

CREATIVE ENGINEERING DESIGN

TEAM CHAIRNOBYL

PRESENTED BY:

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P-TYPE CHAIR

FEATURES

History

- Known as the “**Visitor chair**”
- Frame shaped like the letter “P” from the side
- Used in offices, schools and public institutions as visitor seating



Economical Features

- At **Rs. 1600 MRP***, it is cost-effective, making it accessible for large-scale use

Ergonomics:

- Slightly curved backrest for basic lumbar support, designed for short-duration seating

A N O V E R V I E W O F

SSP ENTERPRISES

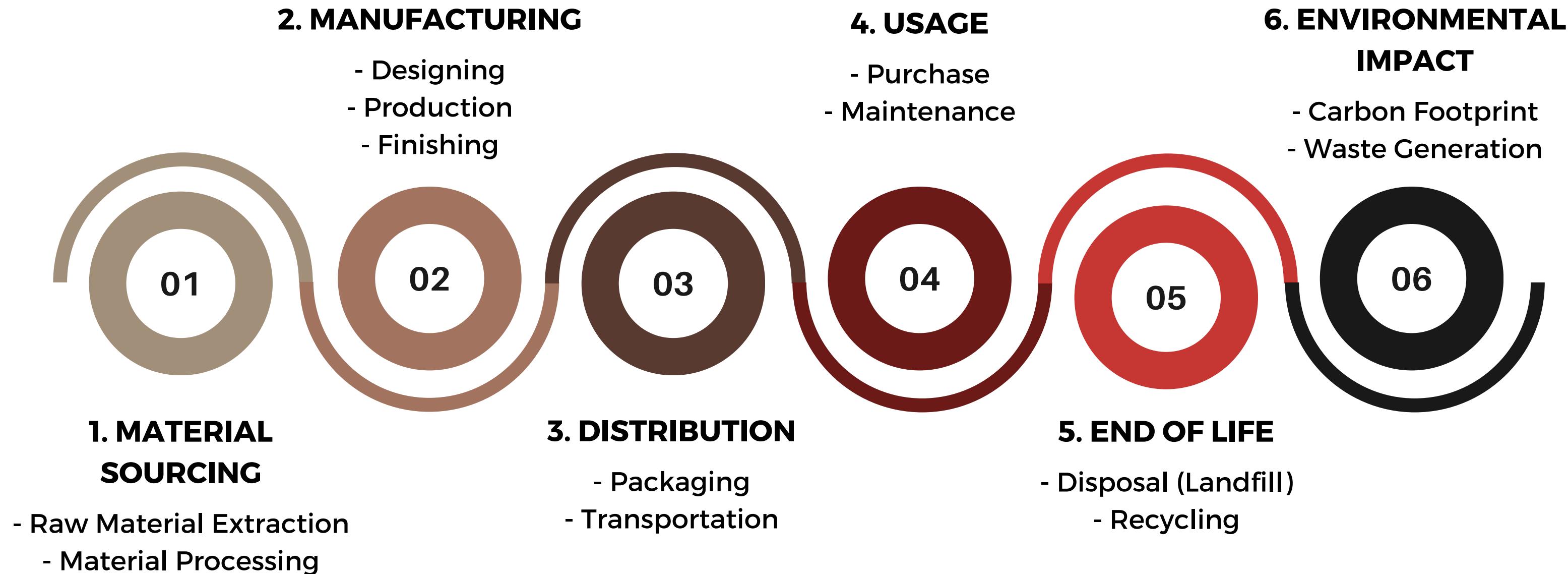
- Furniture manufacturers located in Nagarbhavi, West Bangalore.
- B2B and B2G business primarily.
- Specializes in high-quality Chairs, Almirahs, School Desks, Tables, and Cots.
- Multiple Units for Assembly, Fabrication, and Showroom display.



**30 years of
experience**

60+ employees

C H A I R ' S
LIFE CYCLE



PROJECT

STAKEHOLDERS

01 Material Sourcing

- Foresters and Loggers
- Mining Companies
- Petrochemical Companies

02 Material Processing

- Sawmill workers
- Metal Refineries workers
- Plastic Manufacturers
- Textile and Foam Manufacturers

03 Manufacturing

- Designers/ Engineers
- Factory Workers
- Quality Control Inspectors

This comprehensive list illustrates the complexity and interconnectedness of the processes involved in bringing a chair from concept to consumer and beyond.

04 Supply Chain and Distribution

- Raw material suppliers
- Warehouse Operators
- Freight Companies

05 Usage

- Consumers
- Customer Support Teams

06 End of Life

- Recyclers
- Waste Disposal Companies

07 Regulatory and Compliance

- Government Regulatory Agencies
- Environmental NGOs

PARTS OF THE CHAIR



SEAT



BACKREST



FRAME



CHAIR



FASTENERS



HANDREST



BUSH



BILL OF MATERIALS - BOM

Component	Material	Quantity
Chair Frame	Mild Steel - Hollow	1
Armrest - Cushion + Mount	PU foam - ISF + Mild Steel	2
0.75" Screw	Galvanized Steel	4
1.75" Screw	Galvanized Steel	4
0.75" Nut	Galvanized Steel	4
1.25" Nut	Galvanized Steel	4
0.5" Washer	Galvanized Steel	4
1.25" T-Nut	Galvanized Steel	4



PLASTICS



Polypropylene



Polyester



EPE

Properties

- **Lightweight**
- **Flexible**
- **Tough**

- **Strong**
- **Resistant**
- **Unabrasive**

- **Lightweight**
- **Rigid**
- **Easy to mould**

- **Great physical resistance against flex and temperature**

Use

- **Backing fiber of the chair**

- **For the upholstery covering the chair**

- **Substrate of the cushion**

- **Integral Skin Foam**
- **Low-Density foam**

Reason

- **Resistance to wear and tear**
- **Durable**

- **Durable**
- **Easy to clean**
- **Dries quickly**

- **Helps cushion maintain its shape**

- **Comfort**
- **Durability**
- **Maintains its shape over a long time but also soft**

WOOD

Properties

Use

Reason



Plywood

- **Strong**
- **Flexible**
- **Resistant to cracking**

- **Used for the backrest**
- **Also in the seat panels**

- **Due to the layered structure, provide immense strength**

Metal

Properties

Use

Reason



Mild Steel

- **Strong**
- **Ductile**
- **Weldable**

- **Provide structural strength**

- **Supports weight well due to durability**



Galv. Steel

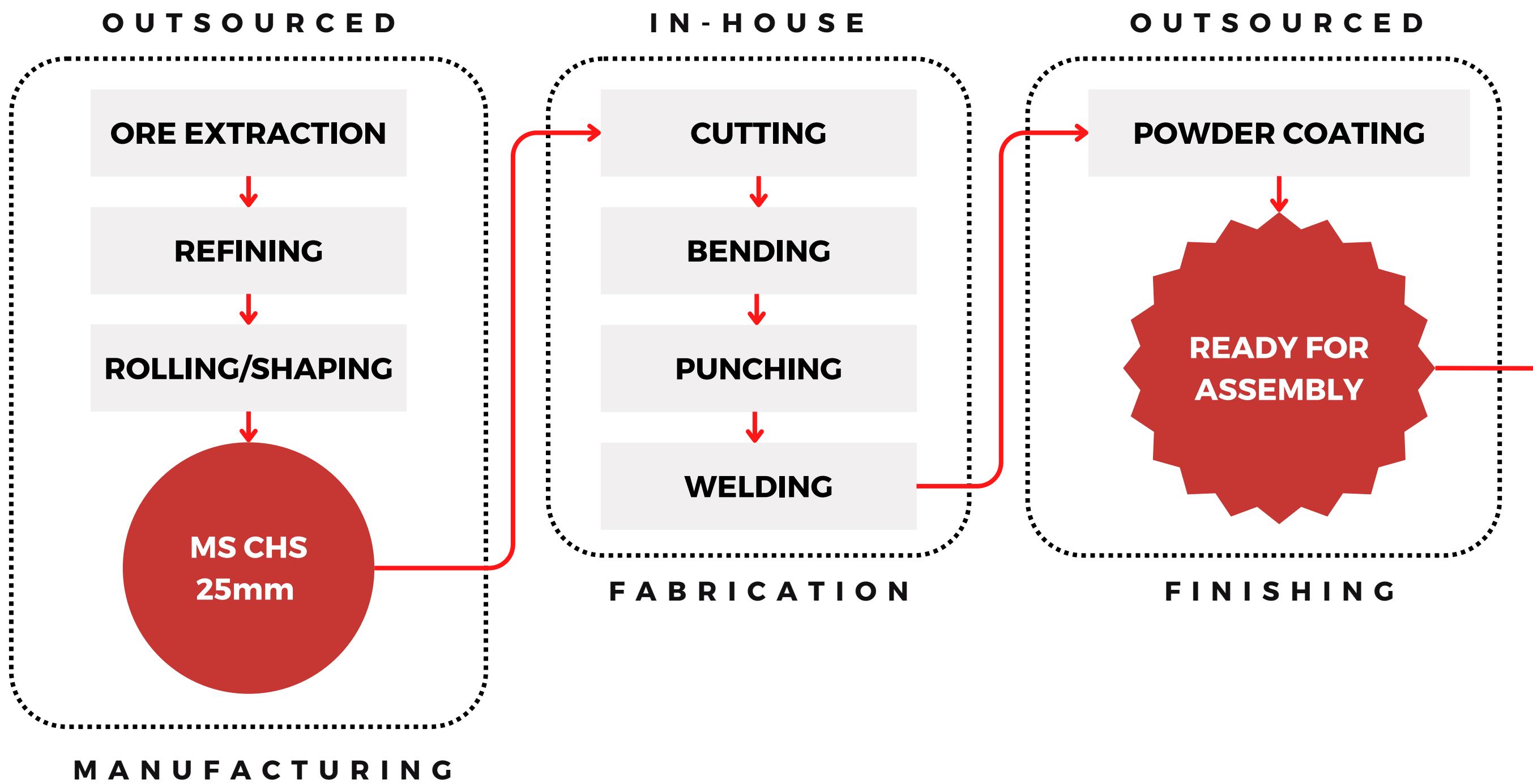
- **Lightweight**
- **Flexible**
- **Tough**

- **Used for the fasteners**

- **Corrosion resistant**
- **Also no effects of humidity**

MANUFACTURING

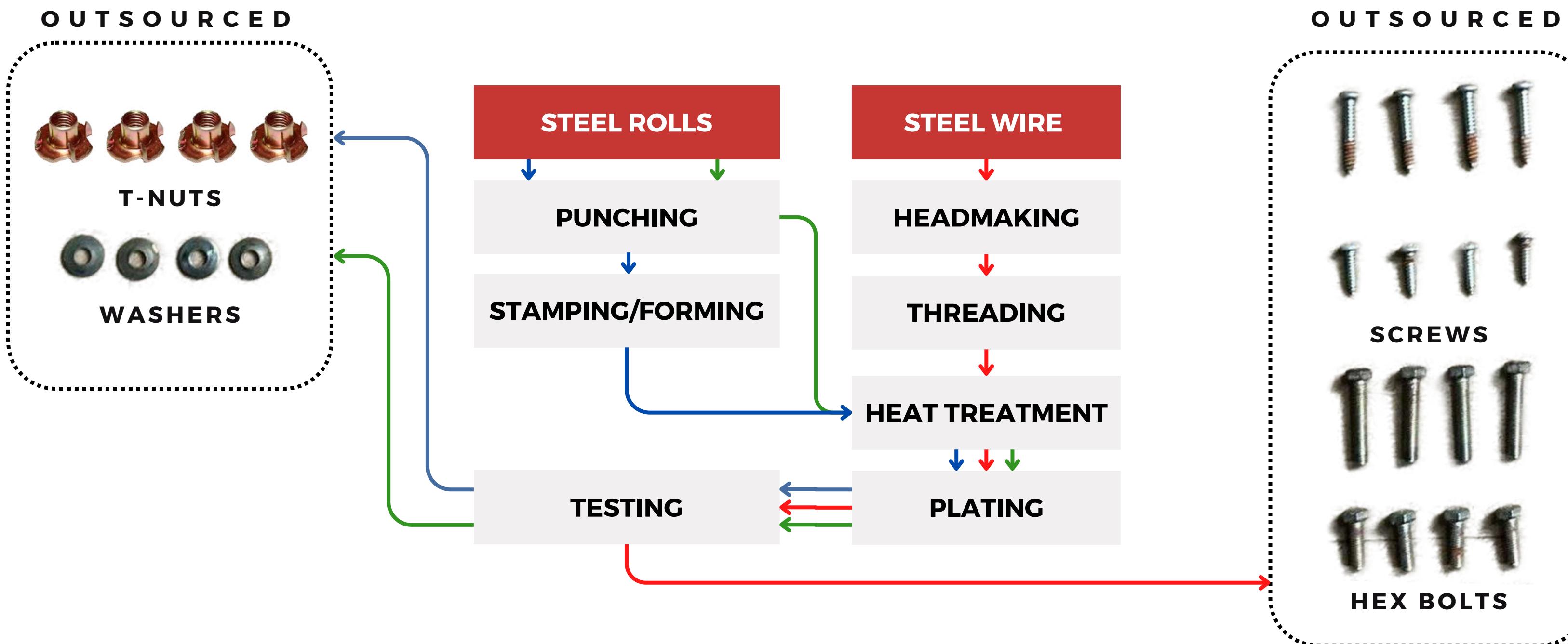
M E T A L C O M P O N E N T S : M I L D S T E E L



