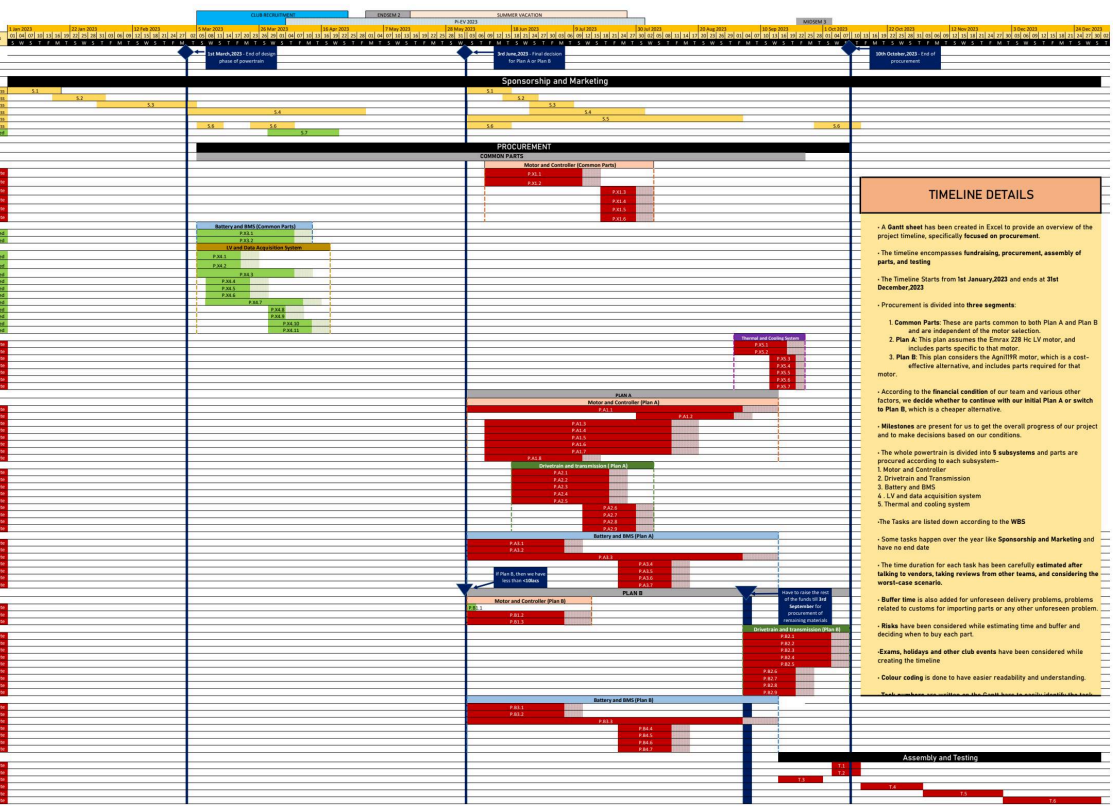
EV POWERTRAIN TIMELINE

Procurement strategy report
Team E05
Mechismu Racing Electric
Indian Institute of Technology (Indian School of Mines), Dhanbad

LEGEND	
For Subsystems	For status
Motor and Controller	Completed
Drivetrain and transmission	In-Progress
Battery and BMS	Incomplete
LV and Data Acquisition System	
Thermal and Cooling System	

