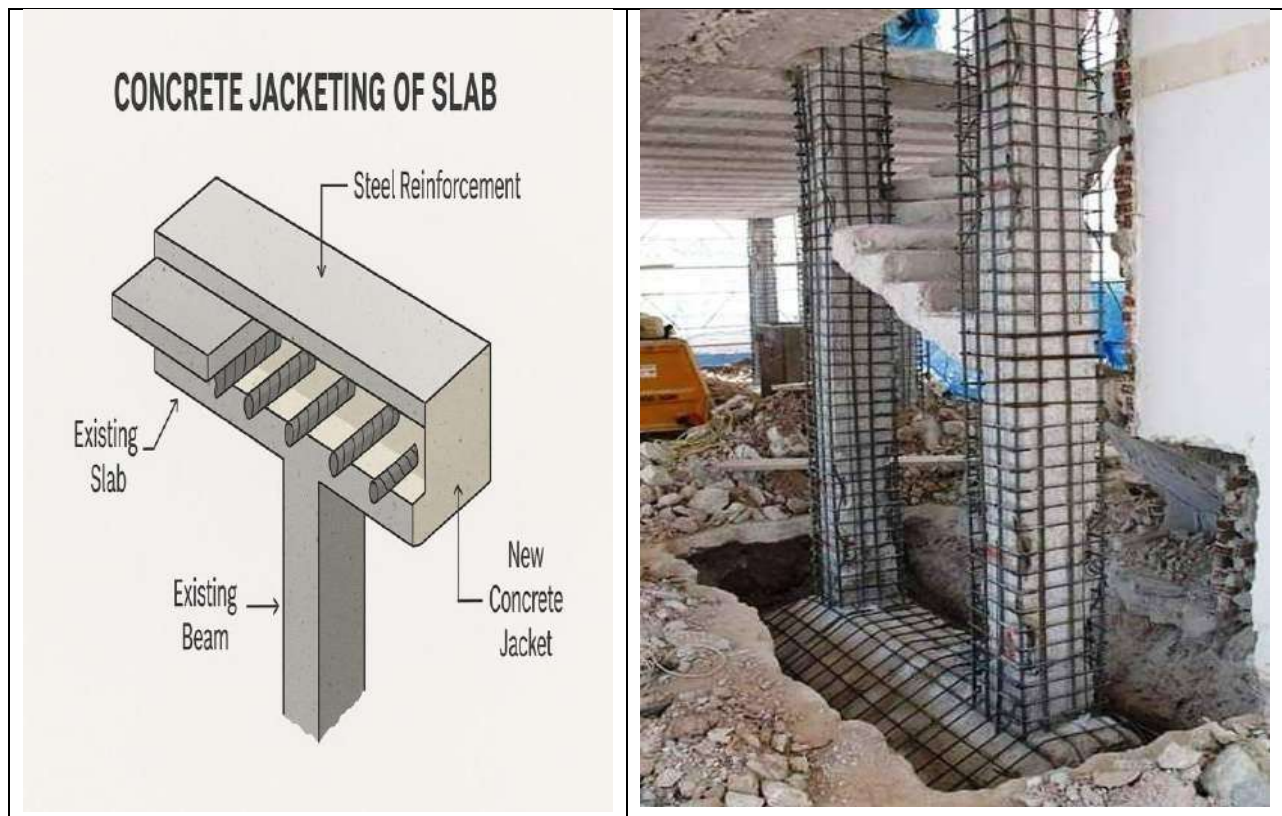


Interface of student feedback and complaint form



Sustainable drinking water supply system using rainwater harvesting and water atm

CONCRETE JACKETING



5. Test Phase

The prototypes ideas were discussed with 15 students, hostel representatives, and the warden. All four solutions received positive feedback:

- Concrete Jacketing was appreciated for safety, with a trial suggested in one damaged room.
- The bathroom drainage layout was well-received and recommended for a pilot in one wing.
- The smart drinking water ATM was highly welcomed, though the warden requested a detailed maintenance plan.
- The complaint feedback form was easy to use and accepted for immediate implementation.

6. CONCLUSION:

Through the Design Thinking process applied to Bhavani Illam hostel, we identified key infrastructure and communication issues, empathized with real users, and developed practical, user-centered prototypes. The feedback during the Test Phase validated many of our solutions, showing clear potential to improve safety, hygiene, and daily living conditions for hostel residents. This project directly contributes to the following Sustainable Development Goals (SDGs):

- SDG 3: Good Health and Well-being - by ensuring hygienic living conditions and clean water access.
- SDG 6: Clean Water and Sanitation - through improved drainage, water supply systems, and maintenance strategies.
- SDG 11: Sustainable Cities and Communities by making hostel infrastructure safer, more inclusive, and resilient.

While our solutions showed promise, the testing phase also revealed areas for refinement. To achieve a truly flawless, scalable solution, it is essential to re-enter the Design Thinking cycle, applying the insights gained during testing to further enhance the prototypes. Continuous iteration will ensure the solutions are not only effective but also sustainable in the long run.

Efficient Drainage Layout and QR-Based Feedback Mechanism for Hostel Maintenance