FRAME

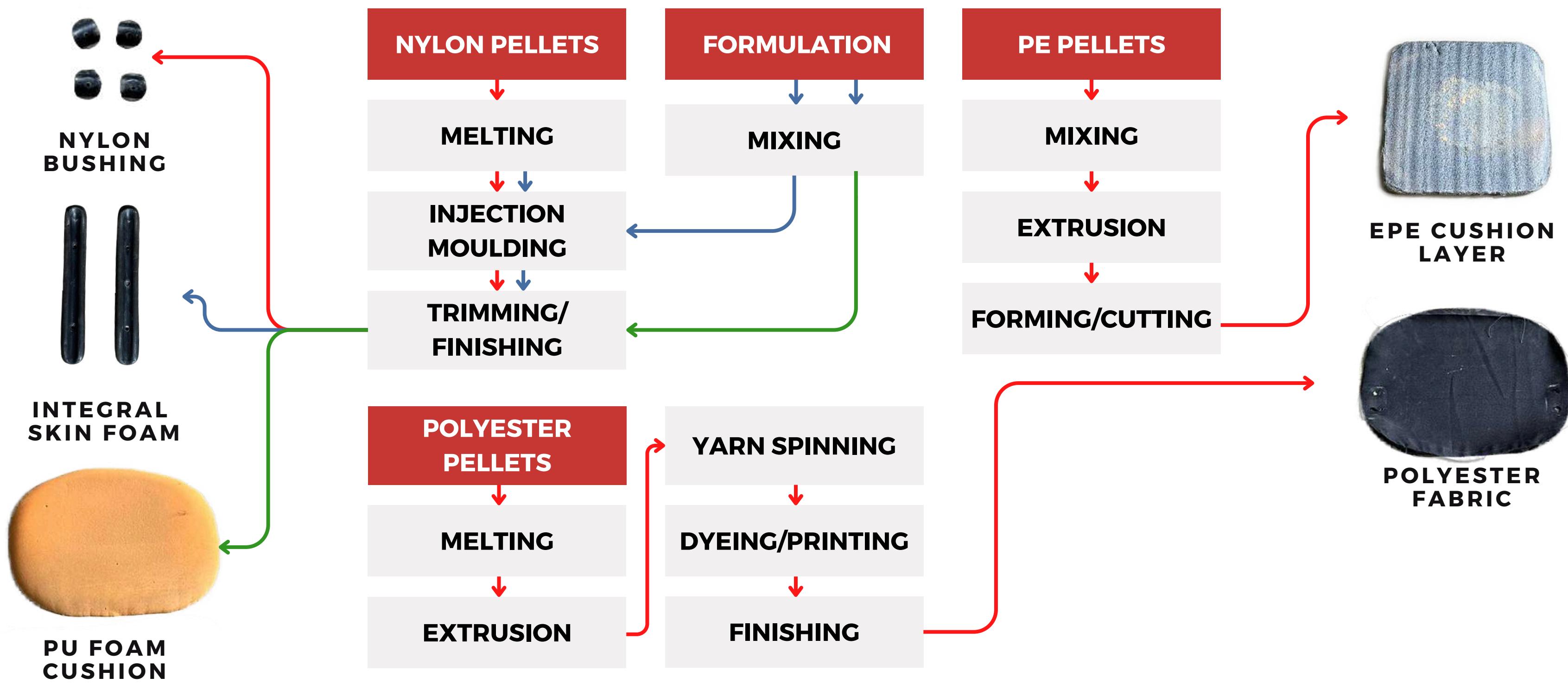
MANUFACTURING

M E T A L C O M P O N E N T S : F A S T E N E R S



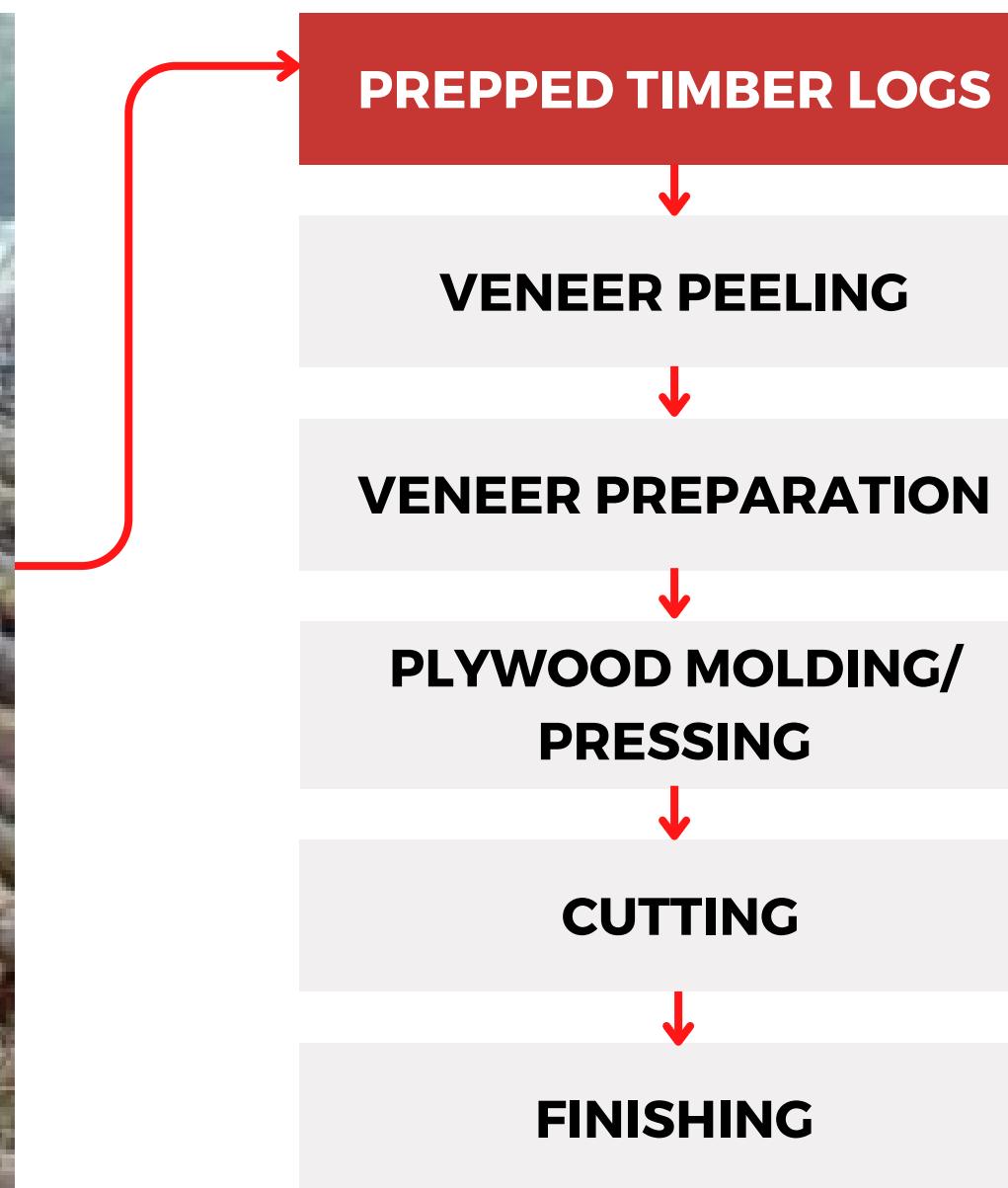
MANUFACTURING

PLASTIC COMPONENTS



MANUFACTURING

WOOD COMPONENTS : PLYWOOD



END OF LIFE CYCLE

O P T I O N S A V A I L A B L E

Repair

- Usually the first choice.
- Possible at low cost, often by changing parts.



Refurbish

- In house refurbishing the returned chair
- Prolongs the life of the chair and reduces waste,



Recycle

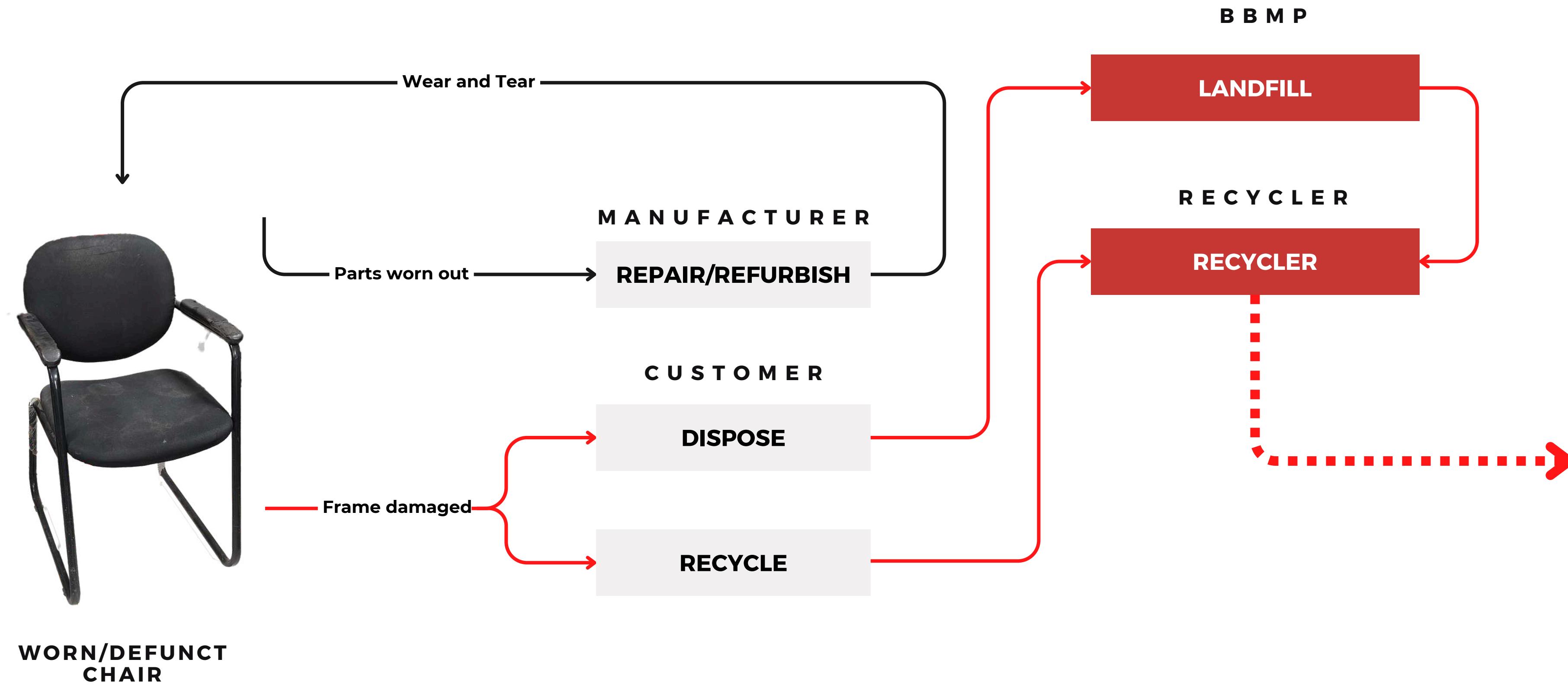
- Facility not provided by the manufacturer.
- Left as an option to consumer.



