Ahmedabad University
2025-2026 Monsoon

ENR215 Design, Innovation and Making

REPORT 3: FINAL DESIGN

Work up to 01 October 2025

Project title: Automatic ramp in trains that reduce the gap between the train and platform	Team ID: 5

1. The team (Team leader at top, others in alphabetical order)

Enrolment no.	Name	Mobile no.	Email ID (@ahduni.edu.in)
AU25L40001	Dhairya Sanathara	7801906876	dhairya.s7@ahduni.edu.in
AU2440126	Hirva Vekariya	6352024178	hirva.v@ahduni.edu.in
AU2440069	Shaanay Kothari	6356400444	shaanay.k@ahduni.edu.in
AU2440238	Tirth Pathar	7874222507	tirth.p7@ahduni.edu.in
AU2440024	Jahanvi Patel	9106129923	jahnavi.p@ahduni.edu.in

2. Time spent on project until 17 September 2025

Number of team meetings, date venue and duration

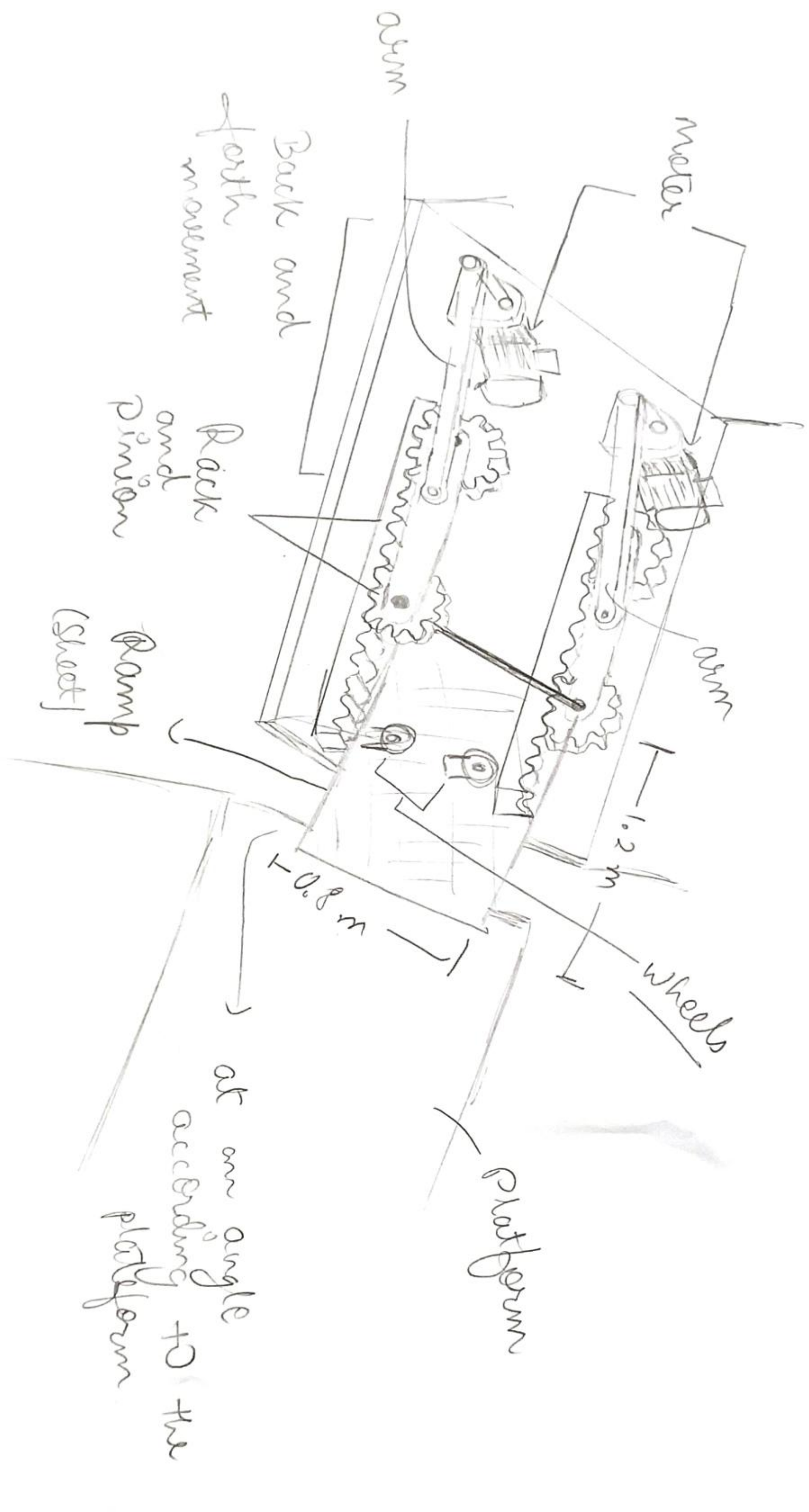
Individual time spent on project

Name	Time spent and work done
Dhairya Sanathara	Bugs, discussion with fabrication manager, professor, model finalization, designing and brainstorming(7-8 hours)
Hirva Vekariya	Making model, prototype, sketching, dimension and analysis, bugs, autocad and mostly designing (8-10 hours)
Tirth Pathar	Discussed our prototype design with the professor and worked on preparing the report. (5-6 hours)
Shaanay Kothari	Bugs,making of model, in-class discussion, fabrication (4-5 hours)
Patel Jahnavi	In-class discussion, talking with manufacturer, bugs (5-6 hours),

Attach the following Annexures as PDF files. (One file per Annexure) *You may take pictures from your prior work/Record Book*

