THE - Impact Rankings 2025

17 PARTNERSHIPS FOR THE GOALS

Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development

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17.2.5 Collaboration with NGOs for SDGs

Collaboration between the University and Non-Governmental Organizations (NGOs) plays a crucial role in advancing the Sustainable Development Goals (SDGs). These partnerships enable the institution to extend its academic, research, and community outreach efforts beyond the campus, ensuring that education contributes directly to societal well-being.

KARE actively partners with regional and national NGOs to design and implement initiatives that align with SDGs such as poverty reduction, quality education, gender equality, good health & well-being, sustainable cities, and climate action. These collaborations allow students, faculty, and community stakeholders to work together on real-world challenges.

Key Components of NGO Collaborations at KARE

1. Curriculum-Integrated NGO Projects

The University designs courses that involve students in NGO-led projects, providing hands-on experience in social development, environmental sustainability, and community empowerment. Students gain practical exposure while directly contributing to SDG-linked activities.

2. Joint Community Outreach Programs

KARE and partner NGOs conduct:

- Health awareness drives
- Skill development workshops
- Environmental conservation initiatives
- Women empowerment programs
- Rural education and digital literacy initiatives

These programs help address local community needs while giving students meaningful experiential learning.

3. Collaborative Research and Data Collection

Faculty and students work with NGOs on:

- Field surveys
- Impact assessments
- SDG-related research studies
- Policy recommendations for local governance

These projects support academic learning while improving the effectiveness of NGO interventions.

4. Capacity Building and Training

NGOs conduct training sessions for students on topics such as:

- Sustainable development
- Waste management
- Climate change awareness
- Health and hygiene
- Social entrepreneurship

These activities strengthen students' knowledge and inspire socially responsible behaviour.

5. Volunteering and Internship Opportunities

Students engage with NGOs through:

- Short-term volunteering
- Long-term service-learning projects
- Internships in community development

Such experiences enhance civic responsibility and professional skills.

Community Service/Focused Project

A community service or focused project at a university is designed to engage students in meaningful work that benefits local communities. These projects often involve collaboration with community organizations and address specific social, economic, or environmental issues. Students can gain practical experience while developing skills such as teamwork, leadership, and problem-solving.

Typically, these initiatives encourage students to apply their academic knowledge in real-world contexts, fostering a sense of social responsibility and civic engagement. Projects may include activities like tutoring, environmental conservation, health awareness campaigns, or infrastructure development, contributing positively to both the community and the students' personal growth.

Some of the Sustainable Community Service projects by students are listed below.

Course Title	Notes	Related SDG Goals
B.Tech (Civil) – Smart Conservation of Water Resources	Focuses on innovative techniques to preserve and optimize water usage. Emphasizes sustainable practices for long-term resource management.	SDG 6, SDG 12
B.Tech (Bio) – Techno-Economic Analysis of Byproduct Production from Wastewater Effluents	Evaluates the economic viability of extracting valuable byproducts from wastewater. Combines technical and financial assessment for waste-to-resource solutions.	SDG 6, SDG 9, SDG 12
B.Tech (Civil) – Water Quality Analysis	Covers methods to test and ensure safe water standards. Addresses contaminants and treatment protocols for clean water supply.	SDG 6, SDG 3
B.Tech (Civil) – Design-Build Water Pressure Management Systems	Involves designing systems to regulate water pressure efficiently. Aims to reduce leaks and improve distribution network performance.	SDG 6, SDG 9

B.Tech – EXSEL Course on Water Reuse	Teaches advanced strategies for recycling and reusing water. Highlights applications in industrial and municipal settings.	SDG 6, SDG 11
B.Tech – Rainwater Harvesting	Explores techniques to collect and store rainwater for sustainable use. Reduces dependency on traditional water sources.	SDG 6, SDG 13
B.Tech (Civil, Biotech) – Wastewater Treatment and Nutrient Recovery	Focuses on treating wastewater while recovering nutrients like phosphorus. Supports circular economy in water management.	SDG 6, SDG 12
B.Tech (All) – Water Leakage Detection and Management	Uses technology to identify and mitigate water leaks in pipelines. Enhances conservation and cost savings.	SDG 6, SDG 9
B.Tech (Civil) – Water Pipe Descaling	Addresses methods to remove scale buildup in pipes. Improves water flow and system longevity.	SDG 6
B.Tech (All) – Water Pressure Management Systems	Combines treatment processes with advanced analysis for effluent quality. Ensures compliance with environmental standards.	SDG 6, SDG 9
B.Tech (All) – Wastewater Treatment and Analytical Techniques	Promotes effective waste separation to maximize recycling. Reduces landfill dependency and environmental impact.	SDG 6, SDG 12
B.Tech (All) – Sustainable Waste Sorting and Segregation for Resource Efficiency	Strategies to recycle and repurpose plastic waste. Aligns with circular economy principles to minimize pollution.	SDG 12, SDG 11
B.Tech (All) – Plastic Waste Management and Circular Economy	Techniques for recycling and reusing plastic waste. Reduces pollution and supports sustainable production.	SDG 12, SDG 14, SDG 15