Images are representative

END OF LIFE CYCLE

O B S E R V E D P R O C E D U R E



INFERENCES

FROM SSP ENTERPRISES

- All parts are outsourced to facilitate **rapid production**, reducing assembly time to **1.5 hours** per chair.
- Components are standardised parts, and **sourced locally**, primarily from vendors located in Mysore Road 10km away, with lead times ranging from **2 hours** (for foam, fabric, fasteners) to **1 week** (for plywood).
- The chair is priced at **₹1600**.
- SSP Enterprises focuses on **B2B and B2G** clients, especially through **government tenders**.
- Chairs are made on order only, due to space restrictions of having a unit in the city.



MR. NATESH
Incharge - Assembly



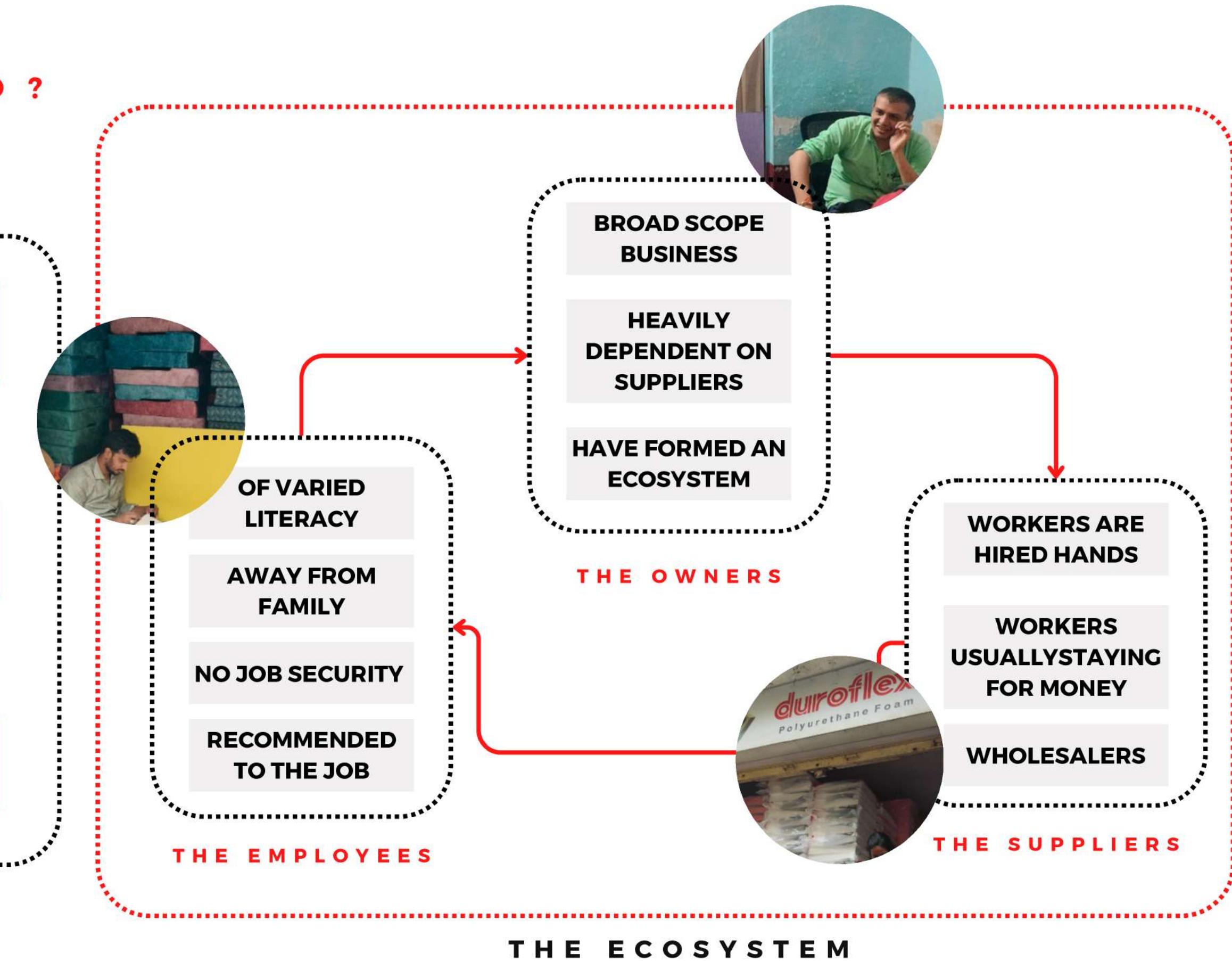
WHAT DO THE PEOPLE DO?

ROLES OBSERVED

OWNERS : OFTEN FIRST GENERATION EMPLOYERS

EMPLOYEES : MIGRANTS, WORKING FOR ALMOST 8 YEARS

SUPPLIERS : USUALLY BIG FACTORIES, NO FIRST PERSON CONTACT



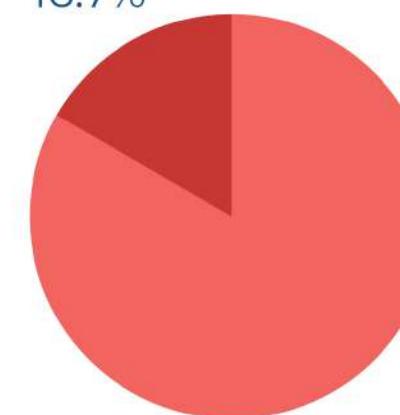
WHO

DEMOGRAPHIC ANALYSIS

PROPREITOR

AGE

< 35
16.7%



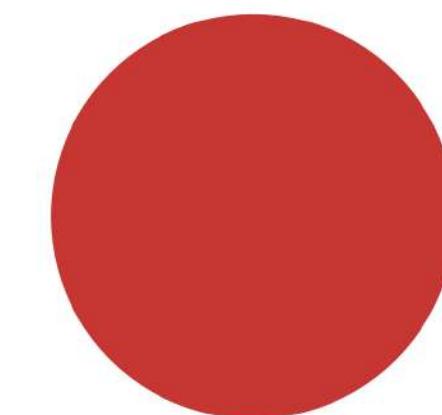
SEX

Male
100%



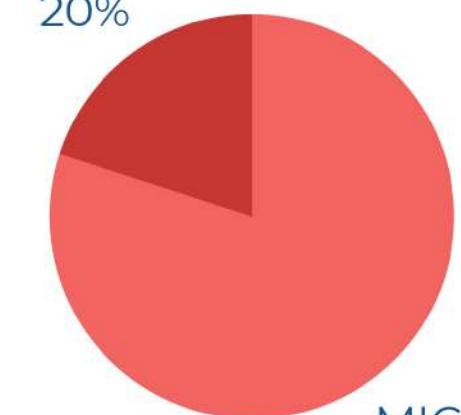
MIGRATION STAT

Local/Naturalised
100%



CLASS

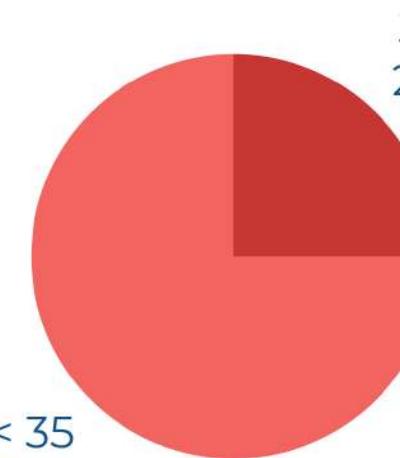
HIG
20%



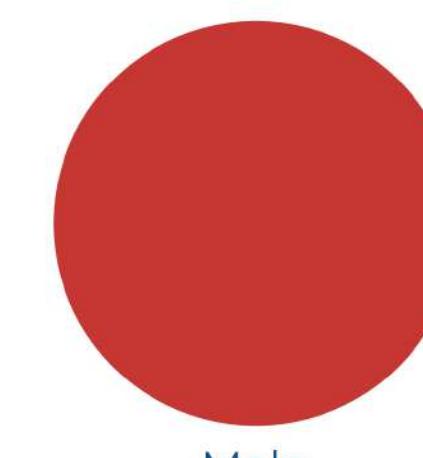
LABOURER

35+
25%

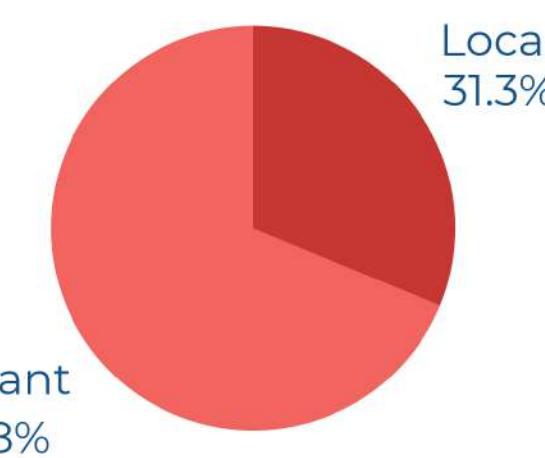
< 35
75%



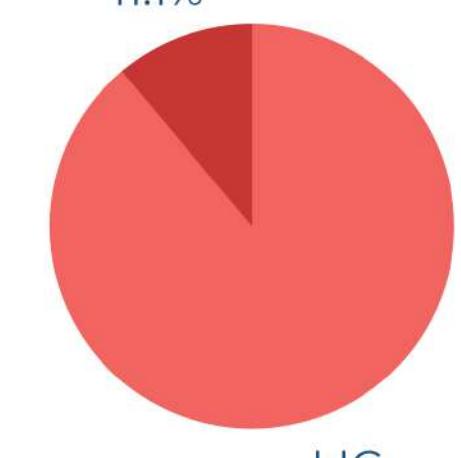
Male
100%



Migrant
68.8%



MIG
11.1%



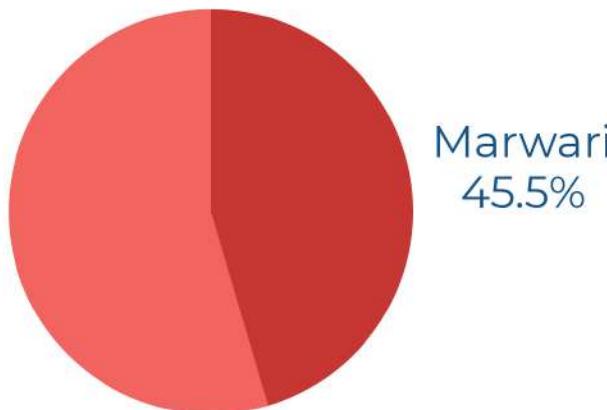
WHO

DEMOGRAPHIC ANALYSIS

PROPRIETOR

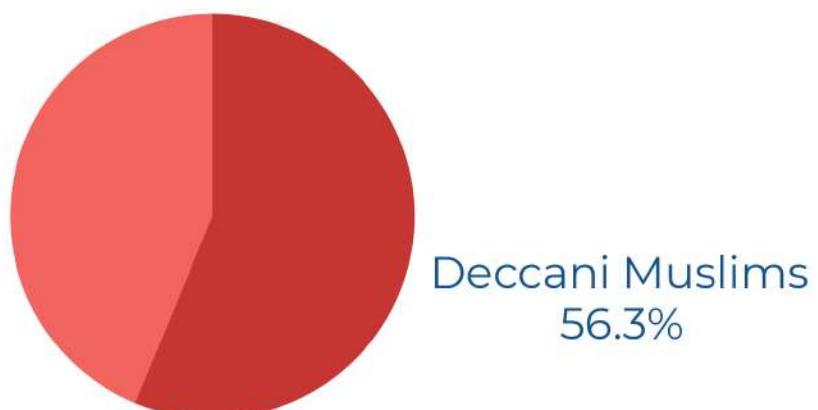
ETHNIC
BACKGROUND

Deccani Muslims
54.5%



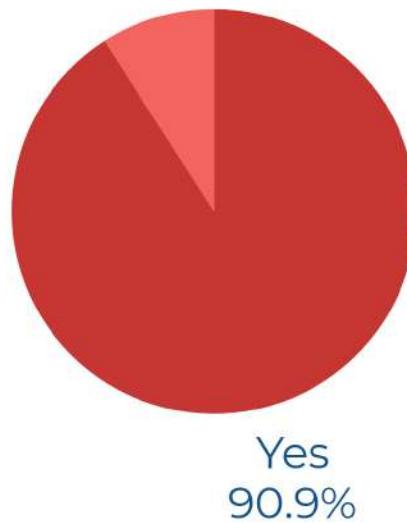
LABOURER

Other
43.8%



LIVING WITH
FAMILY

No
9.1%



ANALYSIS

Proprietors :

- Tended to be individuals in their 40s, typically male, running either a first or second generation family businesses.
- Tended to be predominantly from two mercantile communities.