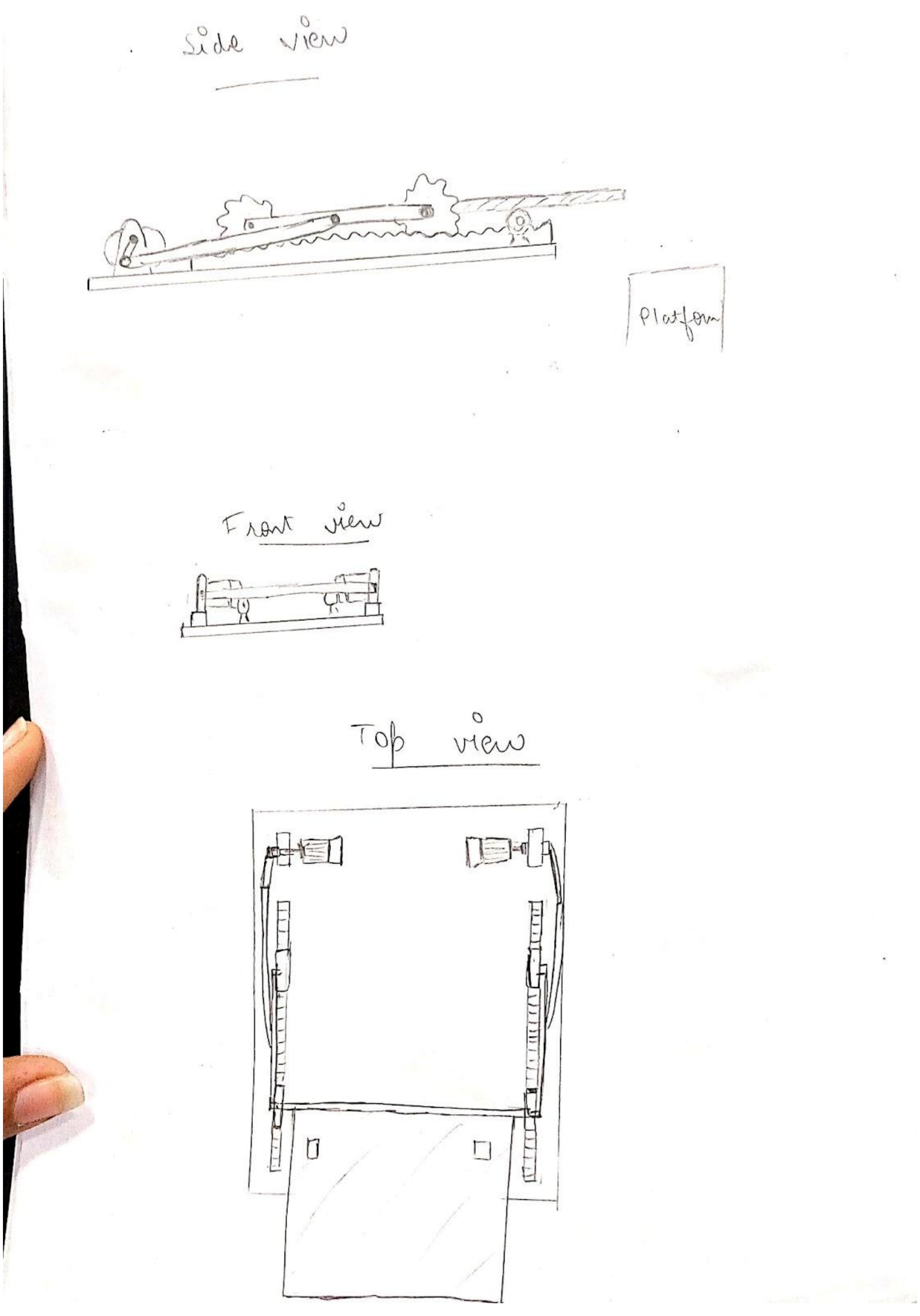
Annexure 3A Chosen Concept

Show a neat sketch (or CAD model) of the chosen final design concept; one A4 sheet.



Annexure 3B Make Quick – Fail quick

3B-1 Pictures of the model (including top view, front view and side view).



3B-2 Video clip, up to 2 minutes.

3B-3 Summary of what went wrong and what design changes did it result in.

First, we decided to make our ramp system by using a pneumatic cylinder system but we found that Pneumatic cylinders are not ideal for applications requiring very high force compared to hydraulic cylinders. so, we discussed it in a group and decided to change the idea and choose a hydraulic mechanism and we finalized it. After that, we went to the tinkerers lab and discussed with them so they suggested us not to use hydraulic mechanisms because it is costly. We had no other idea at that time, but then we did some research and after some thought, we decided on the belt and chain mechanism, but problems arose in that too, so we had to cancel that too. Finally, we decided on the rack and pinion gears mechanism. It is cost-effective and semi-automatic, so we found it easy, so in the end we finalized it for our project. Also, for ramp first we finalized a foldable ramp because we found it creative and we thought that it would make our project more attractive but when we came to implement it, we found that it would be very hard and costly so we decided to make a flat ramp.

Annexure 3C TRIZ basis analysis and design improvement

3C-1 TRIZ impact on the design (TRIZ critical parameters and contradiction matrix).