B.Tech (All) – Sustainable Metal Waste Management	Techniques for recycling and reusing metal waste. Reduces mining demand and energy consumption.	SDG 12, SDG 13
B.Tech (All) – Agricultural Waste Management	Focuses on converting farm waste into useful products like compost or biofuel. Enhances sustainability in agriculture.	SDG 2, SDG 12, SDG 13
B.Tech (All) – Sustainable Food Waste Processing: From Degradation to Product Development	Transforms food waste into value-added products. Addresses food security and waste reduction.	SDG 2, SDG 12
B.Tech (All) – Textile Waste Recycling and Circular Economy	Solutions for recycling textile waste into new materials. Supports sustainable fashion initiatives.	SDG 12, SDG 8
B.B.A, M.B.A, B.Tech (Civil, Biotech, Chemical) – Textile Solid Waste Management and Circular Economy	Promotes sustainable management of textile waste through industrial and business models.	SDG 9, SDG 12, SDG 8
Biotechnology, Biomedical Engg – Biomedical Waste Management	Safe disposal and treatment of medical waste. Prevents health hazards and environmental contamination.	SDG 3, SDG 12
B.Tech (All) – Paper Waste Management and Circular Economy	Encourages recycling paper waste into new products. Reduces deforestation and carbon footprint.	SDG 12, SDG 15
B.Tech (EEE) – Battery Waste Management	Proper disposal and recycling of used batteries. Mitigates toxic leakage and recovers valuable metals.	SDG 12, SDG 13
B.Tech (Civil, Mech) – Hazardous Waste Management and Circular Economy	Manages dangerous waste through safe treatment and recycling. Minimizes environmental and public health risks.	SDG 3, SDG 12, SDG 13

B.Tech (EEE, Aero) – Electric Vehicle Integration (E-Mobility)	Covers EV technology and infrastructure development. Accelerates transition to clean transportation.	SDG 7, SDG 11, SDG 13
M.Tech (VLSI), M.Sc (Physics) – Microgrid System	Designs localized energy grids integrating renewable sources. Enhances energy reliability and sustainability.	SDG 7, SDG 9, SDG 13
B.Tech (EEE), B.Tech (Aero), B.B.A – Wind Energy Conversion System	Explores wind power generation technologies for renewable energy production.	SDG 7, SDG 13
B.Tech (Civil, EEE), B.Sc (Viscom) – Energy Efficient Devices / Energy Efficiency Improvement	Promotes appliances and systems that reduce energy consumption and cost.	SDG 7, SDG 12, SDG 13
M.Sc (Physics) – Solar PV System	Installs and maintains photovoltaic systems for solar energy. Expands renewable energy adoption.	SDG 7, SDG 13
B.Tech (All) – Energy Storage System	Technologies like batteries for storing renewable energy. Ensures stability in power supply.	SDG 7, SDG 9, SDG 13
B.Tech (Civil), M.Sc (Physics) – Solar Thermal Systems	Uses sunlight for heating applications. Provides an eco-friendly alternative to fossil fuels.	SDG 7, SDG 13
M.B.A, B.Sc (Physics) – Smart Building Energy Management	Optimizes energy use in buildings via automation and monitoring.	SDG 7, SDG 9, SDG 11
B.Sc, M.Sc (Physics) – Solar Optimizer for Remote Off-Grid Areas	Tailors solar solutions for remote regions to improve access.	SDG 7, SDG 10

B.Tech (All) – Battery Management Systems and Modeling	Monitors and optimizes battery performance for EVs and renewable energy storage.	SDG 7, SDG 13
B.Tech (All) – Smart Transport Application Development	Creates apps for efficient transport planning to reduce congestion.	SDG 11, SDG 13
B.Tech (All) – Eco-friendly Automation for Transport	Integrates green tech in transportation to reduce emissions.	SDG 9, SDG 11, SDG 13
B.Tech (All) – Transportation: Smart Bicycle	Promotes tech-enabled cycling for health and urban sustainability.	SDG 3, SDG 11, SDG 13
B.Tech (All) – Smart Route Planning for Demand-Responsive Transit Systems	Uses data to optimize public transport efficiency.	SDG 9, SDG 11, SDG 13
B.Tech (EEE, ECE) – Transportation: Battery Electric Vehicles	Focuses on BEV technology and adoption challenges.	SDG 7, SDG 11, SDG 13
B.Sc (Mathematics) – Transport Accessibility Planning	Ensures inclusive transport systems for differently abled and elderly.	SDG 10, SDG 11
B.Tech (EEE, ECE, B.Sc Physics) – Emissions Reduction from Transportation	Strategies to lower greenhouse gas emissions through alternative fuels and policies.	SDG 13, SDG 11
B.Tech (All) – Public Transport Optimization using Data Analytics and Smart Systems	Leverages data to improve public transit reliability.	SDG 9, SDG 11, SDG 13
B.Tech (All) – Driver Behavior Monitoring	Uses technology to enhance road safety and fuel efficiency.	SDG 3, SDG 11, SDG 13
B.Tech (All) – Smart Parking System using IoT	Implements IoT for real-time parking solutions to reduce congestion.	SDG 9, SDG 11, SDG 13

Design Project - EXSEL

A design project conducted at the University for the welfare of the community involves collaborating directly with community members to identify their needs and challenges. In this initiative, students gather problem statements through surveys, interviews, or workshops, ensuring that the projects are grounded in real-world issues faced by the community.

Once the problems are identified, students work in teams to develop innovative solutions, applying their design and engineering skills. These projects not only address specific community needs but also encourage students to engage with the community, fostering collaboration and understanding. The outcome may include prototypes, strategic plans, or other tangible deliverables that can be implemented to improve the quality of life for community members. This hands-on approach helps students learn about social impact while contributing to the welfare of the community.