Labour :

- Tended to be male, age in 20s and 30s
- Tended to be skilled, but from regions of India that lack the opportunities.

WHERE ARE THESE COMPANIES LOCATED?



BAPUJINAGAR, MYSORE ROAD,
BANGALORE, KARNATAKA, INDIA

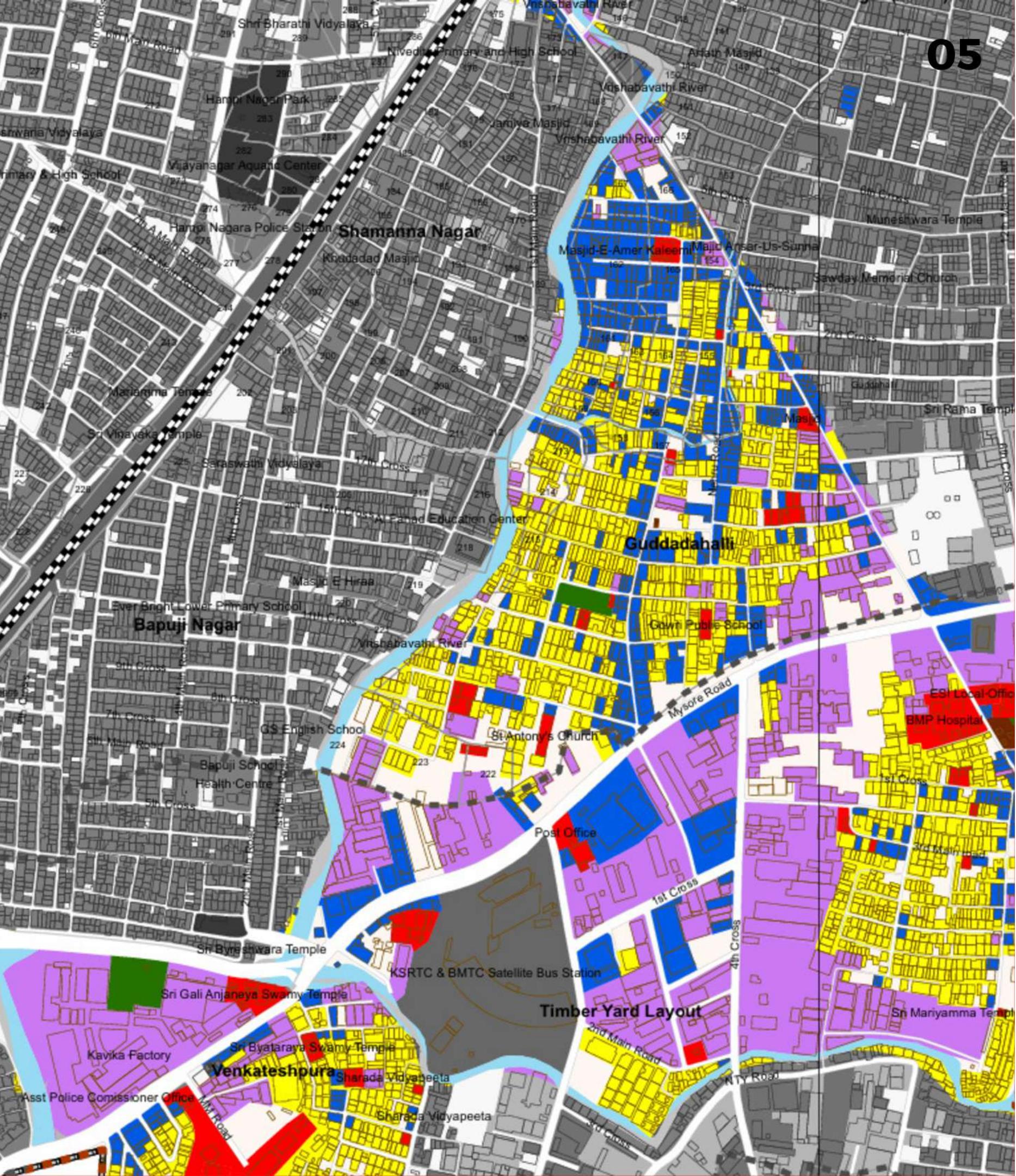
1. Manufacturers: VR Wood
2. Wholesale suppliers: Plywood
3. Foam Suppliers: Duraflex Sofa
4. Steel Frame and Bolts: Peenya
5. Furniture assembly: Amogh
6. Fabric: Panipat, Delhi
7. Plastic Parts: Chandigarh, Aligarh, Delhi, Mumbai

WHERE

P R E C I N C T

The landuse pattern in this precinct of Bapuji Nagar suggests a reason why this area is thriving in the production and assembly of furniture and how this ecosystem would have formed.

- [Yellow] Residential
- [Blue] Commercial
- [Purple] Industrial
- [Red] Public & Semi Public
- [Grey] Unclassified
- [Brown] Public utility
- [Green] Open space/ Parks/ Recreation
- [Dark Grey] Transport & Communication



WHERE

D O T H E S E S T A K E H O L D E R S L I V E ?

- Workers have formed a network that helps them stay connected with one another. Some workers, due to lack of housing options, live directly within the factory premises.
- Interviewees also shared that they prefer living about 4 km away from the main factory area due to overcrowding in the nearby market.
- Skilled workers are often drawn from outside regions, particularly Delhi NCR, as they are attracted by higher income opportunities.
- One notable example is a worker named Mohd Rizwan, who has come from Bihar and has been employed at the factory for 8 years.
- Many workers do not live with their families. They aim to establish financial stability before bringing their families to join them.
- Financially, one worker mentioned earning ₹40,000 per month, out of which they keep ₹5,000 for themselves and send the remainder home.

WHY

Why ARE THEY HERE ?

Employees :

- Migrate for better-paying jobs and stable income.
- Opportunities in furniture-making, a well-established industry.
- Social bonds and reduced living expenses (e.g., factory housing).

Employers :

- Saw profit potential in the growing local furniture market.
- Proximity to suppliers and customers for convenience.
- Industrial growth provided business opportunities.

Why did they choose this craft ?

Employees :

- Learned the trade in home regions; valuable skill here.
- Better wages compared to other low-skill jobs.
- Consistent work allows them to support families.

Employers :

- High demand due to urbanization.
- Low capital investment with well-established supply chains.
- Flexible production (customized and mass-produced furniture) is profitable.

Why did they choose this particular sector ?

Employees :

- Jobs with better pay and proximity to suppliers for constant work.
- Thriving furniture hub offers various related job opportunities.

Employers :

- Close to suppliers, reducing logistical costs.
- Strong local market ensures steady demand.
- Skilled migrant labor available for efficient operations.

WHEN

D I D T H E Y S T A R T T H E O P E R A T I O N S ?

- Most of the businesses started 15 to 20 years ago:
- Tailor shop - Started 30 years ago.

Labourers:

- The carpenter joined the shop 15 years ago.
- Worker from Akram - Joined as an employee 8 years ago.
- Low-level workers - short-term employees



WHEN

When do the workers start and end their workshift?

The carpenter from the furniture shop does not have a fixed work shift works according to the workload.

When do the workers get their pay?

- The carpenter - Gets paid on the basis of work done.
- Many of the workers are hired on contract or short term basis and are not full time employees.
- Chair Parts Shop- Workers to load and unload things - paid a monthly salary

When do they have off days/leisure time?

Carpenter - Gets Fridays off and plays cricket with other workers.

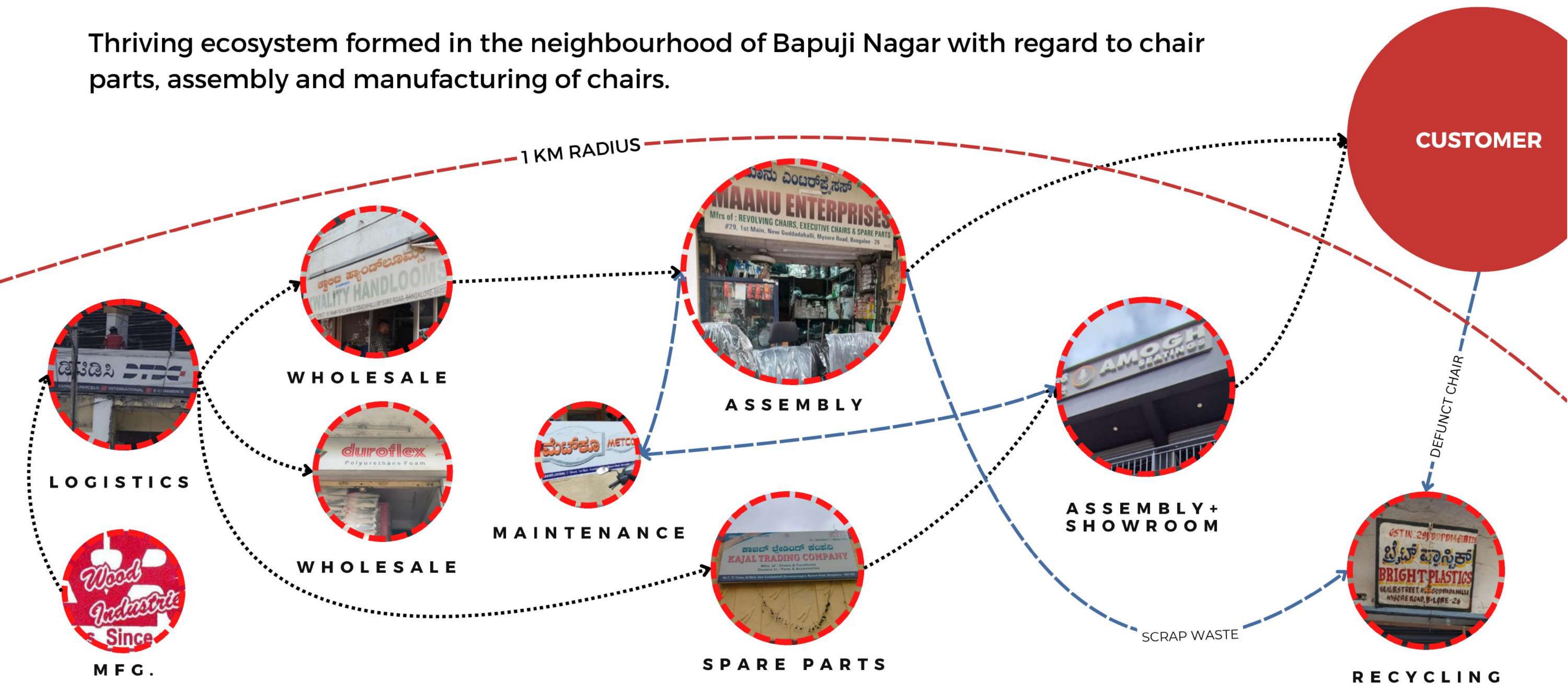
HOW

ARE THESE STAKEHOLDERS?

- **How have things changed for the factory workers of Bangalore since they started?**
- **Low wages- low savings**
- **Long work hours**
- **Work safety**
- **How are they affecting their environment?**
 - Suppliers: air pollution arising from logistics and plastic pollution from packaging.
 - Manufacturers: Byproducts from processing plywood
 - Assembly units: Scrap items from subtractive manufacturing process.
- **How is the future of factory work in Bangalore evolving?**
 - With advancements in technology and increasing awareness about workers' rights, hope for better working conditions and more opportunities for skill development.

INTERDEPENDENCY

Thriving ecosystem formed in the neighbourhood of Bapuji Nagar with regard to chair parts, assembly and manufacturing of chairs.