Project Start 01-01-2023
Project end 31-12-2023

WBS No.	Task	Start date	Due Date	Expected Duration	Buffer	Status
0	**MILESTONES**					
S	**Sponsorship and Marketing**					
S.1	Find Potential and Previous Sponsors			Recurring		In-Progress
S.2	Send Emails to potential sponsors			Recurring		In-Progress
S.3	Approach local companies which provide services			Recurring		In-Progress
S.4	Approach sponsors which might provide parts at subsidised rates			Recurring		In-Progress
S.5	Crowdfunding (From Students, alumni, professors, etc.)			Concurring		In-Progress
S.6	Social media events and Public engagement			Recurring		In-Progress
S.7	Raise funds through workshops	29-Mar	19-Apr	21	0	Completed
P	**Procurement**					
P.X	**Common Parts**					
P.X1	**Motor and Controller**					
P.X1.1	High voltage cable	09-Jun	08-Jul	30	7	Incomplete
P.X1.2	Low voltage cable	09-Jun	08-Jul	30	7	Incomplete
P.X1.3	M4 Screws, 8mm	15-Jul	29-Jul	14	7	Incomplete
P.X1.4	M4 Screws, 16mm	15-Jul	29-Jul	14	7	Incomplete
P.X1.5	M4 Nylock Nuts	15-Jul	29-Jul	14	7	Incomplete
P.X1.6	M3 Screws, 25 mm	15-Jul	29-Jul	14	7	Incomplete
P.X3	**Battery and BMS**					
P.X3.1	Interlocks	05-Mar	04-Apr	30	7	Completed
P.X3.2	Accumulator Isolation Relay	05-Mar	04-Apr	30	7	Completed
P.X4	**LV and Data Acquisition System**					
P.X4.1	Master switch(AMS)	05-Mar	19-Mar	14	7	Completed
P.X4.2	Brake system plausibility device (BSPD)	05-Mar	19-Mar	14	7	Completed
P.X4.3	Insulation Monitoring Devices (IMD)	05-Mar	04-Apr	30	7	Completed
P.X4.4	Arduino Mega Kit	08-Mar	22-Mar	14	7	Completed
P.X4.5	Jumper wires	08-Mar	22-Mar	14	7	Completed
P.X4.6	Low voltage battery	08-Mar	22-Mar	14	7	Completed
P.X4.7	VCU	08-Mar	07-Apr	30	7	Completed
P.X4.8	Shut down buttons	27-Mar	03-Apr	7	3	Completed
P.X4.9	Inertia Switch	27-Mar	03-Apr	7	3	Completed
P.X4.10	High voltage disconnects (HVD)	27-Mar	10-Apr	14	7	Completed
P.X4.11	Master switch (TSMS)	27-Mar	10-Apr	14	7	Completed
P.X5	**Thermal and Cooling System**					
P.X5.1	Pumps	01-Sep	16-Sep	15	7	Incomplete
P.X5.2	Fans	01-Sep	16-Sep	15	7	Incomplete
P.X5.3	Coolant tubes	13-Sep	20-Sep	7	3	Incomplete
P.X5.4	Radiator	13-Sep	20-Sep	7	3	Incomplete
P.X5.5	Coolant tank	13-Sep	20-Sep	7	3	Incomplete
P.X5.6	Mineral Oil	13-Sep	20-Sep	7	3	Incomplete
P.X5.7	Water	13-Sep	20-Sep	7	3	Incomplete
P.A	**Plan A**					
P.A1	**Motor and Controller**					
P.A1.1	EMRAX 228 HV: Liquid cooled	03-Jun	01-Sep	90	12	Incomplete
P.A1.2	X-bracket	30-Jul	29-Aug	30	7	Incomplete
P.A1.3	DTI HV-500 LC	09-Jun	08-Aug	60	10	Incomplete
P.A1.4	DTI DCDM diagnostic tool	09-Jun	08-Aug	60	10	Incomplete
P.A1.5	OBD-II Cable	09-Jun	08-Aug	60	10	Incomplete
P.A1.6	TE Connectivity AMPSEAL 770680-1	09-Jun	08-Aug	60	10	Incomplete
P.A1.7	RLS RM44B1 sensor	09-Jun	08-Aug	60	10	Incomplete
P.A1.8	Sourisse UT96C128 14P Standard Circular Connector	09-Jun	09-Jul	30	7	Incomplete
P.A2	**Drivetrain and Transmission**					
P.A2.1	Open Differential	18-Jun	18-Jul	30	7	Incomplete
P.A2.2	Half Shaft	18-Jun	18-Jul	30	7	Incomplete
P.A2.3	Ball bearing	18-Jun	18-Jul	30	7	Incomplete
P.A2.4	Ball bearing	18-Jun	18-Jul	30	7	Incomplete
P.A2.5	Gear Box	18-Jun	18-Jul	30	7	Incomplete
P.A2.6	Tripod Housing	12-Jul	26-Jul	14	7	Incomplete
P.A2.7	Tripod Joint	12-Jul	26-Jul	14	7	Incomplete
P.A2.8	Scatter Shield for motor	12-Jul	26-Jul	14	7	Incomplete
P.A2.9	Bearts	12-Jul	26-Jul	14	7	Incomplete
P.A3	**Battery and BMS**					
P.A3.1	Fuses	03-Jun	03-Jul	30	7	Incomplete
P.A3.2	35 40A Li-Ion Battery Protection BMS + Ti Master BMS	03-Jun	03-Jul	30	7	Incomplete
P.A3.3	Li-Ion Battery	03-Jun	01-Sep	90	12	Incomplete
P.A3.4	Aluminium busbar	24-Jul	07-Aug	14	6	Incomplete
P.A3.5	M8 Screws, 10 mm	24-Jul	07-Aug	14	6	Incomplete
P.A3.6	Accumulator Container	24-Jul	07-Aug	14	6	Incomplete
P.A3.7	Battery Holder	24-Jul	07-Aug	14	6	Incomplete
P.B	**Plan B**					
P.B1	**Motor and Controller**					
P.B1.1	AGXI 11BR	01-Jun	02-Jun	1	0	Incomplete
P.B1.2	Kelly KS2 Motor Controller	03-Jun	03-Jul	30	12	Incomplete
P.B1.3	Hall sensor	03-Jun	03-Jul	30	12	Incomplete
P.B2	**Drivetrain and transmission**					
P.B2.1	Open Differential	03-Sep	03-Oct	30	7	Incomplete
P.B2.2	Half Shaft	03-Sep	03-Oct	30	7	Incomplete
P.B2.3	Ball bearing (Sprocket side)	03-Sep	03-Oct	30	7	Incomplete
P.B2.4	Ball bearing	03-Sep	03-Oct	30	7	Incomplete
P.B2.5	Gearbox	03-Sep	03-Oct	30	7	Incomplete
P.B2.6	Tripod Housing	03-Sep	17-Sep	14	7	Incomplete
P.B2.7	Tripod Joint	03-Sep	17-Sep	14	7	Incomplete
P.B2.8	Scatter Shield for motor	03-Sep	17-Sep	14	7	Incomplete
P.B2.9	Bearts	03-Sep	17-Sep	14	7	Incomplete
P.B3	**Battery and BMS**					
P.B3.1	Fuses	09-Jun	09-Jul	30	7	Incomplete
P.B3.2	35 40A Li-Ion Battery Protection BMS + Ti Master BMS	09-Jun	09-Jul	30	7	Incomplete
P.B3.3	Li-Ion Battery	09-Jun	01-Sep	90	12	Incomplete
P.B3.4	Aluminium busbar	24-Jul	07-Aug	14	6	Incomplete
P.B3.5	M8 Screws, 10 mm	24-Jul	07-Aug	14	6	Incomplete
P.B3.6	Accumulator Container	24-Jul	07-Aug	14	6	Incomplete
P.B3.7	Battery Holder	24-Jul	07-Aug	14	6	Incomplete
T	**Assembly and Testing**					
T.1	Plan A - Motor and Controller Testing	01-Oct	11-Oct	10	0	Incomplete
T.2	Plan B: Motor and Controller Testing	01-Oct	11-Oct	10	0	Incomplete
T.3	Battery Testing (Plan A and B)	16-Sep	28-Sep	12	0	Incomplete
T.4	Final Assembly	15-Oct	02-Nov	20	0	Incomplete
T.5	Final Testing	02-Nov	30-Nov	28	0	Incomplete
T.6	Buffer for replacement	01-Dec	31-Dec	30	0	Incomplete



TIMELINE DETAILS

- A **Gantt sheet** has been created in Excel to provide an overview of the project timeline, specifically **focused on procurement**.

- The timeline encompasses **fundraising, procurement, assembly of parts, and testing**

- The Timeline Starts from **1st January,2023** and ends at **31st December,2023**

- Procurement is divided into **three segments**:

  1. **Common Parts**: These are parts common to both Plan A and Plan B and are independent of the motor selection.
  2. **Plan A**. This plan assumes the Emrax 228 Hc LV motor, and includes parts specific to that motor.
  3. **Plan B**: This plan considers the AgniTPR motor, which is a cost-effective alternative, and includes parts required for that motor.

- According to the **financial condition** of our team and various other factors, we **decide whether to continue with our initial Plan A or switch to Plan B**, which is a cheaper alternative.

- **Milestones** are present for us to get the overall progress of our project and to make decisions based on our conditions.

- The whole powertrain is divided into **5 subsystems** and parts are procured according to each subsystem–
  1. Motor and Controller
  2. Drivetrain and Transmission
  3. Battery and BMS
  4. LV and data acquisition system
  5. Thermal and cooling system

-The Tasks are listed down according to the **WBS**

- Some tasks happen over the year like **Sponsorship and Marketing** and have no end date

- The time duration for each task has been carefully **estimated after talking to vendors, taking reviews from other teams, and considering the worst-case scenario.**

- **Buffer time** is also added for unforeseen delivery problems, problems related to customs for importing parts or any other unforeseen problem.

- **Risks** have been considered while estimating time and buffer and deciding when to buy each part.

-**Exams, holidays and other club events** have been considered while creating the timeline

- **Colour coding** is done to have easier readability and understanding.