EXperiential and SErvice Learning – EXSEL

Preamble

EXperiential and SErvice Learning – EXSEL links the teaching, learning and research activities of the university to the community to address the specific needs of the society. EXSEL operates in two phases namely experiential core *design-build* and experiential core *design-build-operate*. Its mandatory for all the students to engage in SDG/ community (NGO, Industries) associated real time problem solving. Faculty members are clustered in chosen SDG themes and mentoring multi-disciplinary student teams.

In experiential core *design-build*, teams will understand the problem statement chosen, by the detailed study/ survey on existing product and by developing the conceptual design .
In experiential core *design-build-operate*, teams will develop detailed design of all the components used in the conceptual design and develop the product, which may be deployed to be operational to get the first-hand feedback from the end user.
Digital notes: All the members in the team are expected to note their findings and learnings individually in the digital notes

Scope

This document is applicable to all the students, Faculty members, Community involved in the EXSEL.

Stages of EXSEL

The following stages are involved in the complete cycle of any product

1. Problem Formulation
2. Survey on existing product (Product Analysis)
3. Product Requirement and specifications
4. Conceptual Design
5. Detailed design
6. Prototype/ Product development

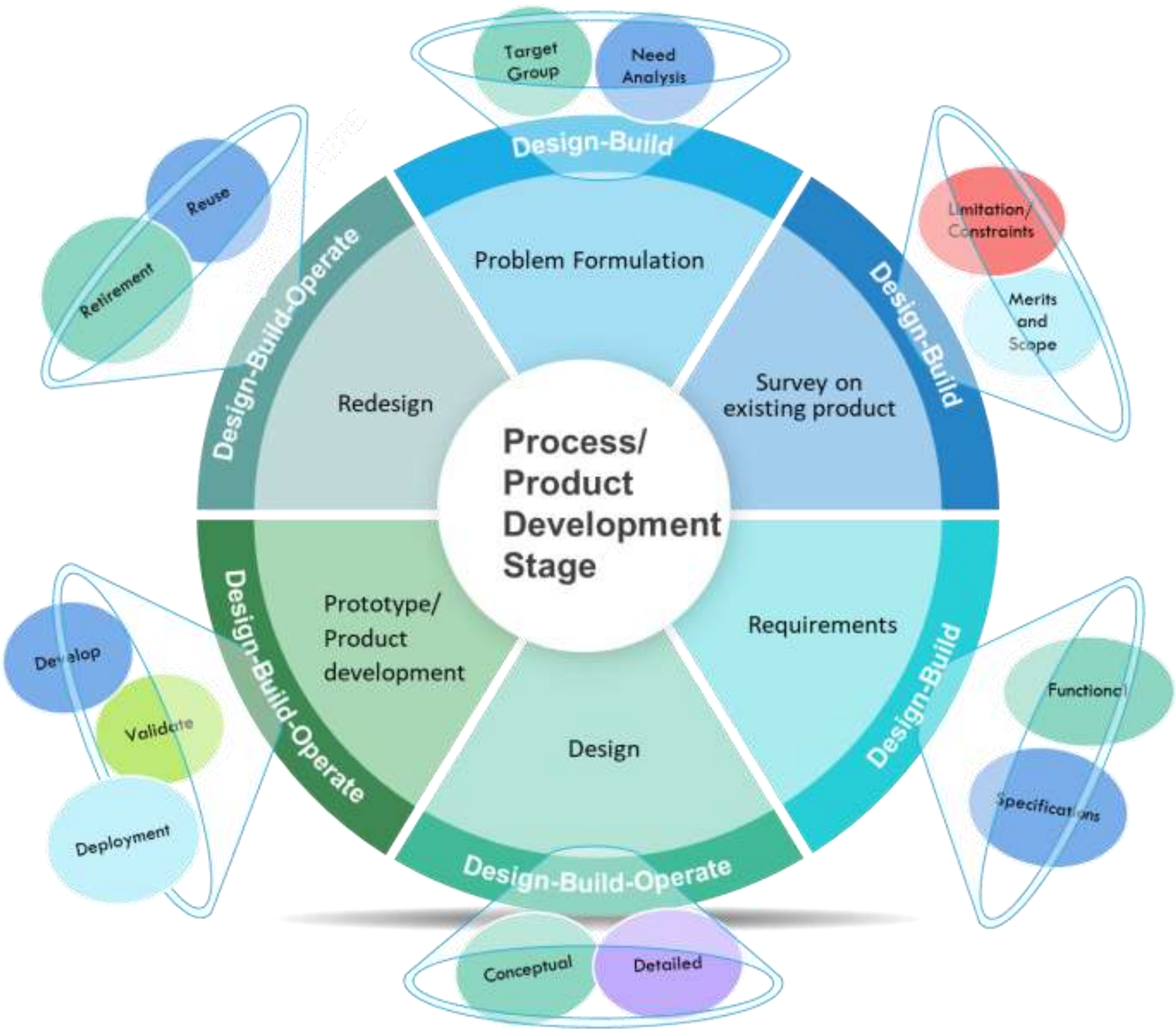
Whenever a new problem statements from the identified SDGs

- Climate Change (SDG 13)
- Clean Energy (SDG 7)
- Food Security and Nutrition (SDG 2)
- Sustainable Agriculture (SDG 2)
- Wellbeing for all at all ages (SDG 3)

or community (NGO / Industry) are floated or identified it should be started from the problem formulation stage. Existing problem statement will move to the next stages along with the existing students and the new students team. Always there will be provision of scope creep based on the feedback received from the various stakeholders.