The TRIZ technique helped us to work out the design contradictions in the semi-automatic train-platform ramp. It was aimed at making it safer and more accessible without exceeding the budget, putting on excessive weight, or losing reliability. The main criteria we used were safety, strength, weight, cost, reliability, complexity, deployment time and adaptability.

The following contradiction matrix analysis is used to calculate standard analysis:

1. Strength/weight- the heavier the ramp the stronger it is.

Solution: To correct it, we divided the ramp into sections and used rack and pinion gears mechanism to balance load.

2. Speed versus reliability- speed may damage reliability.

Solution: we used preliminary action and dynamization to maintain the motion stable and steady.

3. Low cost vs. durability cost reduction can reduce the duration of the life.

Solution: we had the quality of the product we used as locally sourced and limited to only high - grade stuff at the high-stress points.

4. Automation vs. safety- total automation increases risk in case of sensor failure.

Solution: we have added two sensors and a manual override, based on initial anti-action and self-service ideas.

Impact: The application of the TRIZ matrix allowed us to design a balanced model between the safety, strength, cost, and performance. The last ramp we finalized is light, well built, which will be safer to get in and out to train and minimizes accidents during the boarding. to work out the design contradictions in the semi-automatic train-platform ramp. It was aimed at making it safer and more accessible without exceeding the budget, putting on excessive weight, or losing reliability.

3C-2 How the design was improved on the basis of TRIZ implementations?

