Pi-EV Team Management Report

Team Mechismu Racing Electric

(IIT ISM, Dhanbad)

Index:

(I) Main Section:

Team Goals:

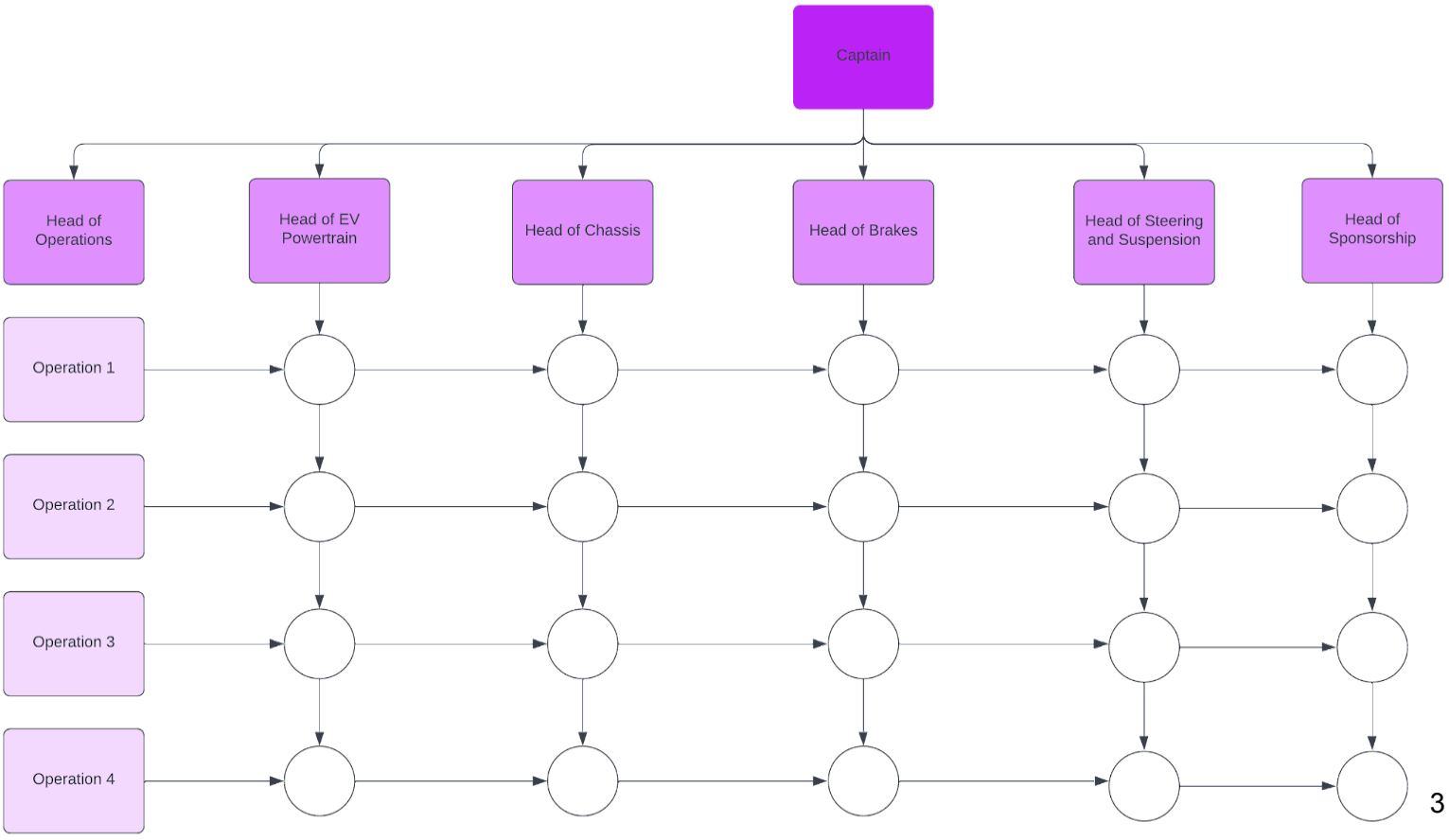
Orchestrating a project is one thing; building a solid team that is up to the task and can cooperate harmoniously is another.