New students team joining in the existing problem statements should spend minimum 2/ 3 weeks in studying the existing product in the market / detailed study of the solution developed as of now to the existing problem.

Figure 1 Different Stages



Section 1- Problem Formulation

In the overall scope of the EXSEL the problem statements are evolved through the following three categories

- SDG's Theme (Based on the theme allotted faculty floating the broad problem statement)
- NGO's (Based on the visit and interaction of the faculty members and the students with the NGO)
- Industries (Based on the requirement of the industries or international partners problem statements are framed)

SDG themes

Out of the 17 Sustainable goals identified and announced by the United Nations, the following four SDGs as five themes are identified, based on the infrastructure, faculty expertise and the programme offered

- Climate Change(SDG 13)
- Clean Energy(SDG 7)
- Food Security and Nutrition (SDG 2)
- Sustainable Agriculture (SDG 2)
- Wellbeing for all at all ages (SDG 3)

Need Analysis

A student team should analyse the broad problem statement given by the faculty members (in any one of the abovementioned themes) / identified based on the interaction with NGO/ industry/ international partner and conduct the need assessment for narrowing down the problem statement.

Problem identification and Definition

The faculty team and the students team discuss together to narrow down the problem definition with the preliminary objective of the problem statements.

Apart from problem identification and definition. as it is a multidisciplinary team from different programme and different year students are expected to interact each other and understand the technical strengths of each member and develop the interpersonal skills.

Confirmation of problem statement by University/ NGO/ Industry or University Partner

The defined problem statement for the development of the new or existing product must be approved by the team of expert members from the university and the Community involved (applicable for NGO/ Industry/ International universities) to ensure the quality of the product.

Documentation

This part ought to have a succinct explanation that responds to inquiries like:

- Why are you working on the project (i.e., what is the driving force behind it?)
- Innovation: How does your design is better than the solutions that are currently available
- Other than your consumer, who else will your project impact?
- Sustainability: what are all the positive impact to the environment
- Social Impact: How your design/ solution will impact in people's live
- Scalability: Feasible of your design to go to market at scale
- Economy/ Cost effective: How the design/ solution is cost effective from the exiting solutions
- Universal design/ Solution : Whether your design/ solution is universal irrespective of age, gender, physical condition, countries etc
- Who is vested in the project's success in a significant way?
- What results can be expected from the project?
- What are the requirements for the project to be a success

Survey on Existing product (Product analysis)

This phase is to emphasis the students' team to be aware of the existing products/ solutions already available in the market which is relevant to the Problem statement they selected. Students are expected to do the analysis which covers the both technical and nontechnical parameters as represented below

PRODUCT ANALYSIS – PARAMETERS TO CONSIDER

Features and Limitations of the existing products

Students are expected to study and understood the features and limitations of the existing product in the above technical and nontechnical parameters. Minimum five parameters need to be analysed in depth. (Minimum three existing solutions)

Constraints of the products

The constraints in the existing product need to be analysed (by interacting with the end user, studying the reviews of users or product feedback) in the above technical and non-technical parameters

Merits of the existing products:

The wow factor or merits of the existing product need to be analysed

Scope for improvement or new development

Based on the detailed analysis of the features, limitations and constraints of the existing product, students' team may propose / come out with the improvement in the existing product or development of a new product. Students team may list out the list of improvements possible in different parameters and in consultation with the faculty guide optimal solution proposed may be frozen as the objectives/ outcomes of the Design project

Matrix representing the Merits and demerits of the product has to be prepared

Product Name	Merits	Merit	Scope of Improvement/ Demerits	Scope of Improvement/ Demerits
Product 1				
Product 2				
Product 3				
Product 4				
Product 5				

Functional Requirements

Functional requirements in the concept development process of a design project refer to the specific capabilities, features, and functionalities that the design solution must possess to meet the needs of users and address the problem or challenge at hand. These requirements focus on the practical aspects of the design and define what the design should be able to do. Here are some key considerations for defining functional requirements during the concept development process:

User Needs: Identify the core needs and expectations of the target users. What problems or challenges should the design solution address? Consider factors such as usability, ease of interaction, accessibility, and user satisfaction.

Use Cases: Define the different scenarios or situations in which the product will be used. This helps identify the specific tasks, actions, or interactions that the design should support. For each use case, determine the required functionalities and features.

Task Analysis: Analyze the tasks and activities that users will perform using the project. Break down these tasks into smaller steps and identify the functionality needed to support each step. Consider factors such as input/output requirements, data processing, and information flow.

Functional Scope: Determine the boundaries and scope of the design solution. What functionalities will be included, and what will be excluded? Consider the project constraints, technological limitations, and available resources.

Integration Requirements: If the design needs to integrate with other systems, platforms, or technologies, define the integration requirements. Identify the necessary interfaces, protocols, or compatibility criteria that need to be met.

Performance Metrics: Specify the desired performance metrics and benchmarks for the design. For example, if it's a software application, consider factors such as response time, loading speed, processing capacity, or data storage requirements.

Safety and Security: Identify any safety or security requirements that need to be considered in the design. This may include data protection, user privacy, compliance with regulations, or physical safety considerations.