HABITAT

STUDY

Science Institute Sub-Post Office, Bangalore

- Located just opposite the main gate of IISc on CV Raman Road
- Operated by 10 employees
- Convenient location for IISc students and staff
- Offers a range of postal and financial services
- Service hours: 9.00AM to 3.00PM on weekdays, 9.00AM to 5.00PM on Saturday, Sunday - Holiday



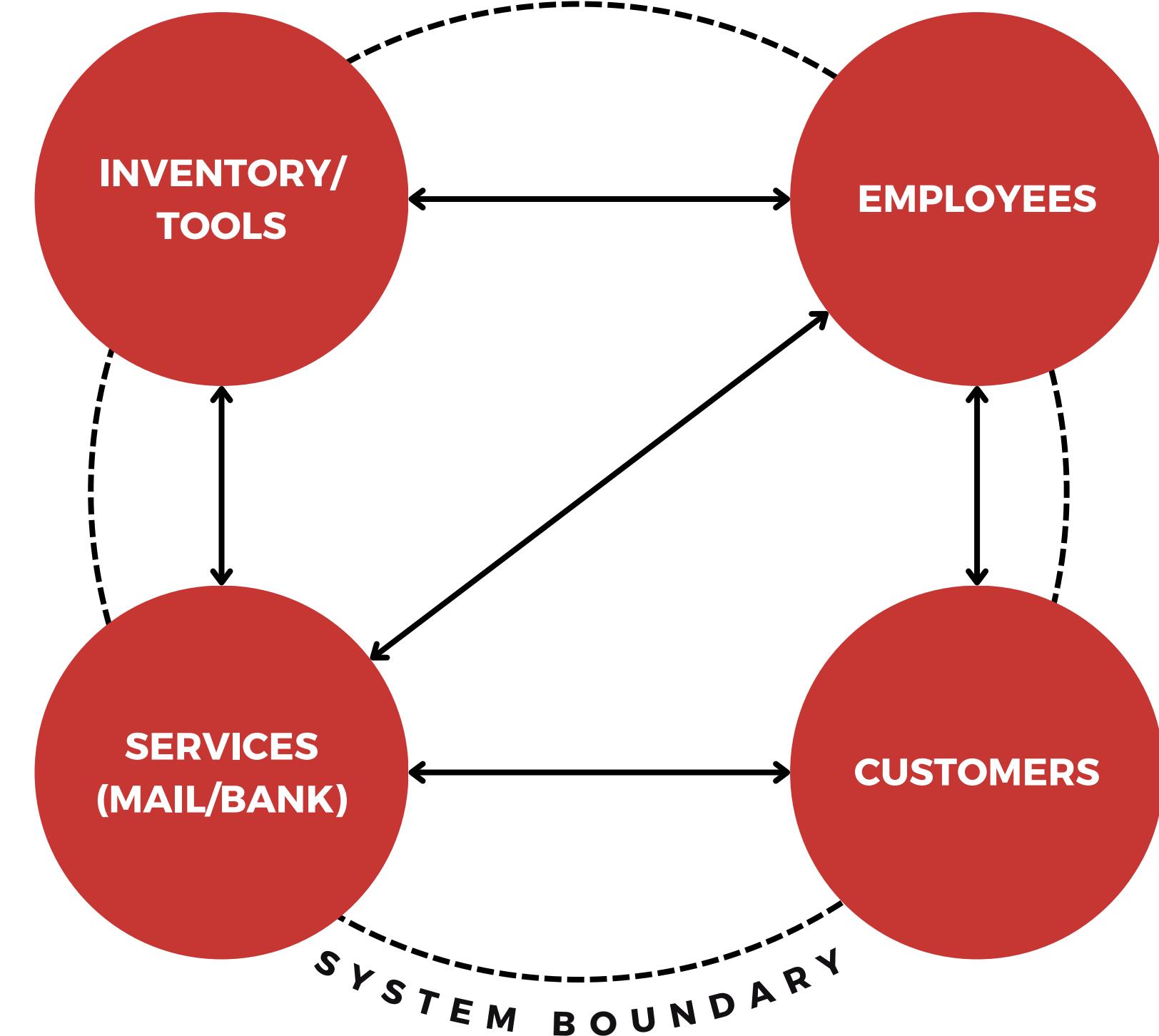
SYSTEM

C O M P O N E N T S

Delivery Vehicles
Computerized Mail
Tracking Tools

O B J E C T S S E R V I C E S

Postal Services
Banking Services



Clerical Employees
Delivery Employees

S T A K E H O L D E R S

Users of Postal Services
Users of Banking Services

SYSTEM

WORKING

Traditionally the primary function of Science Institute post office was collection and delivery of mails but as of today, a Post Office offers many other vital services in addition to its traditional services. The additional services provided by a post office include – Mail Services, Financial Services, Package Delivery Services.

Mail Processing and Delivery:

1. Mail Handling:

- Incoming mail sorted by Sorting Assistants.
- Postmen sort for delivery using GPS/apps.



2. Counter Services:

- Managed by Postal Assistants via POS System.
- Financial transactions supported by Core Banking Solution (CBS).



3. Savings & Insurance:

- Offers PPF, NSC, and Postal Life Insurance.
- Customer data managed with dedicated software.

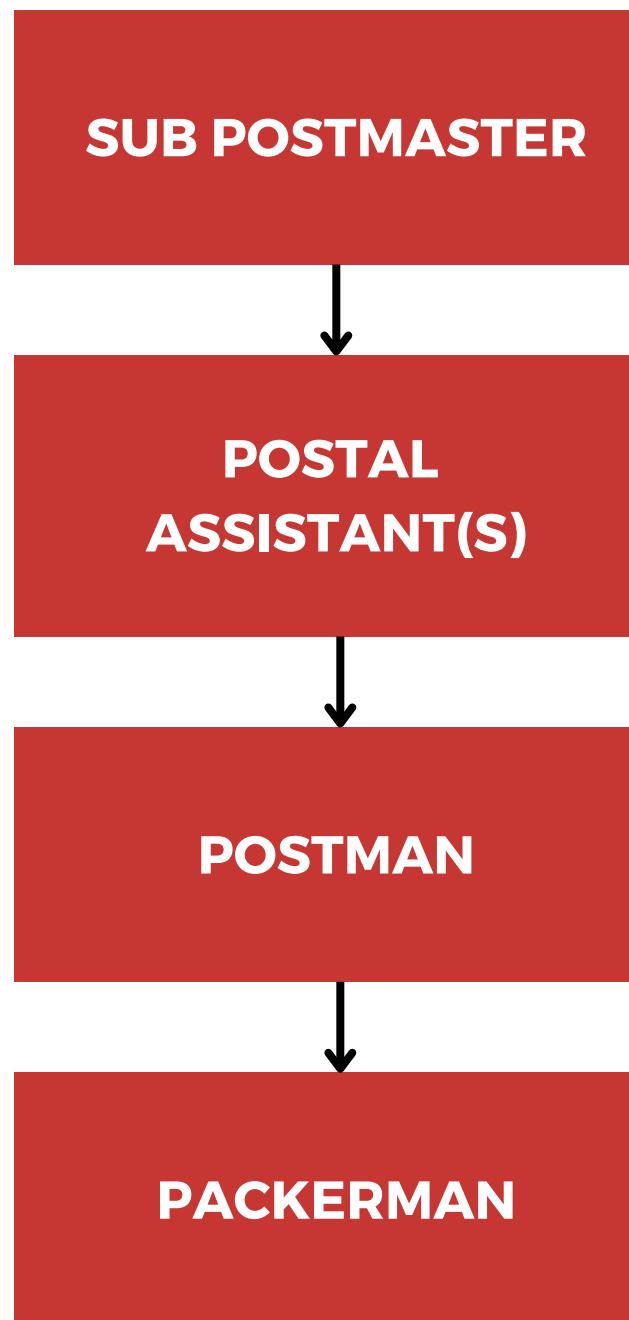


4. Customer Interaction:

- Inquiries handled at counters/helpdesks.
- Digital tracking via India Post Website and Post Info App.

SYSTEM

STAKEHOLDERS : SUB - POST OFFICE



Head of the sub post office.

Handling public grievances and overseeing customer services.



Supporting staff for mail management and customer service.

Sorting and processing incoming and outgoing mail.

Maintenance of records and assisting in managing parcels and logistics.



Primary personnel for delivering mail to residences and offices.

Collecting post from households (for registered and Speed Post services).



Assisting in handling mails, maintaining office cleanliness, and attending to customer inquiries.



OBSERVATIONS

- A lot of instruments used are either **archaic or ad-hoc solutions**
- The dusting of the windows seems to be a minor concern
- The advertisements were an information overload.
- The important papers and files were **stored in open**, where humidity and dust could harm them in some way
- The **packaging sizes** for parcels were usually not followed by the customers.
- The desk officer does keep a measuring tape on his desk to measure the proportions of the parcel, and also a weighing machine.
- The board showing current deposit rates **did not include any regional language** to aid the people not fluent in english.
- Regarding the interviews, the primary cause of frustration was the delay in work and not bombardment of questions.



ROLEPLAY

EMPLOYEES

Roleplay for Postal Assistant Clerk:

I'm Chandrappa, a Postal Assistant Clerk with 21 years of experience, 2 years at this post office. Every morning at 10 AM, I get straight to sorting mail—around **700** parcels and letters a day. Some are tracked, others not, but all need to reach the right destination. It's a routine job, though I do enjoy the order of it. Sometimes there are hiccups, like missing pin codes or unclear addresses, but nothing that can't be fixed. I also help with post office savings accounts when needed. By the afternoon, things settle down. The work may be steady, but it's the transfers that keep me wondering where I'll end up next.



QUESTIONNAIRE

C U S T O M E R S

Saving Account Customers

- How satisfied are you with the banking services provided by the post office (e.g., ease of deposit, withdrawal)?
- Are the savings account details and interest rates clear and easy to understand?
- How would you rate the convenience of using the post office for financial services compared to a bank?
- Have you encountered any issues with the availability of the UPI or digital payment options at the post office?
- Do you feel that the post office staff are knowledgeable about the savings schemes?

Parcel Sending Customers

- How easy was it to find packaging materials or labels for sending your parcel?
- How would you rate the clarity of information displayed about parcel services (e.g., fees, process)?
- Were you informed about the expected delivery time for your parcel?
- How satisfied are you with the tracking options available for your parcel?
- Was the signage and layout of the post office helpful for locating the services you needed?

QUESTIONNAIRE

EMPLOYEES

Employees Inside the Office

- How satisfied are you with the mail sorting and management process at the post office?
- Is the Point of Sale (POS) system efficient and user-friendly for customer transactions?
- What challenges do you face when assisting with savings schemes?
- How often do you experience delays due to manual mail sorting?
- Are the resources (e.g., technology, machines) adequate for your daily work?
- How would you rate the cleanliness and organization of the work environment?
- Are there clear parcel and mail management standards, and do they help reduce errors?