COMMON PARTS

Components	Possible Vendors	Models	Quantity	Procurement Time (Days)	Unit Cost	Total Cost
MOTOR AND CONTROLLER						
High voltage cable	DTI	N/A	5	30	80	400
Low voltage cable	DTI	N/A	100	30	34	3400
M4 Screws, 8mm	Local Vendors	N/A	4	14	₹ 1.50	₹ 6.00
M4 Screws, 16mm	Local Vendors	N/A	2	14	₹ 2.00	₹ 4.00
M4 Nylock Nuts	Local Vendors	N/A	6	14	₹ 0.61	₹ 3.66
M8 Screws, 25 mm	Local Vendors	N/A	6	14	₹ 28.20	₹ 169.20
BATTERY AND BMS						
Interlocks	hyperformance motorsport	N/A	1	30	₹ 1,180.00	₹ 1,180.00
Accumulator Isolation Relay	hyperformance motorsport	N/A	1	30	₹ 30,000.00	₹ 30,000.00
LV AND DATA ACQUISITION SYSTEM						
Master switch (LVMS)	3Burnout Brothers	N/A	1	14	8160	₹ 8,160.00
Brake system plausibility device (BSPD)	3Burnout Brothers	N/A	1	14	12300	₹ 12,300.00
Insulation Monitoring Devices (IMD)	Bender	N/A	1	30	7500	₹ 7,500.00
Arduino Mega R3	Ardunio	N/A	1	14	₹ 1,400.00	₹ 1,400.00
Jumper wires	Local Vendors	N/A	50	14	₹ 15.00	₹ 750.00
Low voltage battery	hyperformance motorsport	N/A	1	14	₹ 50,000.00	₹ 50,000.00
VCU	Dorleceo	N/A	1	30	₹ 1,500.00	₹ 1,500.00
Shut down buttons	hyperformance motorsport	N/A	3	7	₹ 75.00	₹ 225.00
Inertia Switch	hyperformance motorsport	N/A	1	7	₹ 7,080.00	₹ 7,080.00
High voltage disconnects (HVD)	Bender	N/A	1	14	₹ 3,000.00	₹ 3,000.00
Master switch (TSMS)	hyperformance motorsport	N/A	2	14	₹ 8,160.00	₹ 16,320.00
THERMAL AND COOLING SYSTEM						
Pumps	Koolance	PMP-500	2	15	₹ 7,600.00	₹ 15,200.00
Coolant tubes	EPDM	10 mm inner diameter	5	7	₹ 500.00	₹ 2,500.00
Radiator	Volkswagen Group Sales India Pvt ltd	N/A	2	7	₹ 5,100.00	₹ 10,200.00
Coolant tank	Local Supplier	N/A	4	7	₹ 1,200.00	₹ 4,800.00
Fans	EBM	EBM Papst	2	15	₹ 700.00	₹ 1,400.00
Mineral Oil	ZPremium	N/A	15	7	₹ 380.00	₹ 5,700.00
Water	Local Supplier	N/A	10	7	₹ 300.00	₹ 3,000.00

PLAN A (EMRAX)

Components	Possible Vendors	Models	Quantity	Procurement Time (Days)	Total Cost
MOTOR AND CONTROLLER					
EMRAX 228 HV Liquid	EMRAX	PMSM Motor	1	90	₹ 2,83,000.00
X-bracket	Local Vendors	N/A	1	30	₹ 13,220.00
DTI HV 500 LC	DTI	Liquid cooled	1	60	₹ 3,13,000.00
DTI DCCM diagnostic tool	DTI	N/A	1	60	₹ 22,000.00
OBD-II Cable	Vector	N/A	1	60	₹ 4,000.00
TE Connectivity AMPSEAL	DTI	N/A	1	60	₹ 1,700.00
RLS RM44SI sensor	DTI	Encoder (13 bit)	1	60	₹ 12,300.00
Sourlau UT56(C12E14 A Kingpin)	Sourlau	(SSI) + Incremental, 5 V)	1	30	₹ 3,400.00
DRIVETRAIN AND TRANSMISSION					
Open Differential	3Brothers Burnout	N/A	1	30	₹ 10,000.00
Half Shaft	3Brothers Burnout	N/A	2	30	₹ 8,000.00
Ball bearing	3Brothers Burnout	SKF_6005 Output	1	30	₹ 700.00
Ball bearing	3Brothers Burnout	SKF61905 Input	1	30	₹ 1,200.00
Gear Box	3Brothers Burnout	single speed two-gear idler	1	30	₹ 34,000.00
Tripod Housing	Ubuy	N/A	4	14	₹ 10,000.00
Tripod Joint	Ubuy	N/A	4	14	₹ 6,000.00
Scatter Shield for motor	Indiamart	N/A	1	14	₹ 1,160.00
Boots	Indiamart	Tripod Boots	4	14	₹ 3,560.00
BATTERY AND BMS					
Fuses	Mouser electronics	Mouser Electronics 400 A, 500 V	1	30	₹ 5,000.00
35 40A Li-ion Battery Protection BMS + TI Master BMS	Texas Instruments	N/A	10	30	₹ 1,50,000.00
Li-ion Battery	Panasonic	Panasonic NCR18650GA 3450mAh 10A Battery	800	90	₹ 2,76,088.00
Aluminium busbar	Local manufacturer	1mm thickness	1	14	₹ 260.00
M8 Screws, 10 mm	Local manufacturer	Mounting bolts for accumulator container, Allen	16	14	₹ 229.76
Accumulator Container	Local manufacturer	4130 Chromoly steel, 2mm thickness	20	14	₹ 4,100.00

PLAN B (AGNI)

Components	Possible Vendors	Models	Quantity	Procurement Time (Days)	Total Cost
MOTOR AND CONTROLLER					
AGNI 119R	Eco Planet	PMDC Motor	2	1	₹ 1,50,000.00
Kelly KLC Motor Controller	Eco Planet	N/A	1	30	₹ 25,000.00
Hall sensor	Eco Planet	Encoder (13 bit)	1	30	₹ 12,300.00
DRIVETRAIN AND CONTROLLER					
Open Differential	Burnout Brothers	N/A	1	30	₹ 10,000.00
Half Shaft	Burnout Brothers	Nano half shaft	2	30	₹ 8,000.00
Ball bearing (Sprocket side)	Burnout Brothers	SKF_6005 output	2	30	₹ 1,400.00
Ball bearing	Burnout Brothers	SKF 61905 input	2	30	₹ 2,400.00
Gearbox	Burnout Brothers	4:1 gearbox	1	30	₹ 34,000.00
Tripod Housing	Ubuy	N/A	4	14	₹ 10,000.00
Tripod Joint	Ubuy	N/A	4	14	₹ 6,000.00
Scatter Shield for motor	Indiamart	18.5cm × 38 cm, 4 sheets	2.4 kg	14	₹ 1,160.00
Boots	Indiamart	Tripod Boots	4	14	₹ 3,560.00
BATTERY AND BMS					
Fuses	Mouser electronics	430Amp, 200V	5	30	₹ 6,500.00
35 40A Li-ion Battery Protection BMS + TI Master BMS	Texas Instruments	N/A	6	30	₹ 90,000.00
Li-ion Battery	Panasonic	Panasonic NCR18650GA (3450mAh 10A)	550	90	₹ 1,89,810.50
Aluminium busbar	Local manufacturer	1mm thickness	1	14	₹ 260.00
M8 Screws, 10 mm	Local manufacturer	Mounting bolts for	16	14	₹ 229.76
Accumulator Container	Local manufacturer	4130 Chromoly steel, 2mm thickness	20	14	₹ 4,100.00

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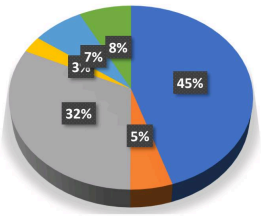
PLAN A

Subsystem-Wise Cost Break Up

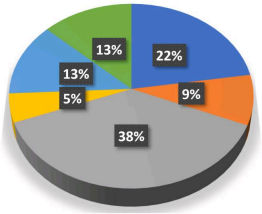


Cost break-up

Motor and Controller	₹ 6,56,602.86
Drivetrain and Transmission	₹ 74,620.00
Battery and BMS	₹ 4,66,857.76
Thermal and Cooling System	₹ 42,800.00
LV and Data Acquisition System	₹ 1,08,235.00
Promotion and Marketing	₹ 1,10,715.00
Total	₹ 14,60,715.00