Scalability and Flexibility: Consider the future scalability and flexibility of the design solution. Will it be able to accommodate potential growth or changes in user needs? Define any scalability or flexibility requirements that should be met.

Constraints and Trade-offs: Recognize the limitations and trade-offs that may need to be made. Consider factors such as budget, time constraints, technical feasibility, and resource availability. Balance the desired functionalities with the practical constraints of the project.

It's important to involve stakeholders, users, and technical experts during the process of defining functional requirements. This helps ensure that the requirements are comprehensive, realistic, and aligned with the project goals and user needs. The functional requirements serve as a foundation for the subsequent design and development phases, guiding the creation of prototypes, wireframes, and ultimately the final product or solution.

Output: Requirements document

Requirement name, what the requirement is, including units (measurable), how do we know it is achieved, where did it come from or the source of the requirement (e.g. user input)

3 Concept Design Phase

3.1 Brainstorming

Define Discuss the Problem: Clearly articulate the design problem you are trying to address. This helps focus the brainstorming session and ensures everyone is on the same page. As the team consists of diverse group of individuals with different backgrounds, perspectives, and expertise related to the design project. This variety can lead to more innovative and unique ideas.

Generate Ideas: Begin the brainstorming session by encouraging participants to generate as many ideas as possible. Encourage them to think freely and avoid self-censorship. Quantity is more important than quality at this stage.

Use Visualization Techniques: Utilize visual aids such as sketches, diagrams, or mood boards to help stimulate ideas and create a shared understanding of concepts.

Organize and Cluster Ideas: Review all the generated ideas and group them into clusters or categories based on their similarities or themes. This organization helps identify patterns and relationships between ideas.

Evaluate and Prioritize: Once you have a collection of ideas, evaluate them based on their feasibility, relevance, and alignment with the project goals. Prioritize the most promising ideas that you want to explore further.

Document and Capture Ideas: This can be done through notes, visual recordings, or a digital collaboration tool like Microsoft OneNote. Make sure all the ideas are recorded accurately.

Narrowing ideas: Create a decision matrix that evaluates the final ideas with the requirements for final concept selection. Compare at least five ideas in the decision matrix. Requirements should be weighted based on their importance.

Follow Up: After the brainstorming session, review the captured ideas, select the most viable ones, and create an action plan to move forward with the design project. Assign responsibilities and set deadlines for further development and implementation.

Products of this stage:

Brainstormed list of ideas (minimum number?)

To create a decision matrix, we will evaluate five ideas based on specific requirements and assign weights to each requirement based on their importance. Here's an example of a decision matrix comparing five ideas (Idea A, Idea B, Idea C, Idea D, and Idea E) against three requirements (Requirement 1, Requirement 2, and Requirement 3) with respective weights:

Ideas	**Requirement 1 (Weight: 4)**	**Requirement 2 (Weight: 5)**	**Requirement 3 (Weight: 3)**
Idea A			
Idea B			
Idea C			
Idea D			
Idea E			

Now, let's fill in the matrix by assigning scores to each idea based on how well they meet the requirements. The scoring can be based on a scale of 1 to 5, with 1 being the lowest and 5 being the highest.

Ideas	**Requirement 1 (Weight: 4)**	**Requirement 2 (Weight: 5)**	**Requirement 3 (Weight: 3)**
Idea A	4	3	5
Idea B	3	4	2
Idea C	5	5	4
Idea D	2	3	4
Idea E	4	4	3

Once the scores are assigned, we can calculate the weighted scores for each idea by multiplying the score with the corresponding weight.

Ideas	**Requirement 1 (Weight: 4)**	**Requirement 2 (Weight: 5)**	**Requirement 3 (Weight: 3)**	**Weighted Score**
Idea A	4	3	5	46
Idea B	3	4	2	38
Idea C	5	5	4	67
Idea D	2	3	4	35
Idea E	4	4	3	45

Finally, we can compare the weighted scores to determine the best idea based on the given requirements. In this example, Idea C has the highest weighted score of 67, indicating that it performs the best according to the specified requirements.

Please note that this is just an example, and the actual requirements, weights, and scores should be tailored to your specific project and criteria.

Clarification 2

The requirements listed below are for illustrative purposes only. In an actual project, it is important to collaborate with stakeholders, including end-users, domain experts, and project managers, to gather and refine the requirements to ensure they align with the project's goals and constraints.

Requirement 1: Response Time

Description: The system should have a response time of less than 100 milliseconds.

Unit: Milliseconds (ms)

Verification: Response time will be measured and tested using appropriate tools or benchmarks during system testing phase.

Source: Derived from user input and industry best practices.

Requirement 2: Power Consumption

Description: The system should consume less than 5 watts of power during normal operation.

Unit: Watts (W)

Verification: Power consumption will be measured using power monitoring equipment during system testing phase.

Source: Derived from efficiency goals and specifications provided by the project stakeholders.

Requirement 3: Memory Usage

Description: The system should use no more than 128 megabytes (MB) of memory for data storage and program execution.

Unit: Megabytes (MB)

Verification: Memory usage will be measured during system testing phase using appropriate monitoring tools or profiling techniques.

Source: Derived from hardware limitations and performance expectations provided by the project stakeholders.

Requirement 4: Reliability

Description: The system should have a mean time between failures (MTBF) of at least 10,000 hours.

Unit: Hours

Verification: Reliability testing will be conducted over an extended period to simulate real-world conditions and measure failure occurrences.

Source: Derived from reliability goals and industry standards for similar systems.