Mechismu Racing Electric, the Formula Student team of the Indian Institute of Technology (Indian School of Mines) Dhanbad, intends to shift to the electric class of formula student in the near future. The 6th Annual FSEV Concept Challenge (Pi-EV 2022) has allowed us to conceptualize and design a Formula Student Electric Vehicle Powertrain Package that meets the Formula Bharat 2023 Rules booklet technical guidelines.

As part of this vision, the team has been working on designing an electric powertrain for a Formula Student car since late-2021. The event aims to ease the transition to the electric class by providing a platform where teams present their EV design without building a car and give feedback and corrections on their design.

Compared to combustion-based cars, an electric FSAE car needs significantly higher investment, and a higher percentage of electric teams fail to clear Technical Inspections at Formula Student events. The team feels it is essential to have the design thoroughly examined and scrutinized before building our first electric Formula Student car.

Team Structure

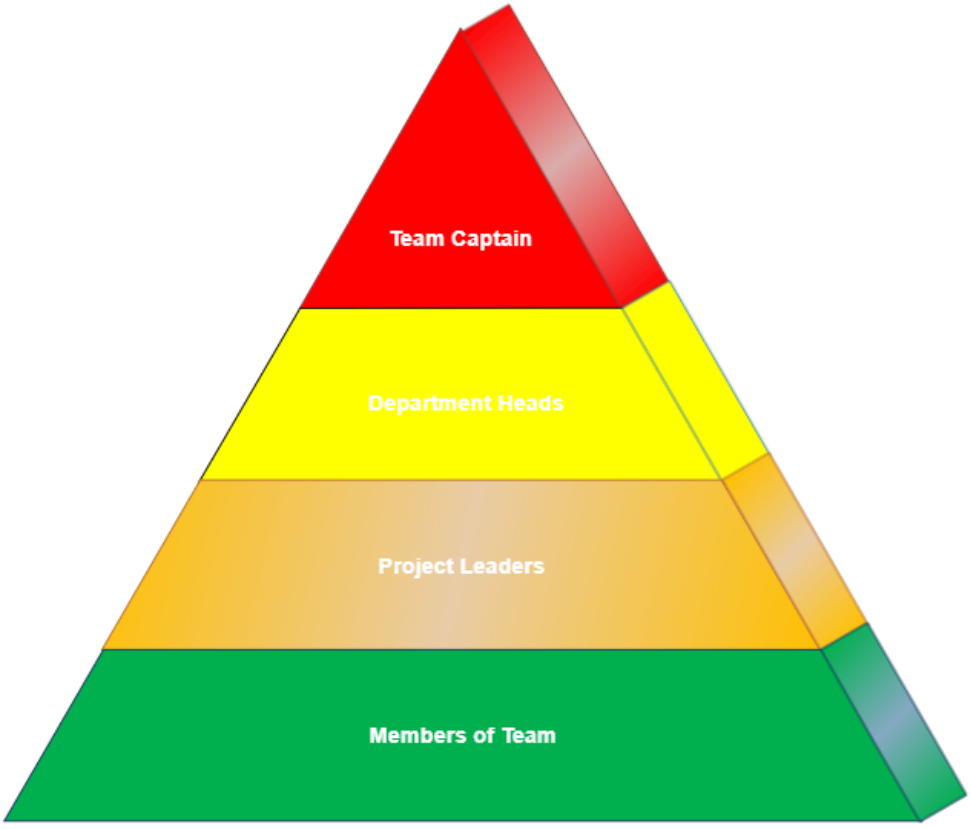


Our team structure is organized in a way such that it is functional as well as project-oriented. This type of structure is known as the matrix organization. In this organization, the teams report to multiple leaders, the project leader, and the department head. This type of arrangement allows open communication to occur, and the members of each department are well informed about the decisions being taken by other departments to adapt accordingly. This type of organization has the following benefits:

1. Higher Employee Engagement
2. Consistent Employee Growth
3. Increased Team Performance and Profitability

Disadvantages of a conventional matrix team organization are eliminated by taking the following steps. The issue of overlapping teams is eliminated as the department heads are the ones who lay down the plan and approach for the respective departments. The operation heads are responsible for monitoring the progress in each operation, setting deadlines, and ensuring that the projects are completed within the set deadlines. The issue of slower decision-making was not applicable in our case as this organizational structure helped us lay out the plans faster with more accuracy after discussion among the various departments.