PLAN B

Subsystem-Wise Cost Break Up



Cost break-up

Motor and Controller	₹ 1,91,202.86
Drivetrain and Transmission	₹ 74,620.00
Battery and BMS	₹ 3,22,080.26
Thermal and Cooling System	₹ 42,800.00
LV and Data Acquisition System	₹ 1,08,235.00
Promotion and Marketing	₹ 1,10,715.00
Total	₹ 8,49,653.12

Budget and Procurement Goals and Objectives

- As the team is on a budget crunch, there are **2 plans** varying mainly on cost and performance
- The decision of choosing Plan A or Plan B will be decided through **decision trees, and forecasting models**
- We had set a **certain target for fundraising** and based on the target completion we will decide what plan to choose
- Our main goal is to **make a car before January** to participate in various formula events
- According to the plan selection and our financial condition procurement of the parts has been laid out on the timeline

Sources of Funds

Institute | Sponsorship | Crowdfunding

Budget Risk Management

1. Insufficient Funds

Triggers-
- Late funding from the college
- Gradual funding from sponsors
- Withdrawal of sponsors
- Low crowdfunding amount

2. Supply chain issues

Triggers-
- Long delivery times for import
- International custom issues
- Lack of funds will cause further delays in procurement

3. Bank issues

Triggers-
- History of bank related issues
- Account transfer not working
- Bank details with a professor

Mitigation Plan

- According to our forecasts, we have decided if we can raise **Rs. 1095536.25** within 3rd June 2023, we will stick to Plan A or else switch to Plan B
- This constraint can be caused due to any of the triggers mentioned above
- Plan B is a **massive cost reduction** from Plan A but the performance is compromised

Details about Plan B

- **Why Plan B?**
  Plan B is a backup plan if we cannot raise enough funds.

- **Why Agni119R?**
  The Agni motor was bought in the past due to miscommunications in the team. We are basically capitalising on this mistake by using it in plan B, as it also saves us time as it is already in our garage!

- **Why does plan B take longer time for procurement?**
  Plan B takes longer as we do not know how much we lack in funds, so we have to have some buffer time to raise the required funds for procurement as we cannot just order all together if we lack funds

Timeline

We have considered buffer times, budget constraints and alternate plans in the timeline

Budget

Our budget has been carefully estimated and also a mitigation plan as PLAN B has been formalised

Subsystems

The powertrain has been divided into subsystems for better decision-making and future planning

Cost v/s Performance

- Selection of vendors has been carefully determined through graphs and model
- Visual representation of Cost, Performance and Reliability has been attached in the appendix for alternate vendors
- After seeing all the graphs and models we have chosen our first preference for vendors
- We have defined our biases and prioritise cost the most

APPENDIX

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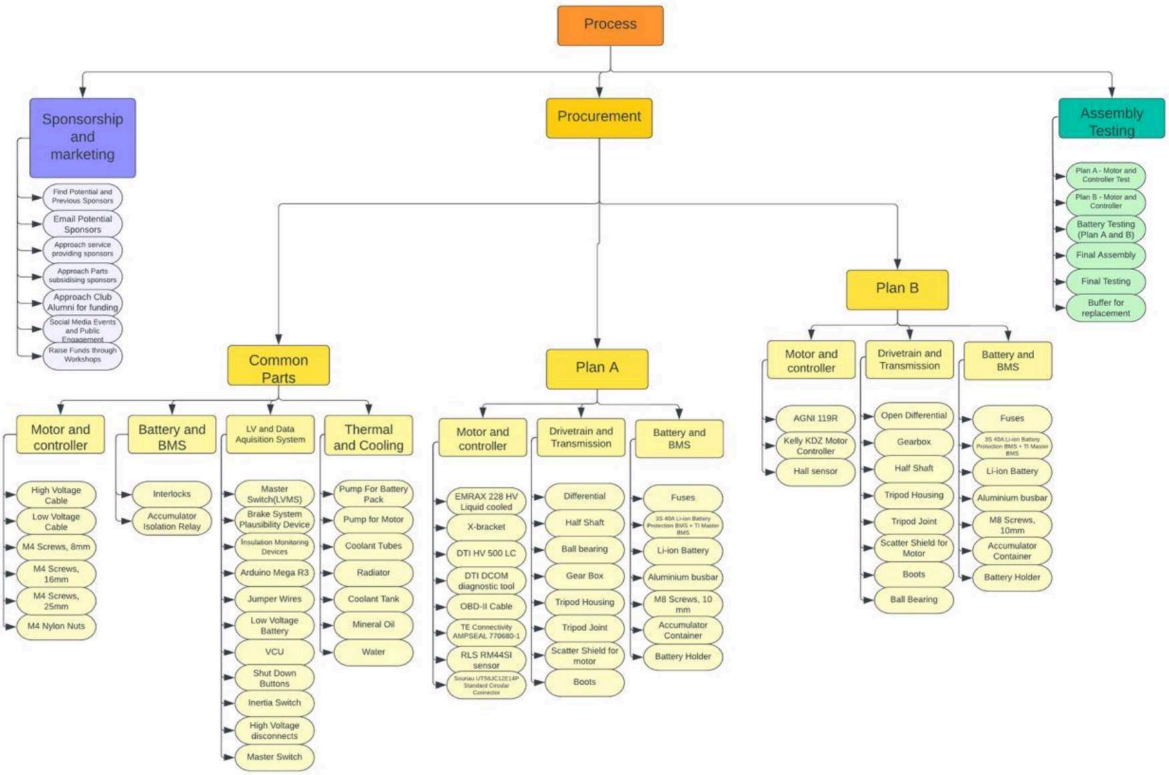
PAGE 6: Forecasting

PAGE 7: Decision Tree

WORK BREAKDOWN STRUCTURE

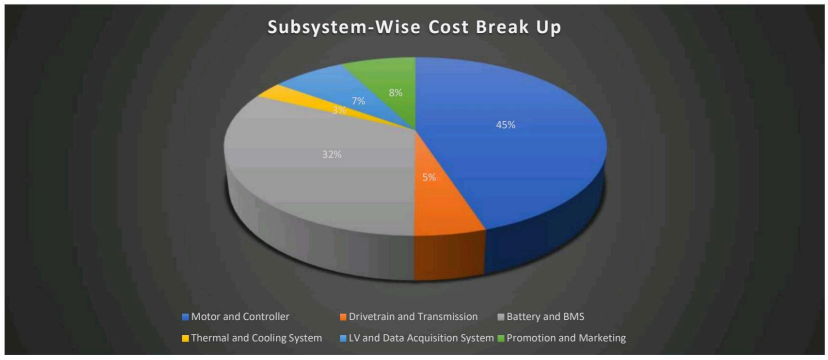
A Work Breakdown Structure (WBS) is a hierarchical decomposition of a project into smaller, more manageable work components. It represents the project scope and provides a visual representation of the deliverables, tasks, and activities required to complete the project. Each level of the WBS breaks down the project into increasingly detailed components.