Requirement 5: User Interface Responsiveness

Description: The user interface of the system should respond to user inputs within 500 milliseconds.

Unit: Milliseconds (ms)

Verification: User interface response time will be measured and tested using appropriate tools or user feedback during system testing phase.

Source: Derived from user input and usability studies conducted with potential end-users.

Rubrics:

1. Originality and Impact:

1	2	3	4	5
Idea lacks originality and have minimal impact.	Limited originality with some potential impact.	Idea shows moderate originality and can have noticeable impact.	Idea demonstrates good originality and have a significant impact.	Idea is highly original, unique, and have a transformative impact.

2. Innovation and Uniqueness:

1	2	3	4	5
Lack of innovative thinking; idea is unoriginal and conventional.	Some attempts at innovation, but idea lack uniqueness.	Idea shows moderate levels of innovation and offer some unique elements.	Idea demonstrates good levels of innovation and incorporate unique elements.	Idea exhibits exceptional innovation and provide truly unique and novel approach.

3. Feasibility of Ideas:

1	2	3	4	5
Idea lacks practicality and feasibility; unlikely to be implemented.	Limited consideration of practicality; some ideas may be difficult to implement.	Idea is moderately feasible, with a mix of practical and less practical concepts	Idea demonstrates good feasibility; most are practical and implementable	Idea is highly feasible, with a strong focus on practicality and implementation

4. Problem Understanding:

1	2	3	4	5
Limited understanding of the problem or challenge.	Some understanding, but concepts do not address the core problem effectively.	Adequate understanding of the problem, with concepts partially addressing the core issue.	Good understanding of the problem, with concepts directly addressing the core issue.	Deep understanding of the problem, with concepts effectively addressing the core issue.

5. Adaptability to Real Problem:

1	2	3	4	5
Idea lacks relevance or fail to address the specific real problem effectively.	Some relevance to the real problem, but the concepts need further refinement.	Moderate relevance to the real problem, with concepts addressing key aspects.	Good relevance to the real problem, with concepts addressing most critical aspects.	Excellent relevance to the real problem, with concepts directly addressing all critical aspects.

6. Product Development Planning:

1	2	3	4	5
Lack of clear product development plan; no consideration of key development stages.	Limited product development planning; some stages or processes are missing or poorly defined.	Adequate product development planning; key stages and processes are defined but may lack detail.	Well-developed product development plan; all essential stages and processes are defined with reasonable detail.	Comprehensive product development plan; well-defined stages, processes, and milestones with thorough detail.

Decision matrix with final ideas compared to requirements.

Concept recommendation

3.2 Analyse and Synthesize the Concept

In the concept development phase of a design project, analysis and synthesis play critical roles in shaping and refining ideas to create viable concepts. Here's how analysis and synthesis are applied in this phase:

Analysis

- **Problem Analysis**
- **User Research**
- **Competitive Analysis**
- **Contextual Analysis**

Problem Analysis: Start by thoroughly understanding the problem or design challenge. Analyse its various aspects, constraints, and requirements. Consider the needs and goals of the target users or audience.

User Research: Conduct user research to gain insights into the users' behaviors, preferences, and pain points. This analysis helps create user personas, identify user journeys, and understand their needs and expectations.

Competitive Analysis: Analyse the offerings of competitors or similar products/services in the market. Identify their strengths, weaknesses, and unique selling points. This analysis helps identify gaps and opportunities for differentiation.

Contextual Analysis: Consider the broader context in which the design will be used. Analyse the environmental, social, cultural, and technological factors that may influence the design decisions.

Synthesis:

Idea Evaluation: Evaluate the generated ideas from brainstorming session conducted earlier against the established design criteria, user needs, and project objectives. Consider factors such as feasibility, desirability, viability, and technical constraints. This evaluation helps identify the most promising ideas for further development.

Concept Development: Combine and refine the selected ideas to create coherent and meaningful concepts. Explore different variations, iterations, and combinations to develop a range of design concepts that address the identified problem and user needs.

Prototyping: Create low-fidelity prototypes or mock-ups to visualize and communicate the concepts. Prototyping allows for quick testing and iteration, helping to refine the concepts further.

Throughout the concept development phase, analysis and synthesis are iterative processes that influence each other. The analysis provides insights and data that inform the synthesis process, while synthesis helps uncover new insights and perspectives that may require further analysis. This iterative approach ensures that the concepts are grounded in research and effectively address the identified problem and user needs.

3.3 Validation and feedback

Validation and feedback are crucial aspects of the concept development phase in a design project. They help ensure that the generated concepts are viable, effective, and aligned with user needs and project goals. Validation and feedback can be incorporated into the concept development process:

User Testing: Conduct user testing to gather feedback and insights on the initial concepts. Create prototypes or mock-ups of the concepts and have users interact with them. Observe their behavior, collect their feedback, and listen to their suggestions and concerns. User testing helps identify usability issues, uncover user preferences, and validate the effectiveness of the concepts.

Iterative Refinement: Based on the feedback and insights gained from user testing, iteratively refine and improve the concepts. Incorporate the feedback into the design, addressing any usability issues or concerns raised by users. This iterative process allows for continuous improvement and ensures that the concepts are well-adapted to user needs.

Expert Reviews: Seek feedback from domain experts, such as designers, engineers, or subject matter experts relevant to the project. Present the concepts to them and gather their insights and suggestions. Their expertise can provide valuable perspectives and help identify potential improvements or considerations that may have been overlooked.