TRIZ analysis enhanced the design of the automatic ramp system with the use of a rack and pinion gears mechanism. The primary idea was to improve the safety, reliability, and ease of use without making the design more complex and expensive. The lightweight but strong materials were used only at the critical load points of the ramp using the Segmentation and Local Quality principles so that the weight of the ramp was minimized without compromising on the strength. The principle of Preliminary Action was used by incorporating IR sensors which indicate when the train is stopped and the ramp extends automatically and then it retracts when the train is being started. The Dynamization principle enhanced the ease of movement of the ramp by the accurate rack and pinion motion. The Preliminary Anti-Action principle made sure it was safe by installing a manual override as well as fail-safe locking mechanism in the event of sensor or mechanism failure. On balance, the implementation of TRIZ resulted in the ability to make the ramp safer, more reliable, and efficient, which guaranteed easy boarding of the passengers and avoided the accidents caused by the distance between the train and the platform.

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ENR215 – Design, Innovation and Making

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Annexure 3D – POKA–YOKE (Mistake-Proofing Sheet)

Project Title: Automatic Ramp in Trains that Reduce the Gap between the Train and Platform

Team ID: 5 | Section: 2 | Group Members: Dhairya Sanathara, Hirva Vekariya, Jahnavi Patel, Shaanay Kothari, Tirth Pathar

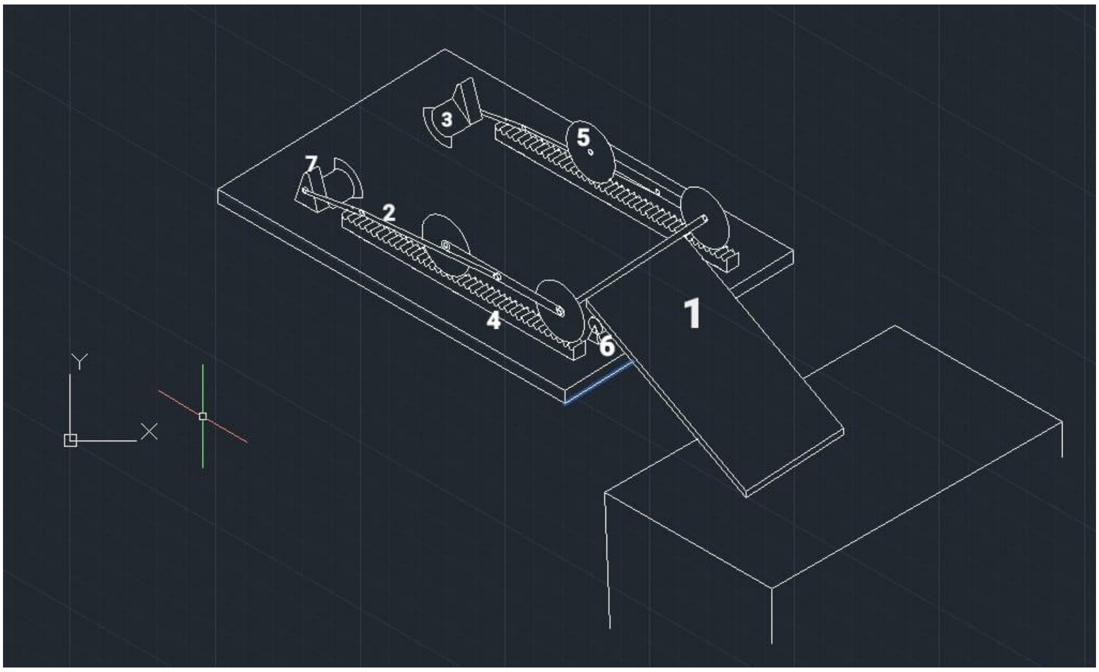
Process / Activity	Possible Error & Cause	Type of Poka-Yoke	Poka-Yoke Description	Benefit / Status
Mounting ramp on train door frame	Ramp fitted wrongly due to symmetrical sides	Preventive	Asymmetric mounting brackets allow fitting in only one direction	Avoids incorrect installation – Implemented
Wiring of motor and sensors	Loose or reversed wiring from unclear labeling	Preventive	Color-coded wires and terminal markings for quick identification	Prevents electrical faults – Implemented
Over-extension of ramp	Motor continues running after full range	Detective	Added limit switches with LED feedback	Prevents motor damage – Implemented
Ramp not retracting properly	Dust or obstruction in rack-pinion system	Preventive	Protective cover and buzzer alert if ramp remains open	Improves reliability – Planned
Load failure under weight	Weak material or poor assembly	Detective	Load-tested up to 150 kg with safety tag verification	Confirms structural safety – Implemented

Summary:

This simplified Poka-Yoke sheet is a summary of the major mistake-proofing methods employed in the Automatic Ramp Prototype. It makes sure that there is reliability, safety, and ease of use of all assembly, wiring, and operations to the passengers, including the elderly and differently-able.