Sl No.	Sub-System	Item/Material	Description	Unit Cost	Quantity	Process Cost	Tooling Cost	Total Cost
1	Motor and Controller	EMRAX 228 HV Liquid cooled	PMSM Motor	₹ 2,83,000.00	1			₹ 2,83,000.00
2	Motor and Controller	X-bracket	Mounting bracket for motor	₹ 12,800.00	1	₹ 220.00	₹ 200.00	₹ 13,220.00
3	Motor and Controller	DTI HV 500 LC	Motor Controller (Liquid cooled)	₹ 3,13,000.00	1			₹ 3,13,000.00
4	Motor and Controller	DTI DCOM diagnostic tool	Diagonostic tool to configure the inverter	₹ 22,000.00	1			₹ 22,000.00
5	Motor and Controller	High voltage cable	4/0 AWG copper wire	₹ 80.00	5			₹ 400.00
6	Motor and Controller	OBD-II Cable	CAN connector for diagnostic tool	₹ 4,000.00	1			₹ 4,000.00
7	Motor and Controller	TE Connectivity AMPSEAL 770680-1	HV-500 main harness connector with crimp pins (770520-1)	₹ 1,700.00	1			₹ 1,700.00
8	Motor and Controller	Low voltage cable	20 AWG copper wire	₹ 34.00	100			₹ 3,400.00
9	Motor and Controller	RLS RM44SI sensor	Encoder (13 bit, Absolute binary synchro-serial (SSI) + Incremental, 5 V)	₹ 12,300.00	1			₹ 12,300.00
10	Motor and Controller	Souriau UTS6JC12E14P Standard Circular Connector	Encoder-motor controller connector (14 pin)	₹ 3,400.00	1			₹ 3,400.00
11	Motor and Controller	M4 Screws, 8mm	Mounting screws for motor controller (M4 Phillips Round Pan Washer Head Machine Screw - 8mm)	₹ 1.50	4			₹ 6.00
12	Motor and Controller	M4 Screws, 16mm	Mounting screws for encoder (M4 Phillips Truss Head Machine Screw - 16mm)	₹ 2.00	2			₹ 4.00
13	Motor and Controller	M4 Nylock Nuts	Nuts for all M4 screws	₹ 0.61	6			₹ 3.66
14	Motor and Controller	M8 Screws, 25 mm	Mounting screws for motor (Allen Bolt M8, 12.9 grade)	₹ 28.20	6			₹ 169.20
15	Battery and BMS	Fuses	Mouser Electronics 400 A, 500 V	₹ 5,000.00	1			₹ 5,000.00
16	Battery and BMS	Aluminium busbar	1mm thickness	₹ 260.00	1			₹ 260.00
17	Battery and BMS	M8 Screws, 10 mm	Mounting bolts for accumulator container, Allen Bolts, M8, 12.9 grade, 10mm	₹ 14.36	16			₹ 229.76
18	Battery and BMS	Accumulator Container	4130 Chromoly steel, 2mm thickness	₹ 150.00	20	₹ 900.00	₹ 200.00	₹ 4,100.00
19	Battery and BMS	3S 40A Li-ion Battery Protection BMS + TI Master BMS	BMS Texas Instrumental	₹ 15,000.00	10			₹ 1,50,000.00
20	Battery and BMS	Li-ion Battery	Panasonic NCR18650GA 3450mAh 10A Battery	₹ 345.11	800			₹ 2,76,088.00
21	Battery and BMS	Interlocks		₹ 1,180.00	1			₹ 1,180.00
22	Battery and BMS	Accumulator Isolation Relay	Normally open, 12V	₹ 15,000.00	2			₹ 30,000.00
23	LV and Data Acquisition System	High voltage disconnects (HVD)	Safety disconnect	₹ 3,000.00	1			₹ 3,000.00
24	LV and Data Acquisition System	Master switch (TSMS)	A mechanical switch that disconnects the high-voltage battery from the tractive system.	₹ 8,160.00	2			₹ 16,320.00
25	LV and Data Acquisition System	Shut down buttons	Emergency stop buttons, 9-12 V	₹ 75.00	3			₹ 225.00
26	LV and Data Acquisition System	Inertia Switch	Normally closed, Detects acceleration resulting from impacts	₹ 7,080.00	1			₹ 7,080.00
27	LV and Data Acquisition System	Arduino Mega R3	Microcontroller board ATmega2560	₹ 1,400.00	1			₹ 1,400.00
28	LV and Data Acquisition System	Jumper Wires		₹ 15.00	50			₹ 750.00
29	LV and Data Acquisition System	VCU	Dorleco VCU	₹ 50,000.00	1			₹ 50,000.00
30	LV and Data Acquisition System	Low voltage battery	12V, 20Ah - Lead Acid - Exide	₹ 1,500.00	1			₹ 1,500.00
31	LV and Data Acquisition System	Master switch (LVMS)	A mechanical switch that disconnects the low-voltage battery from the low-voltage system.	8160	1			8160
32	LV and Data Acquisition System	Brake system plausibility device (BSPD)	5-14V, 3A	12300	1			12300
33	LV and Data Acquisition System	Insulation Monitoring Devices (IMD)	Bender ISOMETER IR155-3204	7500	1			7500
34	Drivetrain and Transmission	Differential	Open Differential	₹ 10,000.00	1			₹ 10,000.00
35	Drivetrain and Transmission	Half Shaft	Nano Half Shaft	₹ 4,000.00	2			₹ 8,000.00
36	Drivetrain and Transmission	Tripod Housing	Tripod Housing	₹ 2,500.00	4			₹ 10,000.00
37	Drivetrain and Transmission	Tripod Joint	Tripod for tripod housing	₹ 1,500.00	4			₹ 6,000.00
38	Drivetrain and Transmission	Scatter Shield for motor	18.5cm × 38 cm, 2 sheets	₹ 300.00	1.2 kg	₹ 600.00	₹ 200.00	₹ 1,160.00

39	Drivetrain and Transmission	Boots	Tripod Boots	₹ 890.00	4			₹ 3,560.00
40	Drivetrain and Transmission	Ball bearing	SKF_6005 Output	₹ 700.00	1			₹ 700.00
41	Drivetrain and Transmission	Ball bearing	SKF61905 Input	₹ 1,200.00	1			₹ 1,200.00
42	Drivetrain and Transmission	Gear Box	Single speed two-gear idler gearbox	₹ 34,000.00	1			₹ 34,000.00
43	Thermal and Cooling System	Pumps	Koolance PMP-500 Pump (16 LPM),12 V	₹ 7,600.00	2			₹ 15,200.00
44	Thermal and Cooling System	Coolant tubes	EPDM, 10 mm inner diameter	₹ 500.00	5			₹ 2,500.00
45	Thermal and Cooling System	Radiator	Manufactured by Volkswagen Group Sales India Pvt Ltd	₹ 5,100.00	2			₹ 10,200.00
46	Thermal and Cooling System	Fans	EBM Papst 4112 N/2H4 (212 CFM)	₹ 1,200.00	4			₹ 4,800.00
47	Thermal and Cooling System	Coolant tank	5 litres	₹ 700.00	2			₹ 1,400.00
48	Thermal and Cooling System	Mineral Oil	ZPremium	₹ 380.00	15			₹ 5,700.00
49	Thermal and Cooling System	Water	Deionized water	₹ 300.00	10			₹ 3,000.00
							Powertrain Total	**₹ 13,49,115.62**