Stakeholder Feedback: Engage with project stakeholders, including NGOs, industry, and other relevant parties. Present the concepts to them and gather their feedback, ensuring that the concepts align with their expectations and requirements. Stakeholder feedback helps ensure that the concepts are on track and meet the project objectives.

Concept Evaluation Criteria: Establish evaluation criteria or metrics to assess the viability and effectiveness of the concepts. Define specific criteria that the concepts should meet, such as user satisfaction, feasibility, alignment with project goals, or technical constraints. Evaluate the concepts against these criteria to determine their strengths and weaknesses.

Concept Presentation and Review: Present the refined concepts to the project team and stakeholders for review. Clearly communicate the design rationale, user insights, and any updates made based on feedback. Encourage open discussions and gather feedback and suggestions from the team and stakeholders. This collaborative review process helps refine the concepts further and ensures buy-in from key stakeholders.

Remember that validation and feedback are ongoing processes throughout the concept development phase. It's important to be open to feedback, embrace constructive criticism, and iterate on the concepts based on the insights gained. By incorporating validation and feedback, you can refine the concepts, address any issues, and increase the chances of developing a successful and well-received design solution.

3.4 Documentation

There are various methods of documenting the concept design phase of a design project. Here are some common methods you can consider:

Written Reports: Create a comprehensive written report that provides a detailed account of the concept design phase. This can include sections such as an executive summary, project background, research findings, concept descriptions, design rationale, user feedback, and next steps. Written reports are useful for capturing in-depth information and can be easily shared with stakeholders.

Presentation Decks: Develop a visual presentation that highlights the key aspects of the concept design phase. Use slides to convey the design brief, research insights, concept descriptions, visual representations, and design rationale. Presentation decks are effective for communicating concepts in a concise and visually engaging manner during meetings or design reviews.

Posters: Create concept boards or posters that visually represent the concepts developed during the design phase. Include key visuals, sketches, descriptions, and design rationale on the boards. Concept boards are particularly useful for presenting multiple concepts side by side, allowing stakeholders to compare and evaluate them.

Digital Prototypes: Build interactive digital prototypes that showcase the concepts. These prototypes can simulate the user experience and demonstrate the functionality and flow of the design. Capture screen recordings or create interactive demos to document the concepts in action. Digital prototypes are especially effective for conveying the interactive aspects of the design.

Online Collaboration Platforms: Utilize online collaboration platforms, such as project management tools or design collaboration software, to document and track the concept design phase. These platforms allow you to create project-specific sections, upload documents, share visuals, and gather feedback in a centralized and accessible manner.

Video Documentation: Record video presentations or walkthroughs of the concept design phase. Explain the research findings, concept development process, and the rationale behind each concept. Video documentation can provide a more dynamic and engaging way of presenting the concepts and can be easily shared with stakeholders.

Choose the methods that best suit your project, team, and stakeholders' preferences. Consider combining multiple methods to provide a comprehensive and well-rounded documentation of the concept design phase. Flexibility and adaptability in your documentation approach will allow you to effectively communicate and capture the essence of the concepts developed during the design project.

Prototype/Product Development

After the completion of the detailed design, the project team has to think about developing the prototype to ensure the functionality of the final product in real-time. Prototyping is an inevitable process before any product development in mass production to ensure effectiveness. There are many factors that need to be considered with rationale to achieve a better-performing prototype with minimal deviation from the target requirement. The following section provides information about the definition, types, purpose, and factors to be considered for the prototype development of different types of problem statements.