Team Hierarchy:



The members of the team are answerable to their respective project leaders as well as their department heads. The project leaders manage the projects and report the progress to the Head of Operations. The heads of the various departments discuss with each other and are answerable to the team's captain.

Decision-Making Process:

Whenever the team makes a particular decision, the team is informed in advance to gather relevant information and identify alternatives before making the decision. A round table discussion takes place where everyone in the team has an equal say, irrespective of their position in the hierarchy. The right decision is then taken based on the majority of a range-voting. Range-voting is a method in which the members score each option, then the option with the highest average score is chosen, and the decision is made. However, the team captain, being the most experienced and knowledgeable in the team, is bestowed with an additional veto power to overrule a certain decision if they feel that it would be against the interests of the team and the spirit of Formula racing.

Conflict Management:

Problems:

1. Floundering
2. Overbearing
3. Dominant
4. Reluctant
5. Opinion w/o facts
6. Rush to accomplishment
7. Attribution
8. Discounts and Plops
9. Wanderlust
10. Feuding Team Members

Solutions:

•Select neutral territory
•Informal setting
•All appropriate people are present
•Set the agenda and ground rules, stick to them
•Manage time carefully
•Use active listening and constructive feedback skills during the session

Project Timeline:

Timeline is often the most frequent project oversight in developing projects. This is reflected in missed deadlines, incomplete activities, and late donor reports. Proper schedule control requires the careful identification of tasks to be performed, an accurate estimation of their durations, the sequence in which they will be done, and how people and other resources are allocated.

TIMELINE

The timeline has been split into three major phases– **CONCEPTUALIZATION, CALCULATION, SELECTION AND PROCUREMENT, ASSEMBLY, AND TESTING.**

Conceptualization

The November-December period was dedicated to the conceptualization of the project. Multiple resources were referred to, performance targets were set, a suitable timeline was prepared, and a budget report was put together.

Calculation, Selection, and Procurement

The whole of January month was dedicated to motor sizing, calculations, and selection, motor controller selection, battery-pack sizing and calculations, and motor mountings' design and manufacture, accompanied by vendor selection and payment for motor and battery pack. The purchase of AIRs, IMD, HVD, gears, chain drives, fuses, insulations, harnesses, connectors, data logging devices, etc., was also made. Procurement of motor, motor controller, battery back with BMS, onboard battery charger, sensors, and testing was completed by March. HV/LV connectors and PCBs of safety circuits were acquired by April.

Assembly and Testing

The April-August period will be utilized for the assembly, testing, and automobile tuning.
Risk analysis, assumptions, constraints, and mitigation

RISKS IN TIMELINE

- Delay in completion of a certain task
- Delay in procurement delivery leading to delay in the timeline
- Outbreak of disease/ natural calamity causing a stoppage in progress
- Scope Creep- Initial project objectives are not met, and work goes on as extra objectives
- The vendor is unable to make a deal for a part, causing a stoppage in work
- Getting the sequence of milestones in the project wrong would get the timeline off
- Misplacing/ Damaging resources potentially compromising the project timelines
- Replacement of part(s), if required, may cause a delay in the timeline

TIMELINE ASSUMPTIONS

Reviewing the project timelines of various teams from previous years and taking into account the size of the team and a unanimous set of deadlines set by multiple teams, a reasonable timeline was put together.

TIMELINE CONSTRAINTS

Work on the charger, AIRs, and IMD cannot be done until and unless we know the battery's specifications. Similarly, work on the battery will be constrained if motor specifications are unknown. Since all the components are interdependent, a proper sequence of events must be set. To get the sequence of the targets in the project timeline right, proper ground research is done before preparing the timeline, and other teams are contacted to learn from their experiences and mistakes.