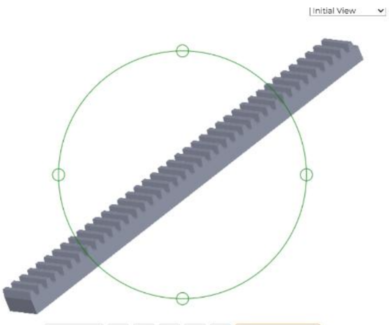
Annexure 3E Final design (to make for use by beneficiary)

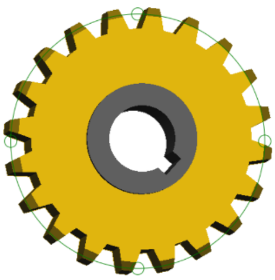
3E1 Provide <u>CAD assembly drawing</u> (1 sheet). (In AutoCAD/Solid Works/etc.). Each part must be numbered (called part number).



3E-2 Provide <u>exploded assembly drawing</u>; every part should be visible and its part number should be indicated (1 sheet A3 size).

1





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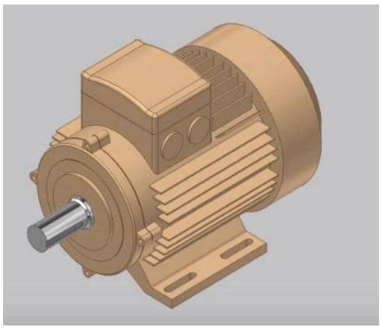

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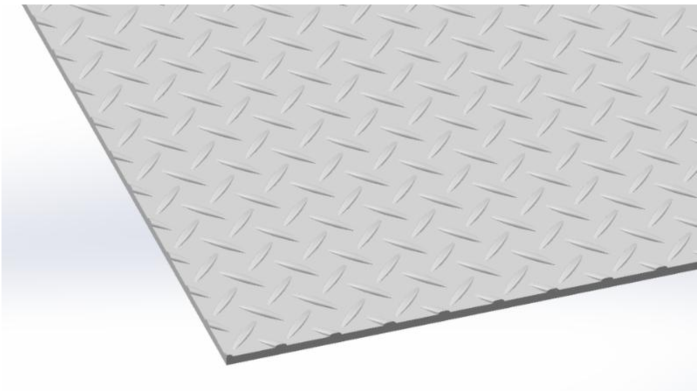

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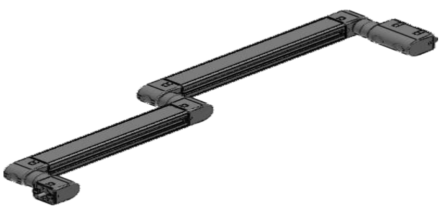

3E-3 Attach Parts List (1 sheet A4 size) as per assembly drawing(s): The format is as under

Sl. No.	Part number	Part name	Quantity	Remarks
1	1	Ramp	1	This will come out and board or deboard the p to avoid gap
2.	2	Arms and support	2	This will provide suppo and pully to move
3.	3	motor	2	This will apply force to and make the object m
4.	4	reck	2	This is the main part on which will play an impo in mechanism
5.	5	Pinion	4	This will move over the help to move the ramp
6.	6	Wheel	2	For less friction and sli support
7.	7	Triangular support	2	This will provide suppo mechanism

3E-4 Bill of Materials - BUY: List the parts that will be bought, and used in the assembly without any reworking or modification. The format is as under:

Sl. No.	Part number	Part name	Nos. reqd.	Make(s) and Manufacturer(s)	Manufacturer's Catalog no./ID
1	1	Aluminum sheet	1	-	-
2	4 and 5	Rack and pinion gears	4	-	-
3	3	DC warm gear motor	2	-	-
4	3	Motor driver	2	-	-
5	-	Wiring, connectors, switches		-	-
6	-	Mild steel frame	1	-	-
7	-	Bearings / shafts / couplings		-	-
8	-	Rivets / bolts / fasteners / washers		-	-
9	-	Hinges & folding hardware		-	-
10	-	Rechargeable battery (12V 7Ah)	1	-	-
11	-	Battery charger / charging module	1	-	-
12	-	Testing & demo materials		-	-
13	-	Aluminium rods	2	-	-
14	-	Painting, finishing & anti-slip strips		-	-

15	-	Enclosure / control box	1	-	-

3E-5 Bill of Materials – MAKE: List the parts that will be realized after working and/or modification. Also list the raw material required from which each part will be made. The format is as under:

Sl. No.	Part number	Part name	Raw material needed	Quantity	Processing operations
1.	1	Ramp	Aluminium sheet		To design ramp
2.	1	Ramp	Mild sheet frame	1	To design ramp
3.	3	Power supply/ gear box	DC gear motor	2	To rotate pinion gears
4.	5	Base part	Rack and pinion gear,	4	To get in and get off ramp
5.	-	Base part	aluminium rod	1	move downward the ramp
6		Power supply/ gear box	Motor driver		
7		Power supply/ gear box	Battery	1	Supply power to DC motor
8		Assemble	Wires, bolts, hinges, shaft, bearing		For joining parts, electricity supply

Annexure 3F Equipment and Space Requirements

3F-1 Mention equipment and machines required for making.

1. For fabrication and cutting:

- hand held grinder / mettle cutting machine (for aluminium sheets and mild steel parts)
- shearing machine or sheet metal cutter
- power drill and drilling bits (for holes)
- hacksaw and file set (for manual trimming and finishing)

2. Machining and assembly:

- lathe machine (for finishing)
- Milling machine (for gear alignment)
- Welding machine
- Bench wise clamps (for holding components during assembly)
- Spanner, screw-driver and Allen key set (for mechanical fitting)

3. For Electrical work:

- Soldering iron and soldering kit
- Mustimeters
- Wire stripper, cutter
- DC power supply

Finishing and Testing

- Measuring tape, Vernier callipers, and spirit level
- Paint brush or spray gun
- Load-testing setup

3F-2 Indicate the space (sq.m.) required for the duration of the project where the team will work. – approx**. 4-5 sq.m**

Indicate the space required (sq.m.) for storing your project product after the end of the course. **1.5-2 sq.m**

3F-3 Indicate possible location and space required (sq.m.) where you will display and demonstrate the product made.

ANYWHERE BUT ON GROUND-FLOOR ARE HAVE A PROER SPACING OR NEAR ENTRANCE TO SHOW THE REAL GAP AND HEIGHT DIFFERENCE FOR THE SAME

Annexure 3G Preliminary Costing

Provide preliminary costing for making the final design concept based on the Parts List/ complete BOM.

Sr. No	Component	specification	Qty.	Unit cost (₹)	Total (₹)
1	Aluminium sheet(top surface)	4 sheets arranged 2Ã-2 â†’ 1200Ã-800 mm	4	700	2800
2	Mild steel frame (angles/box + cross members)	1200Ã—800 mm outline + cross supports	1	2500	2500
3	Rack & pinion set	Steel, module -2, matched to pinion	4	1500	6000
4	DC worm-gear motor	12–24 V, high torque	2	2500	5000
5	Motor driver (BTS7960 / suitable)	12–24 V, 15 A rated	2	700	1400
6	Rechargeable battery (12V 7Ah)	Lead-acid or Li-ion pack	1	500	500
7	Battery charger / charging module	-	1	250	250
8	Hinges & folding hardware	Heavy-duty stainless hinges / joints	3	300	900
9	Rivets / bolts / fasteners / washers	Joining sheets & frame		500	500
10	Bearings / shafts / couplings	For pinion & drive coupling		500	500
11	Wiring, connectors, switches	Power & signal harness		600	600
12	Enclosure / control box	Plastic or metal electronics box	1	500	500
13	Painting, finishing & anti-slip strips	Anti-rust, powder coat + non-slip tape		1000	1000

14	Testing & demo materials	Platform mockup, load test tools		1000	1000
15	Aluminium rods		2	600	1200

Grand total: 25, 450 ₹