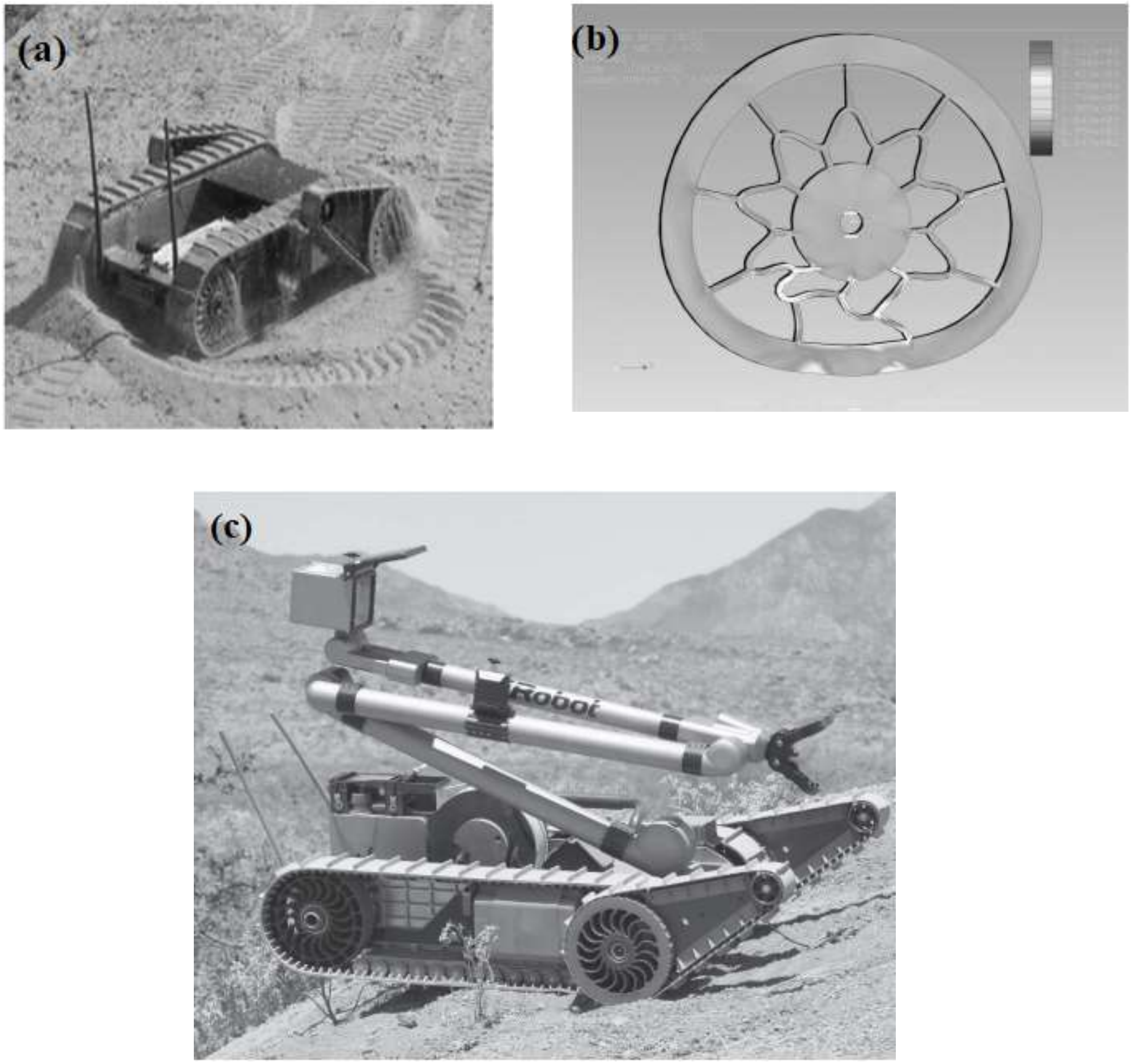
(a) Basics of Product prototyping

(i) Definition:

Prototype development is the process of replicating the working nature of the product for effective communication.

(ii) Types of Prototypes:

Prototypes can be used in different forms and at all stages of the design process to learn about the design or their requirements, to communicate with the user and to get information from stakeholders. Depending on the problem definition they can take many forms, like concept sketches, mathematical models, simulations, test components, and fully functional preproduction versions of the product. Prototypes can be analytical or physical, depending on the problem to be addressed. Examples of analytical prototypes include computer simulations, systems of equations encoded within a spreadsheet, and computer models of three-dimensional geometry. In general, physical prototypes have been extensively used to communicate ideas to customers. Examples of physical prototypes include models that look and feel like the product, proof-of-concept prototypes used to test an idea quickly, and experimental hardware used to validate the functionality of a product.



The above figure shows the (a) military robot physical prototypes under sand test conditions; (b) analytical prototype of robot wheel testing simulation; and (c) deployment of the robot in a real-time military operation.

(iii) Purpose of Prototypes:

Prototypes are mainly used for four purposes: learning, communication, integration, and milestones through which the functionality of the product can be improved.

Learning – The project team can understand the rationale for each activity of prototype development while performing testing and evaluation.

Communication – The designer can easily communicate with the customer based on the working model and receive specific feedback with respect to the modifications made in the previous stages.

Integration –The team members can identify and integrate the functions of various components used in the system and determine the efficiency of the outcomes and shortcomings to be addressed.

Milestone– Through this milestone prototype, the team members can provide tangible goals, demonstrate progress, and enforce the schedule. Sometimes the customer requires a prototype that demonstrates certain functions before proceeding with product development.

(b) Prototype development Process:

1. **Define the purpose of the prototype** –The specific needs and properties of the prototypes should be identified based on priority.

2. **Establish the level of approximation of the prototype** - The materials used, geometry, machining, boundary conditions, and loading to be applied have to be fixed.

3. **Outline an experimental plan** – To identify the suitable design of experiments for fabrication and testing through an iterative process reflecting the actual testing conditions to validate the performance of the prototype

4. **Create a schedule for procurement, construction, and testing** –To prepare the schedule for the entire prototype development process, starting from the procurement of materials, fabrication of components based on the design and specification, mechanisms, assembly, and testing.

5. **Identify the suitable technologies used for prototyping** – Based on the selection of the above parameters, the appropriate design for manufacturing has to be identified to reproduce the concept, design, and manufacturing technologies in a cost-effective manner. In this aspect, the recent developments in 3D CAD modelling, 3D printing and digital twin technologies have reduced the relative cost and time required to create and analyse prototypes.

(c) Demonstration of prototype –The project team has to demonstrate the fabricated prototype to the customer and gather information about its effectiveness and degree of approximation with respect to the expected product performance. As per the customer's suggestion, the modifications can be done at the appropriate stage to recreate the prototype.

(d) Product development –Based on the satisfying performance of the prototype, the project team can approach the industry for the commercialization of the product through a sustainable business model.

Associated Documents

Annexure 1: KARE Academic (B.Tech) Regulations, 2021
Annexure 2: Problem statements with intended Outcome
Annexure 3: Rubrics (Zeroth, First and final)
Annexure 4: Project Report Template
Annexure 5: Powerpoint Template
Annexure 6: List of Problem Statements with requirements

Patent review/design review

NOTE : Usage of Dervent need to be added