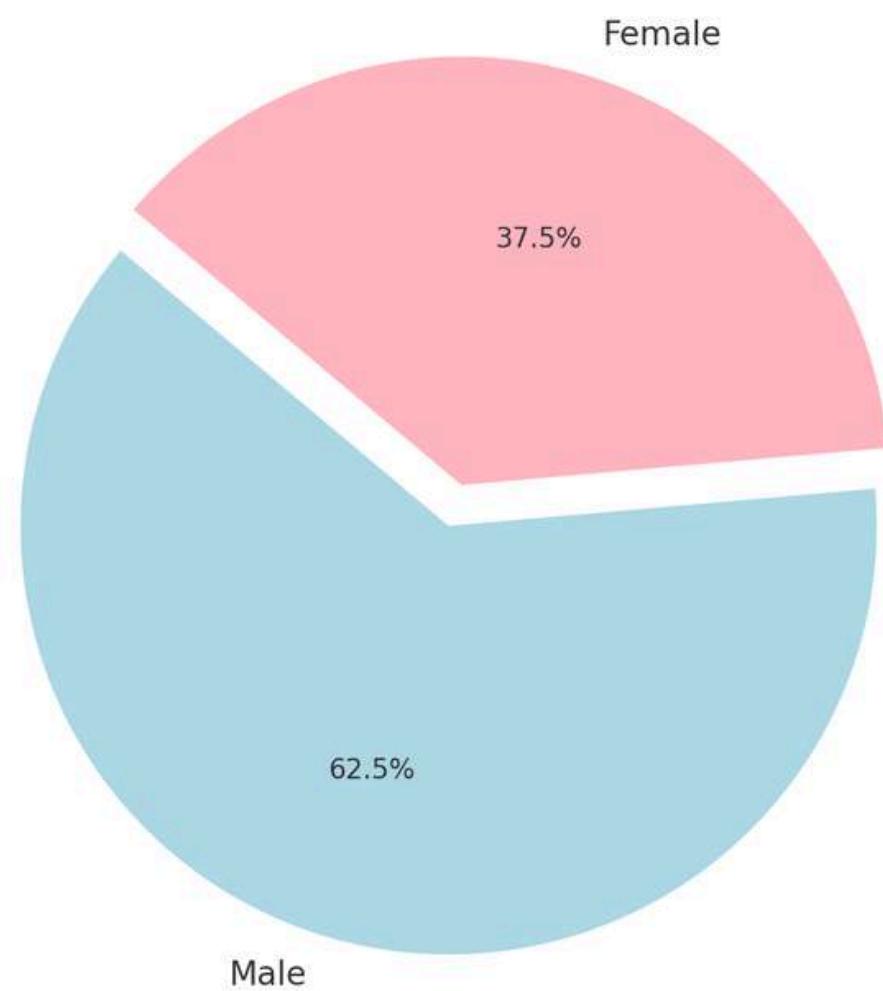
Employees Outside the Office

- How easy was it to find packaging materials or labels for sending your parcel?
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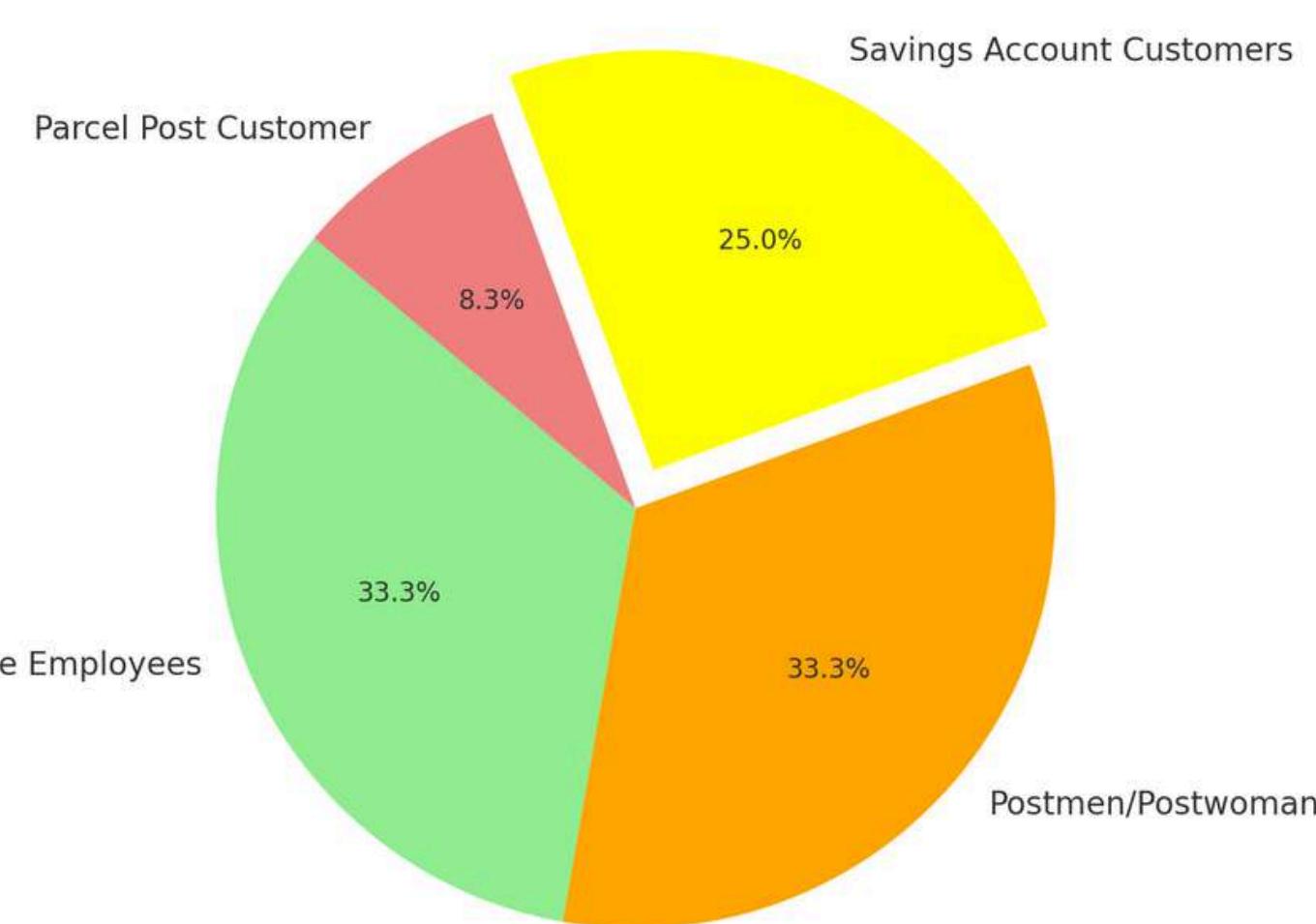
STAKEHOLDER ANALYSIS

DEMOGRAPHICS

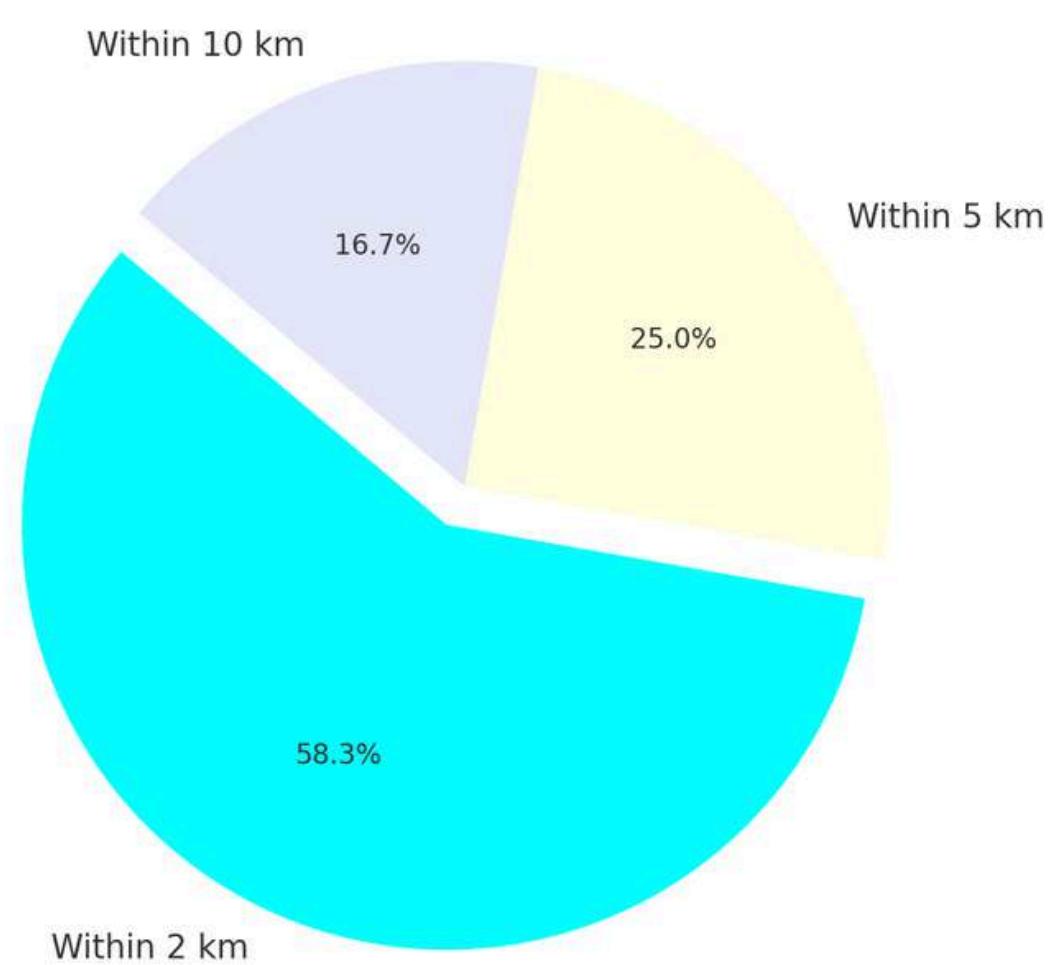
Male-Female Work Ratio



Task Categories (Employees and Customers)



Distance from Office



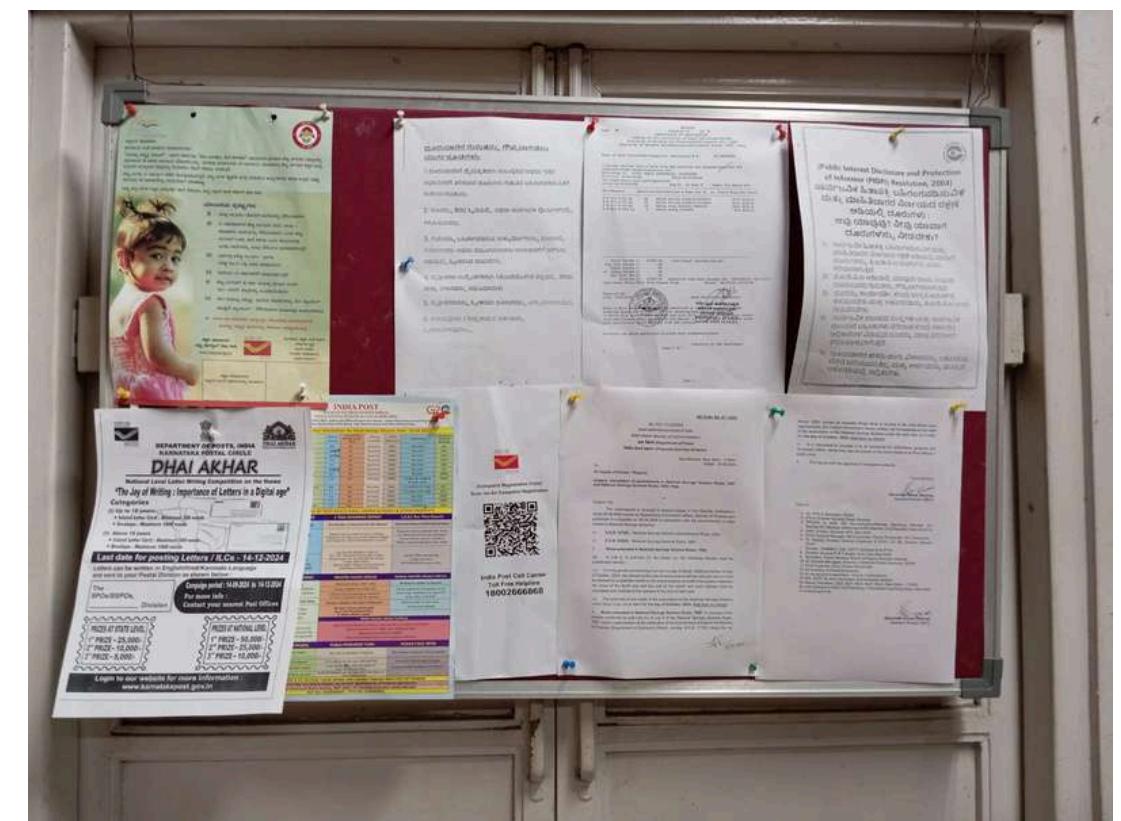
PROBLEMS IDENTIFIED

- Lack of appropriate, readable signages
- Accessibility restricted to ramp outside.
- Glue station - Messy and Inefficient
- Unavailability of pens
- Standards not followed for packaging
- No standards for labeling address
- Delay in mails, packages
- Displayed information is very unorganized
- UPI payment unavailable
- Mail receiving cannot be scheduled
- No reception available for customers



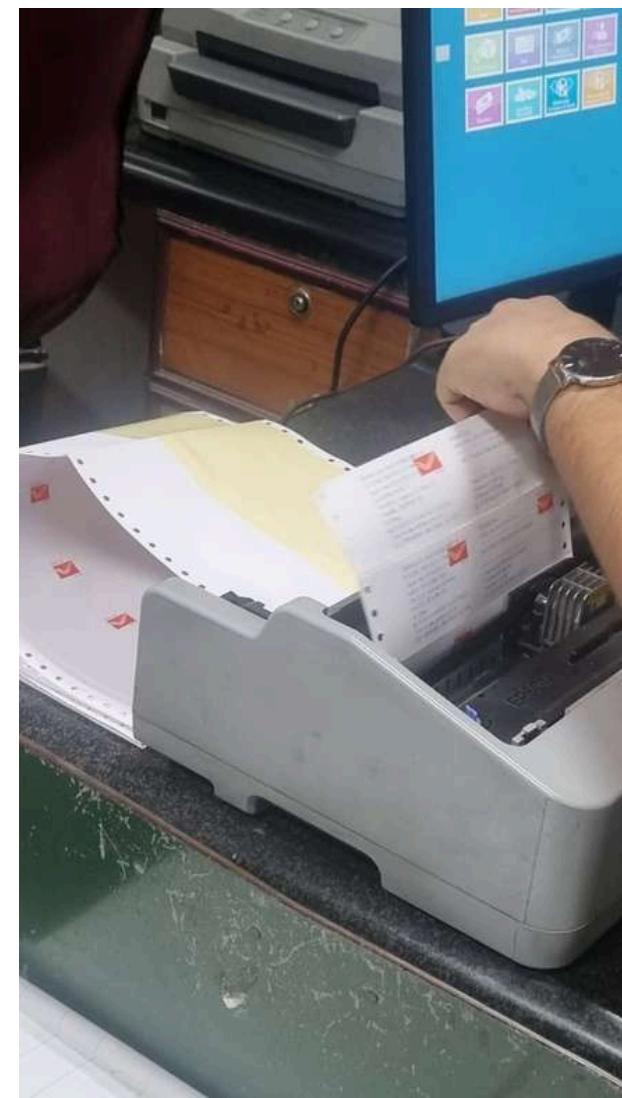
PROBLEMS IDENTIFIED

- Manual sorting of mail is exhausting.
- No cash counting machine at the cash counter.
- Poorly planned parking space.
- No drive through route for vehicles, including delivery vehicles.
- Limited accessibility to the disabled population.
- Location is difficult to access due to busy roads.
- Mails sent through postbox cannot be tracked.
- Absence of even 1 employee leads to a hectic environment - Staff shortage
- All-weather postbox- kept inside the P.O.
- Locating postboxes is a difficult task.
- Postboxes don't display a clearance date.