Motor and Controller	₹ 6,56,602.86
Drivetrain and Transmission	₹ 74,620.00
Battery and BMS	₹ 4,66,857.76
Thermal and Cooling System	₹ 42,800.00
LV and Data Acquisition System	₹ 1,08,235.00
Promotion and Marketing	₹ 1,10,715.00
Total	₹ 14,60,715.00

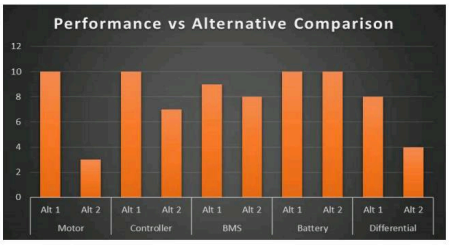


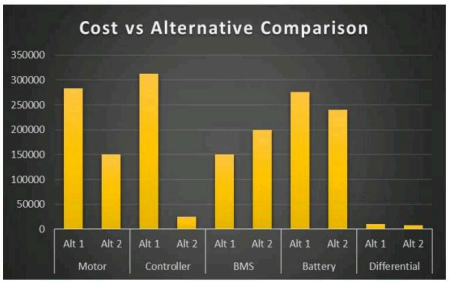
The **Alternative Comparison Table** compares the performance, reliability and cost of the various alternatives present. In order to do this, firstly, we have **quantized** the **qualitative factors** of performance and reliability into **quantitative measures.** The parts' Reliability and Performance are defined on a scale of **1-10**, 10 being the best and 1 being the worst. Next, we defined a factor called as **quantitative factor** used for making our comparison procedure less cumbersome. The Qualitative factor has been defined as **Cost/(Reliability*Performance).**

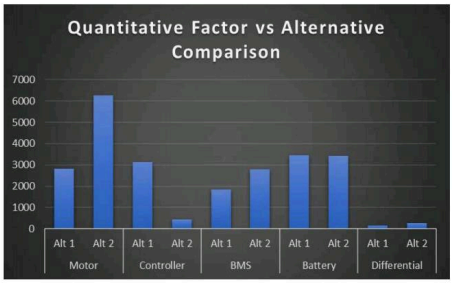
Our calculations as well as the Graphical visualization of it have been shown below:

Alternative Comparison Table

Part	Alternatives	Cost	Reliability	Performance	Quantitative Factor
Motor	Alt 1	₹283,000.00	10	10	2,830
	Alt 2	₹150,000.00	8	3	6,250
Controller	Alt 1	₹313,000.00	10	10	3,130
	Alt 2	₹25,000.00	8	7	446
BMS	Alt 1	₹150,000.00	9	9	1,852
	Alt 2	₹200,000.00	9	8	2,778
Battery	Alt 1	₹276,088.00	8	10	3,451
	Alt 2	₹240,000.00	7	10	3,429
Differential	Alt 1	₹10,000.00	8	8	156
	Alt 2	₹8,000.00	8	4	250







Sponsorship Category		Amount Sponsored	Sponsorship % Used for Promotion	Number of Sponsors	Probability	Amount Per Sponsor	Promotion Amount Per Sponsor	Promotion Rate Per Sponsor
Part		₹ 20,000.00	5.00%	17	0.34	₹ 6,800.00	₹ 340.00	1.70%
Bronze		₹ 50,000.00	6.25%	15	0.3	₹ 15,000.00	₹ 937.50	1.88%
Silver		₹ 1,00,000.00	7.50%	10	0.2	₹ 20,000.00	₹ 1,500.00	1.50%
Gold		₹ 2,50,000.00	8.75%	6	0.12	₹ 30,000.00	₹ 2,625.00	1.05%
Platinum		₹ 4,50,000.00	10.00%	2	0.04	₹ 18,000.00	₹ 1,800.00	0.40%
						₹ 89,800.00	₹ 7,202.50	6.53%

Crowdfunding Target Audience		Promotion Rate
Alumni		2.50%
College Students		5.00%
College Professors		0.00%
General Public		7.50%
		15.00%

Payoff Table

					Outcome				
					% of Target Achieved				
		Crowdfunding	Sponsorship	College	100%	75%	50%	25%	0%
Decision	% Split Between Funding Sources	100.00	0.00	0.00	0.050	0.150	0.250	0.500	0.050
		75.00	25.00	0.00	0.050	0.150	0.300	0.450	0.050
		50.00	50.00	0.00	0.050	0.175	0.325	0.400	0.050
		25.00	75.00	0.00	0.050	0.150	0.300	0.450	0.050
		0.00	100.00	0.00	0.050	0.150	0.250	0.500	0.050
		0.00	75.00	25.00	0.200	0.300	0.500	0.000	0.000
		0.00	50.00	50.00	0.250	0.400	0.350	0.000	0.000
		0.00	25.00	75.00	0.200	0.300	0.500	0.000	0.000
		0.00	0.00	100.00	0.100	0.300	0.600	0.000	0.000
		25.00	0.00	75.00	0.200	0.300	0.500	0.000	0.000
		50.00	0.00	50.00	0.300	0.400	0.300	0.000	0.000
		75.00	0.00	25.00	0.200	0.400	0.400	0.000	0.000
		16.67	16.67	66.67	0.400	0.300	0.300	0.000	0.000
		16.67	33.33	50.00	0.400	0.400	0.200	0.000	0.000
		16.67	50.00	33.33	0.400	0.450	0.150	0.000	0.000
		16.67	66.67	16.67	0.300	0.400	0.200	0.100	0.000
		33.33	16.67	50.00	0.500	0.400	0.100	0.000	0.000
		33.33	33.33	33.33	0.700	0.200	0.100	0.000	0.000
		33.33	50.00	16.67	0.300	0.400	0.200	0.100	0.000
		50.00	16.67	33.33	0.600	0.250	0.150	0.000	0.000
		50.00	33.33	16.67	0.400	0.300	0.200	0.100	0.000
		66.67	16.67	16.67	0.300	0.400	0.200	0.100	0.000

	Effective Amount Available Original - Promotion Rate
Crowdfunding	0.85
Sponsorship	0.93
College	1.00