TIMELINE RISKS AND CONSTRAINTS MITIGATION

- Realistic deadlines are set, and progress is tracked regularly to avoid delays in completion of a certain task.
- Procurement delay can be avoided by visualization of supply chains, contacting reliable vendors, maintaining effective communication with vendors, taking constant updates on procurement delivery, and contacting other vendors for backup in case of any mishap.
- In case of an outbreak of disease/ natural calamity, the prime concern will be the safety of team members. Proper rules and regulations will be followed while interacting with people.
- Clear communication and feedback and proper management of new ideas will be ensured to avoid scope creep.
- To get the sequence of the targets in the project timeline right, proper ground research is done before preparing the timeline, and other teams are contacted to learn from their experiences and mistakes.
- To avoid misplacing/ damaging parts, extra care is taken when packaging or unpackaging goods. Also, it is crucial to keep the workplace clean and not cluttered.

Human Resource Capability:

The human resource includes the project team, whose contribution is on a physical or intellectual level. Team Mechismu Racing Electric had a very significant contribution from the human resources.

Recruitment

Each individual in the team was among the most skilled and knowledgeable in the college, and they made their way into the team after a rigorous recruitment process. The individuals interested in joining the team were first taught in workshops conducted by the existing team members. In this way, the incoming members always carried on from where the current members left off, thus allowing improvement in the performance of the team year after year. The individuals then had to pass an exam that tested their grasp in the domain of Formula Student vehicles and their general aptitude. After passing their first-level filter, these candidates had to prepare a group case study assigned to them by mentors from the team. This was a yardstick to evaluate the individual's ability to work in a team, their presentation and communication skills, and their research skills and grasp of the department. The final selection criteria were the interview process where each candidate was interviewed. The team members were able to estimate the individual's zeal to work and contribute to the team and understand their skills and their departmental interests. The top-performing individuals were then recruited into the team.

Retention

Preparing for an FSAE event can be challenging mentally and physically. To keep the members motivated and mentally active, the team decided to hold regular one-to-one interactions with the captain where the members could communicate any problems or difficulties they were having. Continuous feedback was taken on the team's performance, and practical actions were taken. Regular training sessions were kept to make each individual feel like they were learning something new and working towards a common goal.

Every member was given recognition and appreciation for the work they did. Those who performed well were rewarded with a leadership role in the team. This reward system kept the members motivated to work and excel in their field of work.

Occasional team outings to play a sport or a tour to a go-karting circuit were made. This acted as a fun experience that helped the members to take their minds off the work while building team unity and communication.

Financial Management:

Financial Resources

Financial resources for our team came from four significant sources, as mentioned below:

College

The institute had funds available to assist in the completion of student projects. These funds can be accessed through the institute's purchasing system. The limit of these funds is approximately **Rs. 3,00,000** for the team.

Naresh Vashisht Centre for Tinkering and Innovation (NVCTI) IIT(ISM) Dhanbad

NVCTI is an organization based in IIT (ISM) Dhanbad, which funds students for any innovative idea in a field of importance. The organization recognized our project on electric vehicles and decided to provide us with a certain fund for our project. Funds of about **Rs. 11,25,000** were provided for the electric vehicle powertrain department.

Sponsorship

Several sponsors made donations to the team. These donations are detailed in Appendix. In total, **Rs. 5,00,000** is donated to our team, of which **Rs. 3,25,000** is used for the electric vehicle powertrain.

Crowdfunding

Fundraising activities had the dual purpose of raising funds and providing exposure for the team and sponsors. In total, approximately **Rs. 3,50,000** was raised through crowdfunding. Out of this, an amount of **Rs. 1,75,000** was used for the electric vehicle powertrain.

Cost Estimation and Financial Control

The management team was in charge of managing finances. Each team member calculated the cost of the components needed for their area of the design. The management head studied this pricing further and completed purchasing approvals. Our team's goal is to build a competitive race car at the lowest possible cost. Engineers employed engineering judgment to decide whether a component's price was reasonable.