PROBLEMS IDENTIFIED

- More awareness about the mailing process is required
- Translation of address from regional language
- Legibility and readability of mail address
- Safety of mail from external factors
- Banking services - Security of deposited cash
- Poor lighting in the outer seating area
- Postal services - Prone to human errors
- Very poor cable management around the post office
- Naked wires observable in open.
- for the long times of waiting, the post office didn't have a washroom, or one that was directly in sight.



EXISTING SYSTEM

STUDY

Q. Name of the system?

A. Mail Dispatch Management System

Q. Primary function?

A. To scan, sort and seal mails, to identify and authenticate its delivery location



EXISTING SYSTEM & ENVIRONMENT

STUDY

Q. Behaviour?

A. Mental sorting and manual sealing using physical tools, relying on human effort and decision-making

Q. Structure?

A. Bottom heavy cylindrical instrument for stamp, scanning device, ink well

RESOURCES AVAILABLE TO USE

STUDY

What are the Materials available

- Paper
- Ink
- Inkwell
- Stamp
- Human resource
- Slate
- Stone
- Information scanner
- Table
- Collection bag
- Computer system

What are the actions available

- Chemical Energy between Ink and Paper
- Energy use by man to work
- Mechanical displacement
- Electric energy used by the scanners
- Electromagnetic radiations
- Impact force
 - Important consideration for successful imprint
- Friction

What functions does the workplace allow naturally

- The Ink has a tendency to dry on its own
 - The property can be leveraged to assess when it is okay to stack papers over one another
- The parcels/letters are already labelled.
- Time in hand to complete the tasks: 10PM-3PM
- A space of two work tables
 - Usually the reason of mixup or letter losses

UNDERSTANDING THE DRAWBACKS

STUDY

Instantly recognizable drawbacks in current situation

- The scanning equipment, when held for long time causes strain in the wrist.
 - De Quervain's Tenosynovitis and Carpal Tunnel Syndrome are two of the most common effects.
- An instrument to automate the process would decrease the manual effort and increase the efficiency of the post office.
- The bottom heavy stamp requires manual work against gravity, causing strain over the arm
 - Was one thing pointed out directly by the workers

Reasons for the drawbacks

- The barcode scanners have non-ergonomic handles
- The stamp requires strong impact of the heavy stamp to leave proper indentations to be read by devices.

INFORMATION ABOUT THE PROBLEM SITUATION

H I S T O R Y

Q. History of the development of the problem?

A.

- The metal stamp has been in use since the colonial period.
- It symbolises the prompt delivery routine (same day received and delivered)
- **However, the stamp itself is archaic and requires continuous manual assistance and effort.**
- The sorting of letters has always been seen as a manual job.
- Job positions of sorting assistants and trading is common.
- **However, increased manual activity requiring precise detection leads to chances of human error and discrepancies.**

INFORMATION ABOUT THE PROBLEM SITUATION

OTHER PROBLEMS

Q. Modified direction of development?

A.

- The metal stamp is too heavy and requires a lot of force to leave indentation on paper.
- It also requires manual changing of the dates (everyday activity)
- The activity of stamping could lead to RSI (repetitive stress injury)
- The ink pad required can dry out and get messy.
- The closely knit space makes it difficult for demand of personal space while sorting the letters.
- The scanning device itself is slow and a hand held device requiring extra effort and maneuvering.

CHANGING THE SYSTEM

STUDY

Q. Allowable changes?

A.

- Ink not necessary for authentication.
- Behaviour of the authentication tool can be changed
- Processes can be quicker and automated
- Can occupy a fixed/moving location.

CHANGING THE SYSTEM

STUDY

Q. Limitations, what can't be changed?

A.

- Mail has to be sorted by destination.
- Mail must be authenticated for delivery to take place.
- Mail has to be delivered on the date of authentication at the last node (Sub-Post Office)
- Date and location must be authenticated.
- Solution cannot occupy too much space.

CRITERIA FOR SOLUTION SELECTION

STUDY

Q. Desired technological characteristics?

A.

- **Reduce/Eliminate** operational fatigue of user.
- Increase operational efficiency of process.

Q. Expected degree of novelty?

A. Solution does not have to be novel, and should be familiar enough to be learned and operated with ease.

CRITERIA FOR SOLUTION SELECTION

STUDY

Q. Desired economic characteristics?

A.

- Leverage due to the sheer number of packages, leads to many operational hours saved, hence money saved.
- Material usage can be economical (ink)
- Cost-benefit should make sense for post offices with volume.

COMPETITOR ANALYSIS FOR STAMPING

H A N D S T A M P I N G

Functionality:

- The manual process involves using stamps and ink pads.
- It is labor-intensive and requires significant effort.
- Precision is required to ensure accurate stamping.

Challenges:

- Operational fatigue affects worker efficiency.
- Inconsistency in stamping can lead to errors.
- The process is time-consuming and slows down operations.
- There is a high risk of human error in manual stamping.

Key Competitor:

- Manual systems are commonly used in many offices.
- They face high-volume limitations in processing mail.
- There is a need for modern solutions to improve efficiency.



COMPETITOR ANALYSIS FOR STAMPING

FRANKING MACHINE

Functionality:

- Automated postage application speeds up mail processing.
- It is ideal for high-volume mail handling.
- Integrated postage calculation determines the correct postage automatically.
- The process is efficient and saves time.

Challenges:

- High maintenance costs are a burden for post offices.
- Complexity can lead to downtime and delays.
- Consumable costs can impact the budget.
- Smaller post offices find these systems inaccessible due to high costs.

Key Competitor:

- Key competitors dominate the franking machine market.
- They offer advanced technology in their systems.
- Cost is a major consideration for businesses choosing franking machines.



Franking a Letter 'Pass Through' Mode

OPPORTUNITIES FOR IMPROVEMENT

- **Hybrid Solutions:** A semi-automated system could reduce manual labor while keeping costs lower than fully automated systems.
- **Ergonomic Design:** Redesigning manual stamps to reduce wrist strain and improve the efficiency of hand stamping.
- **Cost-Effective Automation:** Developing lower-cost franking machines with simpler maintenance needs could provide an affordable solution for smaller post offices.

COMPETITOR ANALYSIS FOR SORTING MACHINE

Siemens Automated Mail Processing System

- Siemens offers cutting-edge sorting machines that use **OCR** (Optical Character Recognition) and **barcode reading** for high-speed automation of letters and parcels.
- machines are capable of **processing large volumes of mail** and parcels (up to **40,000 items per hour**), making them suitable for large postal hubs like those in metro cities.
- Siemens has a **strong global reputation** in postal automation, with **reliable, field-tested solutions** used by national postal systems, including India Post



Patents:

- Siemens holds **numerous patents** related to automated mail sorting.

Key patents include:

- **Mail Sorting System with OCR Integration** (Patent No. US6311912B1): Describes the use of OCR and video coding in letter sorting machines.
- **High-Speed Parcel Sorting Conveyor** (Patent No. EP2047822A2): Details a modular parcel sorting system designed for high-speed and high-efficiency sorting.

WEAKNESSES/SHORTCOMINGS OF COMPETITOR:

- Siemens' machines are technologically advanced but come with a high price tag, making them less accessible to smaller or regional postal hubs in India.
- Advanced systems like these provided by Siemens require specialized technicians and significant maintenance, which can be challenging for postal systems with limited technical support.
- Siemens typically designs its systems for large-scale sorting centers, which may not cater effectively to the needs of small or mid-sized post offices with lower traffic.

Opportunities for Designing a Novel Product

- Develop a system that requires minimal setup and is easy to maintain.
- Ensure the design is modular and scalable to cater to different postal needs.
- Developing machines that do not require highly specialized skills and can be used with limited technical expertise.



MARKET ANALYSIS

POSTAL FRANKING MACHINE

As per the report :  DATAINTEL

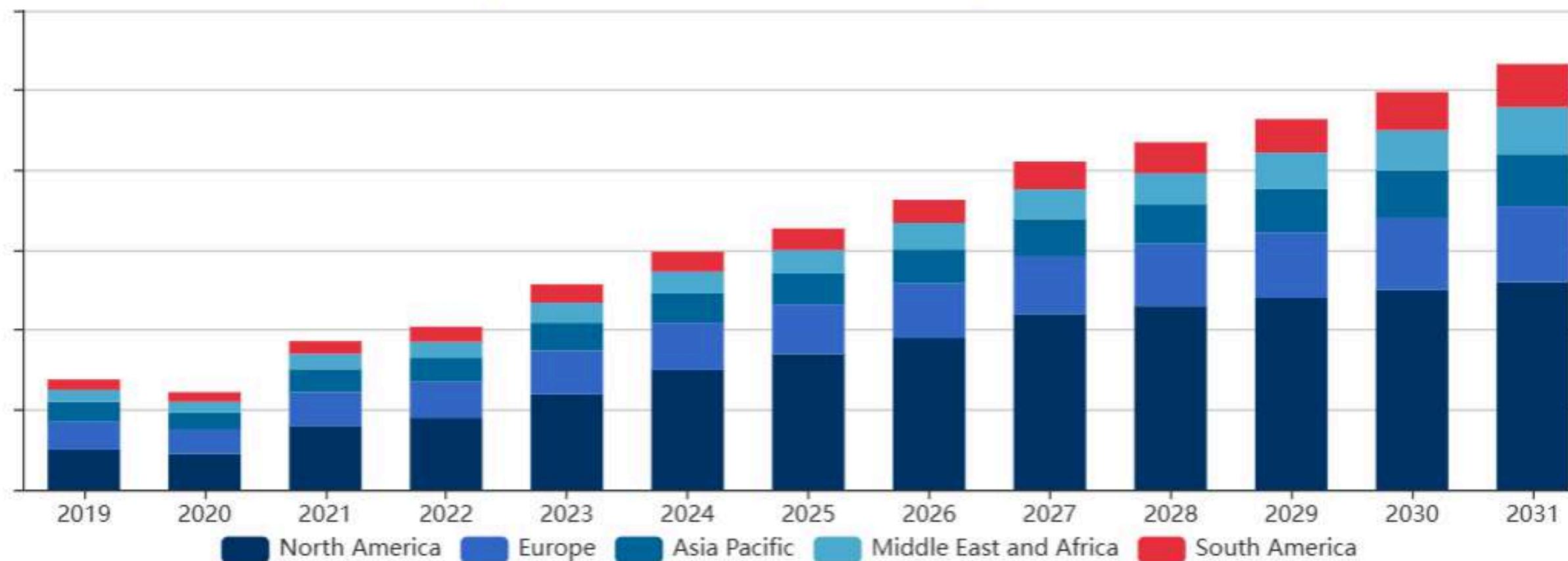
- The global franking machines sales **market size** was valued at USD 1.2 billion in 2023 and is projected to reach USD 2.0 billion by 2032, **growing at a CAGR** of 5.2% from 2024 to 2032.