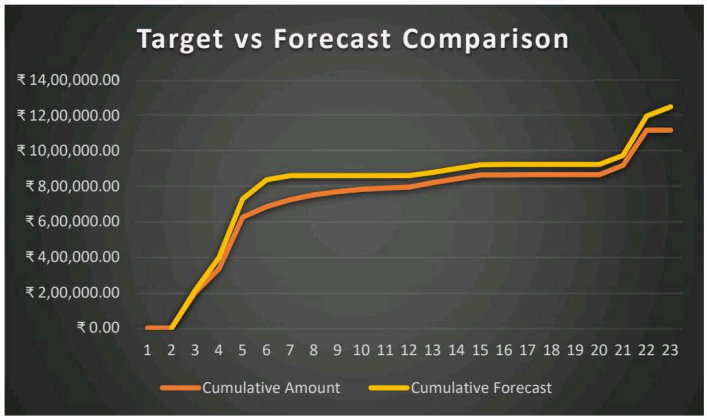
Effective Payoff Table

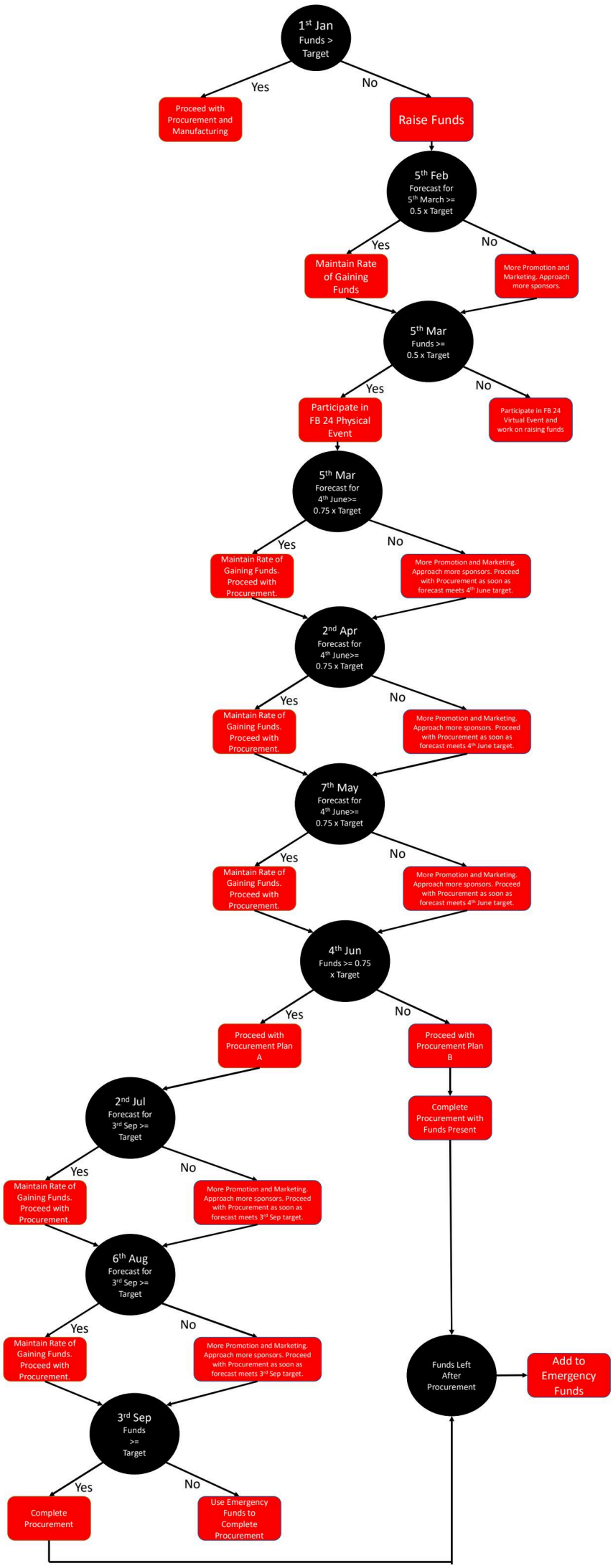
						Outcome					
						% of Target Achieved					
		Crowdfunding	Sponsorship	College	Effective Amount	100%	75%	50%	25%	0%	
Decision	% Split Between Funding Sources	100.00	0.00	0.00	0.85	0.04	0.13	0.21	0.43	0.04	
		75.00	25.00	0.00	0.87	0.04	0.13	0.26	0.39	0.04	
		50.00	50.00	0.00	0.89	0.04	0.16	0.29	0.36	0.04	
		25.00	75.00	0.00	0.91	0.05	0.14	0.27	0.41	0.05	
		0.00	100.00	0.00	0.93	0.05	0.14	0.23	0.47	0.05	
		0.00	75.00	25.00	0.95	0.19	0.29	0.48	0.00	0.00	
		0.00	50.00	50.00	0.97	0.24	0.39	0.34	0.00	0.00	
		0.00	25.00	75.00	0.98	0.20	0.30	0.49	0.00	0.00	
		0.00	0.00	100.00	1.00	0.10	0.30	0.60	0.00	0.00	
		25.00	0.00	75.00	0.96	0.19	0.29	0.48	0.00	0.00	
		50.00	0.00	50.00	0.93	0.28	0.37	0.28	0.00	0.00	
		75.00	0.00	25.00	0.89	0.18	0.36	0.36	0.00	0.00	
		16.67	16.67	66.67	0.96	0.39	0.29	0.29	0.00	0.00	
		16.67	33.33	50.00	0.95	0.38	0.38	0.19	0.00	0.00	
		16.67	50.00	33.33	0.94	0.38	0.47	0.14	0.00	0.00	
		16.67	66.67	16.67	0.93	0.28	0.37	0.19	0.09	0.00	
		33.33	16.67	50.00	0.94	0.47	0.38	0.09	0.00	0.00	
		33.33	33.33	33.33	0.93	0.65	0.19	0.09	0.00	0.00	Optimum Split
		33.33	50.00	16.67	0.92	0.28	0.37	0.18	0.09	0.00	
		50.00	16.67	33.33	0.91	0.55	0.23	0.14	0.00	0.00	
		50.00	33.33	16.67	0.90	0.36	0.27	0.18	0.09	0.00	
		66.67	16.67	16.67	0.89	0.27	0.36	0.18	0.09	0.00	

Sources of Funding	Target Amount	Promotion & Marketing Overheads	Effective Target Amounts
College	₹ 4,50,000.00	₹ 43,215.00	₹ 4,93,215.00
Sponsorship	₹ 4,50,000.00	₹ 67,500.00	₹ 5,17,500.00
Crowdfunding	₹ 4,50,000.00	₹ 0.00	₹ 4,50,000.00
		Total	₹ 14,60,715.00