Budget and Investment Allocation

Our team approached sponsors during the duration of the 2022-2023 academic year to raise the necessary funds for the components that needed to be bought. A business presentation was developed, then modified for each potential sponsor. The team successfully raised a total of Rs. 19,25,000, which is sufficient to cover all project costs. Significant contributions came from the college, NVCTI, crowdfunding, and sponsors. Our team's largest expenses were on the battery pack, motor, and motor controller. Our team focused on buying these three major components using most of our budget to maximize performance and used the remaining funding to procure the remaining parts. The Appendix has a detailed budget, showing the cost of each component. The team's purchases and the money spent were put on a spreadsheet so that the team has a reference to how much money we had. Our team also keeps an account of our current expenses.

Communication Methods and Protocols:

Communication within the team was achieved through holding open meetings. Meetings were held online during the COVID phase on Google Meet. This allowed the team to conduct quick, hassle-free meetings and easily share and explain documents and plans. Recording meets and sharing documents permitted the members to go through the main highlights of the meeting as many times as they required. It was often beneficial to hold one-to-one meetings. This allowed us to check in on the individual progress of each member and discuss any problems that they might be facing in terms of work or their personal life.

Physical meetings were held once COVID protocols were relaxed. This allowed the team to share their ideas and concepts on the whiteboard. This was an added benefit, as working together as a team in one physical space uplifted the morale of the team members.

Our team used shareable Google Documents and Spreadsheets to document all the work that was being done collaboratively. They provided various team-friendly features and were of great use, especially to teams like us. The ‘Add Comments’ option allowed us to tag members specifically and tell them if something needed to be edited or added to the document. The member would receive a notification through email when they were tagged in a comment. This allowed for a streamlined workflow.

Good communication practices were followed. A receptive environment was maintained in the team, and suggestions and new ideas were always welcomed. Whenever a speaker was presenting, the rest of the group listened carefully until the floor was open to questions and feedback. Each member has an equal right to voice their opinions and thoughts irrespective of their hierarchical position or year of study. Feedback and queries were entertained once the speaker had finished speaking. This was an essential process as it allowed the members to clearly understand what was being discussed and let the speaker know what the team thought about the topic they had presented.

Last but not least, a positive environment was created in the team, where everyone was appreciated for their work, and members often provided a helping hand to one another in times of need. All this resulted from good communication and understanding that the members had developed over time in the team.

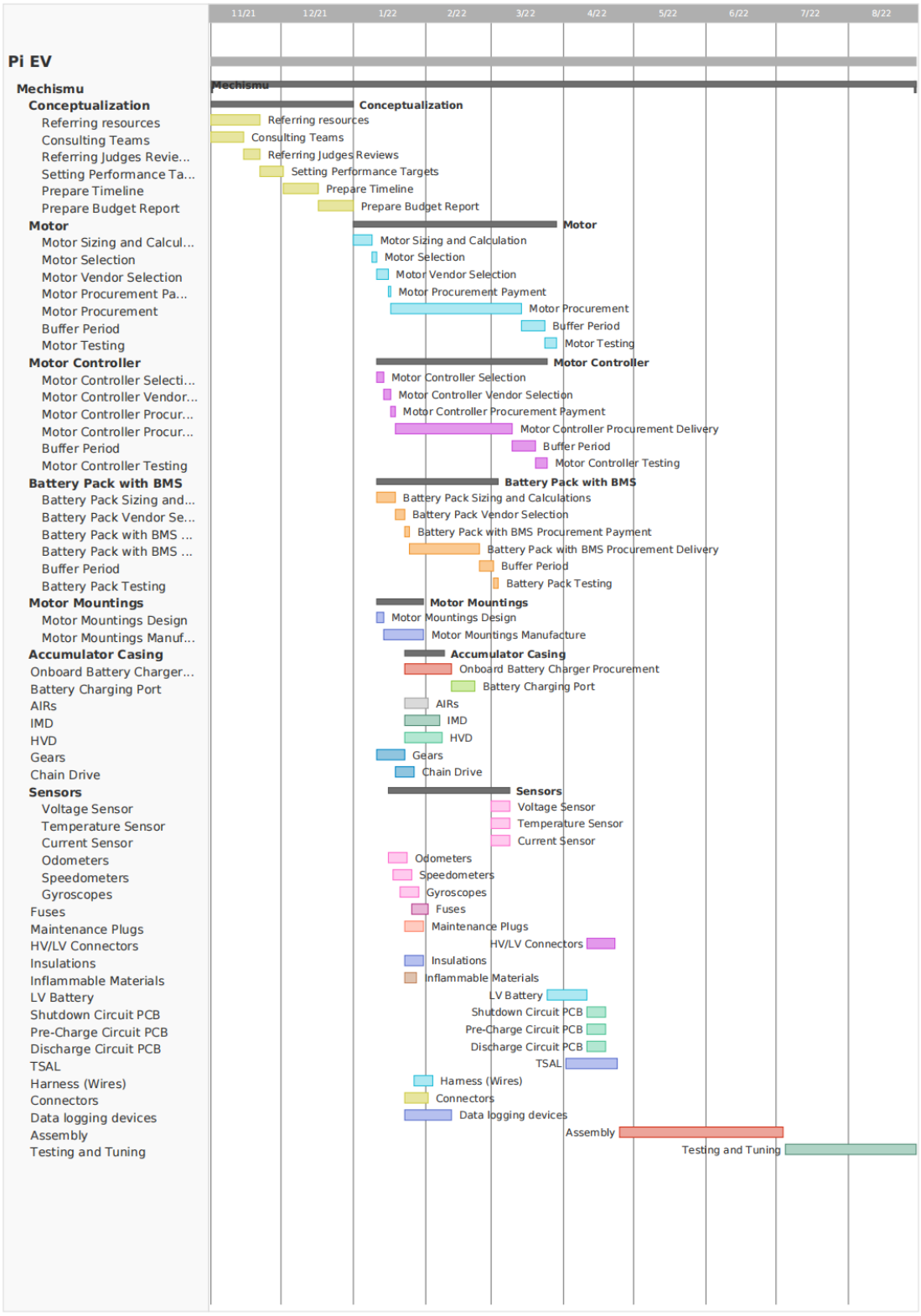
Media and Marketing Strategies and Protocols:

The main objective is to provide a capable, environmentally friendly, and elegant race car. Automobiles are recognized as more than just a mode of mobility for the intended market. The vehicle is positioned as a superb product with a high-performance design that is also revolutionary. We don't use any fuel. Therefore it employs modern technologies to deliver a clean overall experience.

The world leaders have set a target to ultimately convert to clean energy transport by the year 2050, which is the first step towards that. Our team will showcase our vehicle as a product that can outperform conventional IC engine cars and emphasize the need to switch to cleaner energy transport options. Supporting this with data on the pollution in India from traditional transport methods will give us an upper hand. This will help us attract funds from all over the country.

Our team will keep our social media handles and website up-to-date with the latest trends and updates in the EV industry through news posts, blogs, and seminars. Regular advertisements will be placed in newspapers, pertinent journals, and other periodicals. The product will be displayed at various tech events to demonstrate our car's capabilities. This will provide us with insight into the minds of younger generations while also broadening our exposure.

Appendix


11/21
12/21
1/22
2/22
3/22
4/22
5/22
6/22
7/22
8/22
Pi EV
Mechismu
Conceptualization
Referring resources
Consulting Teams
Referring Judges Revie...
Setting Performance Ta...
Prepare Timeline
Prepare Budget Report
Motor
Motor Sizing and Calcul...
Motor Selection
Motor Vendor Selection
Motor Procurement Pa...
Motor Procurement
Buffer Period
Motor Testing
Motor Controller
Motor Controller Selecti...
Motor Controller Vendor...
Motor Controller Procur...
Motor Controller Procur...
Buffer Period
Motor Controller Testing
Battery Pack with BMS
Battery Pack Sizing and...
Battery Pack Vendor Se...
Battery Pack with BMS ...
Battery Pack with BMS ...
Buffer Period
Battery Pack Testing
Motor Mountings
Motor Mountings Design
Motor Mountings Manuf...
Accumulator Casing
Onboard Battery Charger...
Battery Charging Port
AIRs
IMD
HVD
Gears
Chain Drive
Sensors
Voltage Sensor
Temperature Sensor
Current Sensor
Odometers
Speedometers
Gyroscopes
Fuses
Maintenance Plugs
HV/LV Connectors
Insulations
Inflammable Materials
LV Battery
Shutdown Circuit PCB
Pre-Charge Circuit PCB
Discharge Circuit PCB
TSAL
Harness (Wires)
Connectors
Data logging devices
Assembly
Testing and Tuning
Mechismu
Conceptualization
Referring resources
Consulting Teams
Referring Judges Reviews
Setting Performance Targets
Prepare Timeline
Prepare Budget Report
Motor
Motor Sizing and Calculation
Motor Selection
Motor Vendor Selection
Motor Procurement Payment
Motor Procurement
Buffer Period
Motor Testing
Motor Controller
Motor Controller Selection
Motor Controller Vendor Selection
Motor Controller Procurement Payment
Motor Controller Procurement Delivery
Buffer Period
Motor Controller Testing
Battery Pack with BMS
Battery Pack Sizing and Calculations
Battery Pack Vendor Selection
Battery Pack with BMS Procurement Payment
Battery Pack with BMS Procurement Delivery
Buffer Period
Battery Pack Testing
Motor Mountings
Motor Mountings Design
Motor Mountings Manufacture
Accumulator Casing
Onboard Battery Charger Procurement
Battery Charging Port
AIRs
IMD
HVD
Gears
Chain Drive
Sensors
Voltage Sensor
Temperature Sensor
Current Sensor
Odometers
Speedometers
Gyroscopes
Fuses
Maintenance Plugs
HV/LV Connectors
Insulations
Inflammable Materials
LV Battery
Shutdown Circuit PCB
Pre-Charge Circuit PCB
Discharge Circuit PCB
TSAL
Harness (Wires)
Connectors
Data logging devices
Assembly
Testing and Tuning

RISK DESCRIPTION	IMPACT DESCRIPTION	IMPACT LEVEL	PROBABILITY LEVEL	RISK LEVEL	MITIGATION NOTES
Give a brief summary of the risk.	What will happen if the risk is not mitigated or eliminated?	Rate 1 (LOW) to 5 (HIGH)	Rate 1 (LOW) to 5 (HIGH)	(IMPACT X PROBABILITY) Address the highest first.	What can be done to lower or eliminate the impact or probability?
Delay in completion of a certain task	1. Delay in Timeline 2. Missing deadlines	2	5	10	1. Setting realistic deadlines 2. Knowledge Management 3. Tracking progress regularly
Delay in procurement delivery	1. Delay in timeline	3	3	9	1. Visualization of supply chains 2. Maintaining effective communication with vendors and taking constant updates on procurement delivery
Outbreak of disease/ Natural calamity	1. Delay in timeline 2. Delay in Procurement 3. Financial Losses	5	1	5	1. Prime concern is to keep the team members safe. 2. Maintain proper rules and regulations while interacting with people.
Scope Creep	1. Delay in Timeline 2. Resource Constraints	2	3	6	1. Clear Communication and Feedback 2. Assessment and Estimation 3. Managing New Ideas Effectively
Vendor is unable to deal the part	1. Delay in Timeline 2. Delay in Procurement	4	2	8	1. Reliable vendors are contacted 2. Other vendors are also contacted for backup in case of any mishap
Getting the sequence of the targets in the project timeline wrong	1. Delay in Timeline 2. Delay in Procurement 3. Financial Losses	5	2	10	1. Proper ground research is done before preparing timeline 2. Other teams are contacted in order to learn from their experiences and mistakes
Misplacing/Damaging parts	1. Delay in Timeline 2. Financial Losses	4	2	8	1. Extra care when packaging or unpackaging goods 2. Workplace is kept clean and not cluttered
Replacement of part if required	1. Delay in timeline	3	3	9	1. Maintaining effective communication with vendors and asking them for visu proof of the parts to make sure they are as required and not damaged 2. Vendors are asked to send pictures of the part before delivery
Product is not able to be delivered	1. Delay in timeline 2. Delay in procurement	4	1	4	1. Maintaining effective communication with vendors 2. Reliable vendors are contacted
Unorganized supplier relationship management	1. Faulty Procurement 2. Financial Losses	4	1	4	1. Use of supplier management software/tools to keep track of information about the suppliers in one place 2. Maintaining effective communication with vendors
Poor supplier performance	1. Delay in Timeline 2. Compromise in Quality 3. Financial Losses	4	2	8	1. Developing best practice policies among suppliers 2. Maintaining effective communication with vendors 3. Reliable vendors are contacted
Supplier company gets shut down	1. Delay in timeline 2. Delay in procurement 3. Finaincial losses	5	1	5	1. Maintaining effective communication with vendors 2. Reliable vendors are contacted 3. Conducting a supply chain vulnerability audit 4. Other vendors are also contacted for backup in case of any mishap
Supplier might not uphold the correct ethical standards	1. Financial Losses 2. Increases budget 3. Delay in timeline	4	1	4	1. Contacting other teams would let us know which suppliers hold correct ethical standards 2. Diversifying supply base
Delayed approvals	1. Delay in timeline 2. Delay in procurement	4	2	8	Allocating buffer time for procurement in timeline
Error-ridden documentation	1. Delay in timeline 2. Delay in Procurement	3	3	9	1. Carefully planning of all the timeline and objectives and discussing it with all the team members would reduce the chances of error 2. Rechecking of every documentation before finalisation
Cuts in the estimated budget	1. Lowers the level of performance indirectly 2. Delay in Timeline 3. Delay in Procurement	5	3	15	1. Contacting teams and estimating costs 2. Including some extra budget
Budget allocation doesn't happen by the required time	1. Delay in timeline 2. Delay in procurement	5	3	15	1. Reaching out to multiple parties for sponsorships 2. Using the crowdfunding in this case
Issues in Money Transfer/Payment	1. Delay in timeline 2. Delay in procurement	4	3	12	1. Using alternate payment methods 2. Asking the vendors in advance about the available payment methods
Unanticipated transportation requirements	1. Delays Procurement 2. Increases budget	3	2	6	1. Contacting suppliers would really help us to properly estimate transportation costs and method 2. Team would use most reliable means of transportation
Banking fees and charges being amended	Increases budget	3	2	6	1. These costs are constantly monitored and predicted 2. Extra costs are included in budget taking these factors into account