Holt's Exponential Smoothing Method for Forecasting

				α = 0.53	β = 0.53			
Date	Amount Raised	Cumulative Amount	Target	Level	Trend	Forecast	Cumulative Forecast	Mean Square Error
01-Jan	₹ 0.00	₹ 0.00		₹ 0.00	₹ 0.00			
08-Jan	₹ 0.00	₹ 0.00		₹ 0.00	₹ 0.00	₹ 0.00	₹ 0.00	0
15-Jan	₹ 2,00,000.00	₹ 2,00,000.00		₹ 1,06,039.70	₹ 1,06,039.70	₹ 2,12,079.41	₹ 2,12,079.41	145912070
22-Jan	₹ 1,34,064.01	₹ 3,34,064.01		₹ 1,70,715.76	₹ 14,858.45	₹ 1,85,574.20	₹ 3,97,653.61	2653300175
29-Jan	₹ 2,89,865.79	₹ 6,23,929.80		₹ 2,40,869.45	₹ 89,586.39	₹ 3,30,455.84	₹ 7,28,109.46	1647552262
05-Feb	₹ 60,238.84	₹ 6,84,168.64		₹ 1,87,187.19	-₹ 79,660.05	₹ 1,07,527.14	₹ 8,35,636.60	2236183351
12-Feb	₹ 40,379.30	₹ 7,24,547.95		₹ 71,925.46	-₹ 47,953.91	₹ 23,971.55	₹ 8,59,608.15	269214330.9
19-Feb	₹ 27,067.06	₹ 7,51,615.00		₹ 25,612.78	-₹ 29,586.95	₹ 0.00	₹ 8,59,608.15	732625555.5
26-Feb	₹ 18,143.59	₹ 7,69,758.60		₹ 7,752.64	-₹ 18,631.20	₹ 0.00	₹ 8,59,608.15	329189882
05-Mar	₹ 12,162.01	₹ 7,81,920.61	₹ 7,30,357.50	₹ 1,337.51	-₹ 11,924.39	₹ 0.00	₹ 8,59,608.15	147914548.7
12-Mar	₹ 8,152.44	₹ 7,90,073.05		-₹ 651.32	-₹ 7,727.97	₹ 0.00	₹ 8,59,608.15	66462290.93
19-Mar	₹ 5,464.74	₹ 7,95,537.79		-₹ 1,039.20	-₹ 5,055.62	₹ 0.00	₹ 8,59,608.15	29863432.34
26-Mar	₹ 23,663.13	₹ 8,19,200.92		₹ 9,682.80	₹ 7,273.62	₹ 16,956.42	₹ 8,76,564.57	44979983.87
02-Apr	₹ 22,455.47	₹ 8,41,656.39		₹ 19,872.01	₹ 2,776.86	₹ 22,648.86	₹ 8,99,213.43	37401.18434
09-Apr	₹ 21,645.95	₹ 8,63,302.34		₹ 22,117.12	₹ 875.37	₹ 22,992.48	₹ 9,22,205.91	1813158.07
16-Apr	₹ 1,103.31	₹ 8,64,405.65		₹ 11,386.88	-₹ 10,480.43	₹ 906.45	₹ 9,23,112.36	38754.54583
23-Apr	₹ 739.57	₹ 8,65,145.22		₹ 817.97	-₹ 5,116.57	₹ 0.00	₹ 9,23,112.36	546967.8426
30-Apr	₹ 495.75	₹ 8,65,640.97		-₹ 1,756.64	-₹ 2,533.05	₹ 0.00	₹ 9,23,112.36	245768.4941
07-May	₹ 332.31	₹ 8,65,973.29		-₹ 1,839.11	-₹ 1,276.69	₹ 0.00	₹ 9,23,112.36	110430.9029
14-May	₹ 222.76	₹ 8,66,196.04		-₹ 1,345.70	-₹ 657.88	₹ 0.00	₹ 9,23,112.36	49619.8032
21-May	₹ 50,149.32	₹ 9,16,345.36		₹ 25,647.81	₹ 26,161.92	₹ 51,809.73	₹ 9,74,922.09	
28-May	₹ 2,00,100.09	₹ 11,16,445.45		₹ 1,30,433.06	₹ 91,794.59	₹ 2,22,227.64	₹ 11,97,149.74	
04-Jun	₹ 0.00	₹ 11,16,445.45	₹ 10,95,536.25			₹ 51,978.56	₹ 12,49,128.30	
11-Jun	₹ 0.00	₹ 11,16,445.45				₹ 57,376.84	₹ 13,06,505.14	
18-Jun	₹ 0.00	₹ 11,16,445.45				₹ 62,775.12	₹ 13,69,280.26	
25-Jun	₹ 0.00	₹ 11,16,445.45				₹ 68,173.41	₹ 14,37,453.67	
02-Jul	₹ 0.00	₹ 11,16,445.45				₹ 73,571.69	₹ 15,11,025.36	
09-Jul	₹ 0.00	₹ 11,16,445.45				₹ 78,969.97	₹ 15,89,995.33	
16-Jul	₹ 0.00	₹ 11,16,445.45				₹ 84,368.25	₹ 16,74,363.58	
23-Jul	₹ 0.00	₹ 11,16,445.45				₹ 89,766.53	₹ 17,64,130.11	
30-Jul	₹ 0.00	₹ 11,16,445.45				₹ 95,164.81	₹ 18,59,294.92	
06-Aug	₹ 0.00	₹ 11,16,445.45				₹ 1,00,563.10	₹ 19,59,858.02	
13-Aug	₹ 0.00	₹ 11,16,445.45				₹ 1,05,961.38	₹ 20,65,819.40	
20-Aug	₹ 0.00	₹ 11,16,445.45				₹ 1,11,359.66	₹ 21,77,179.05	
27-Aug	₹ 0.00	₹ 11,16,445.45				₹ 1,16,757.94	₹ 22,93,936.99	
03-Sep	₹ 0.00	₹ 11,16,445.45	₹ 14,60,715.00			₹ 1,22,156.22	₹ 24,16,093.21	
10-Sep	₹ 0.00	₹ 11,16,445.45				₹ 1,27,554.50	₹ 25,43,647.72	
17-Sep	₹ 0.00	₹ 11,16,445.45				₹ 1,32,952.78	₹ 26,76,600.50	
24-Sep	₹ 0.00	₹ 11,16,445.45				₹ 1,38,351.07	₹ 28,14,951.57	
01-Oct	₹ 0.00	₹ 11,16,445.45				₹ 1,43,749.35	₹ 29,58,700.91	




1st Jan
Funds > Target
Yes
No
Proceed with Procurement and Manufacturing
Raise Funds
5th Feb
Forecast for 5th March >= 0.5 x Target
Yes
No
Maintain Rate of Gaining Funds
More Promotion and Marketing. Approach more sponsors.
5th Mar
Funds >= 0.5 x Target
Yes
No
Participate in FB 24 Physical Event
Participate in FB 24 Virtual Event and work on raising funds
5th Mar
Forecast for 4th June>= 0.75 x Target
Yes
No
Maintain Rate of Gaining Funds. Proceed with Procurement.
More Promotion and Marketing. Approach more sponsors. Proceed with Procurement as soon as forecast meets 4th June target.
2nd Apr
Forecast for 4th June>= 0.75 x Target
Yes
No
Maintain Rate of Gaining Funds. Proceed with Procurement.
More Promotion and Marketing. Approach more sponsors. Proceed with Procurement as soon as forecast meets 4th June target.
7th May
Forecast for 4th June>= 0.75 x Target
Yes
No
Maintain Rate of Gaining Funds. Proceed with Procurement.
More Promotion and Marketing. Approach more sponsors. Proceed with Procurement as soon as forecast meets 4th June target.
4th Jun
Funds >= 0.75 x Target
Yes
No
Proceed with Procurement Plan A
Proceed with Procurement Plan B
Complete Procurement with Funds Present
2nd Jul
Forecast for 3rd Sep >= Target
Yes
No
Maintain Rate of Gaining Funds. Proceed with Procurement.
More Promotion and Marketing. Approach more sponsors. Proceed with Procurement as soon as forecast meets 3rd Sep target.
6th Aug
Forecast for 3rd Sep >= Target
Yes
No
Maintain Rate of Gaining Funds. Proceed with Procurement.
More Promotion and Marketing. Approach more sponsors. Proceed with Procurement as soon as forecast meets 3rd Sep target.
Funds Left After Procurement
Add to Emergency Funds
3rd Sep
Funds >= Target
Yes
No
Complete Procurement
Use Emergency Funds to Complete Procurement