Budget allocation	***Allocation Target***	***Percentage to be used in powertrain***	***Amount for Powertrain***
From College	300000	100	300000
Nvcti	1500000	75	1125000
Crowd Funding from alumni	350000	50	175000
Dassault Systems	200000	50	100000
MRF Tyres	150000	75	112500
State Book of India	150000	75	112500
		Total	1925000

Motor	2,94,000/-
Motor Controller	187500/-
Battery	
Battery Management System	270000/-
Motor Mountings (We purchased material for manufacturing it ourselves.)	**1 Kg of Aluminum alloy 6061 T6 Sheets - 1819/-** **1 Kg of Mild Steel - 1612/-**
Accumulator Casing (We purchased material for manufacturing it ourselves.)	**1 Kg of Aluminum alloy 6061 T6 Sheets - 1819/-** **1 Kg of Mild Steel - 1612/-**
Onboard Battery Charger	
Battery Charging Port	207000/-
AIRs	15000/-
IMD	2,00,000/-
HVD	6000/-
GEARS (Final gear ratio is 3.14 No of teeth are 14 & 44)	270/-
Chain Drive	0/-
Fuses	**3 Fuses of 350A - 9500/-** **1 Fuse of 150A - 1605/-** **1 Fuse of 5A - 5/-**
Maintenance Plugs	550/-
HV/LV Connectors	4599/-
Insulations	2800/- **10kg mica sheets** 1240/- **silcon 5 Kg**
Inflammable Materials	**1 Kg of Aluminum alloy 6061 T6 Sheets - 1819/-** **1 Kg of Mild Steel - 1612/-**
LV Battery	5679/-
Shutdown Circuit	30000/-
TSAL	5499/-
Harness (Wires)	1950/- **for 3 pieces**
Connectors	150000/-
Sensors	Voltage sensor - 7800/-
	Temperature sensor - 210/-
	Current sensor- 3000/-
	Odometer - 17000/-
	Speedometer - 5400/-
	Gyroscope - 42000/-
Total	1453287
Risk Cost	471713


DESIGNING THE CHASSIS
CHASSIS
Stiffness
Weight