- Key Players**

- Pitney Bowes Inc.(market leader)
- Neopost S.A.
- Frama AG

- Market share by region**

Franking Machines Market Share (%) by Region (2019-2031)



- Market segmented on the basis of**

- Product Type**
- Automatic
- Semi-Automatic
- Manual Franking Machines
- Application**
- Corporate Offices
- Government Offices
- Educational Institutions
- Others
- Distribution Channel**
- Online Stores
- Offline Stores

MARKET ANALYSIS

POSTAL FRANKING MACHINE

- Some popular machines for each category:

for Small Business



Pitney Bowes DM60

Price

- Approximate Price: ₹70,000

Features:

- Processes up to **18 letters per min**
- Manual feeding for precise and accurate impressions.
- Supports up to **2.5 kg** weight.
- Connectivity:** LAN, WiFi, or PC Meter Connect.

for Medium Business



Pitney Bowes DM130i

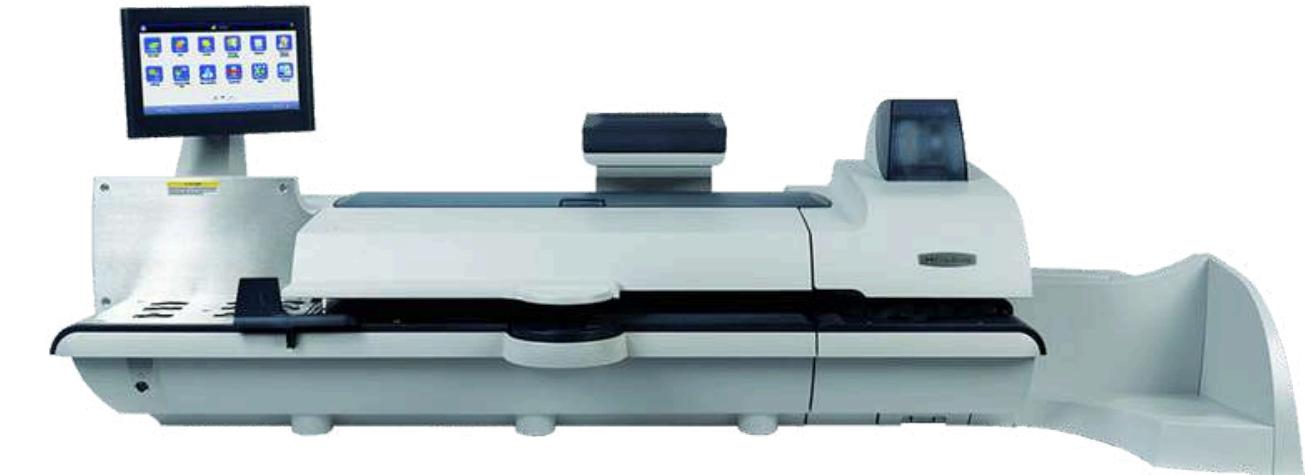
Price

- Approximate Price: ₹1,20,000

Features:

- Processes **45 letters per minute.**
- capacity of up to **2.5 kg.**
- Connectivity:** LAN, WiFi, or PC Meter Connect.
- PIN Security:** Yes.
- Smart Meter Technology:** Yes.
- Mailmark Technology**

for large Business



Pitney Bowes Connect+ 3000

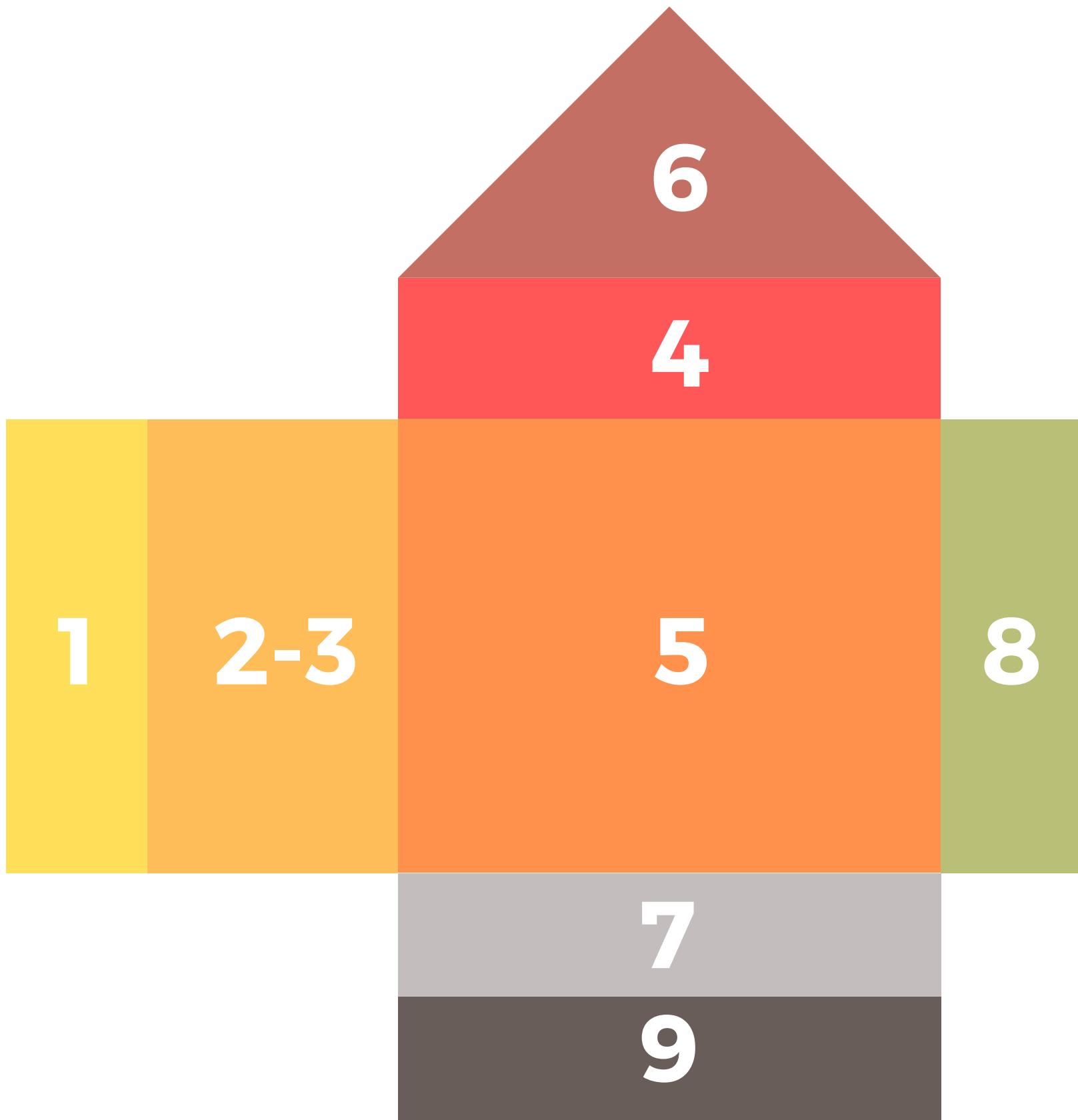
Price

- Approximate Price: ₹3,50,000

Features:

- Processes up to **310 letters per minute.**
- Weighs variable-sized mail automatically upto **67.59 kg.**
- Printing: 1,200 dpi HP powered ink-jet printing color
- Better Display:** 10.2" color touch-screen display
- High-speed LAN connectivity
- Programmable job**,Includes options for **barcode** scanner, laser printer, wireless keyboard etc.
- Package Tracking**, Address Correction, and electronic Return Receipt

QUALITY FUNCTION DEPLOYMENT





1

**Make an overview of product
attributes reflecting wishes of the
customer**

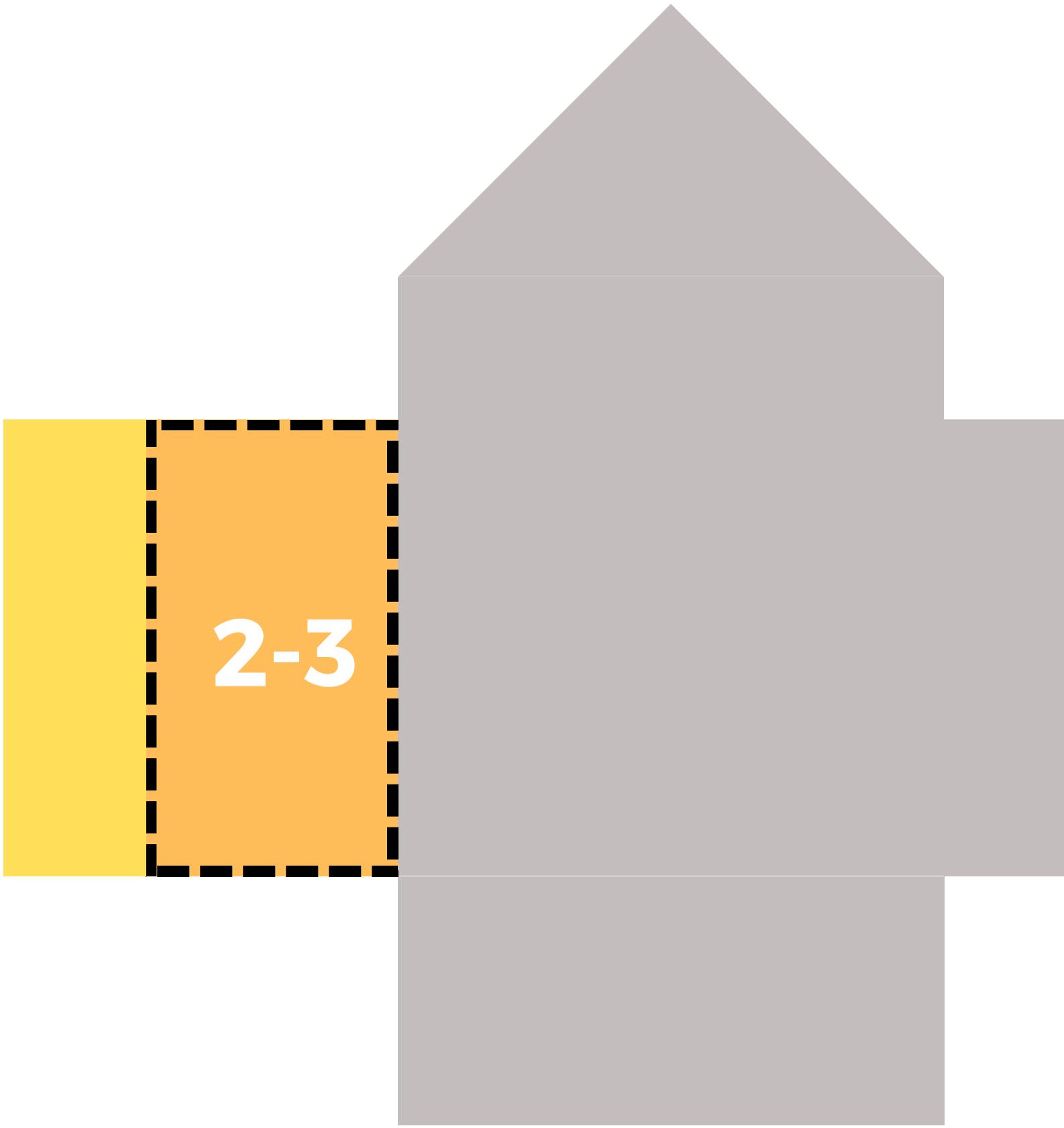
STEP 1

MAKE AN OVERVIEW OF PRODUCT ATTRIBUTES REFLECTING WISHES OF THE CUSTOMER

Parameter	Weight
Economical	3
Compact	1
Reliable	5
Easy to use	4
Efficiency	4
Automatic	3
Speed	3
Connectivity	2
Accuracy	5

MATRIX METHOD FOR DETERMINING CUSTOMER REQUIREMENT PRIORITY

Sr. No.		K1	K2	K3	K4	K5	K6	K8	K7	K9	SUM	100 Points distribution	10 Points scaling	Rank
1	Economic		0.5	0.5	0	0.5	1	0	0	0	2.5	7.35	4.16	6
2	Compact	0.5		0	1	0	1	0	0.5	0	2	5.88	3.33	7
3	Easy to use	0.5	1		0.5	0	1	0.5	0	0	3.5	10.29	5.83	4
4	Automatic	1	0	0.5		0.5	0.5	0.5	0.5	0	3.5	10.29	5.83	4
5	Reliable	0.5	0.5	1	0.5		1	0.5	1	0.5	5.5	16.18	9.27	2
6	Speed	1	1	0.5	0.5	0		0	0	0	3	8.83	5.00	5
7	Efficiency	0.5	1	1	0.5	0	1		1	0.5	4.5	13.24	7.50	3
8	Connectivity	1	0	0.5	0.5	0.5	1	0		0	3.5	10.29	5.83	4
9	Accuracy	0.5	1	0.5	1	0.5	1	1	0.5		6	17.65	10	1



2-3

**Benchmark current product with
competitive products**

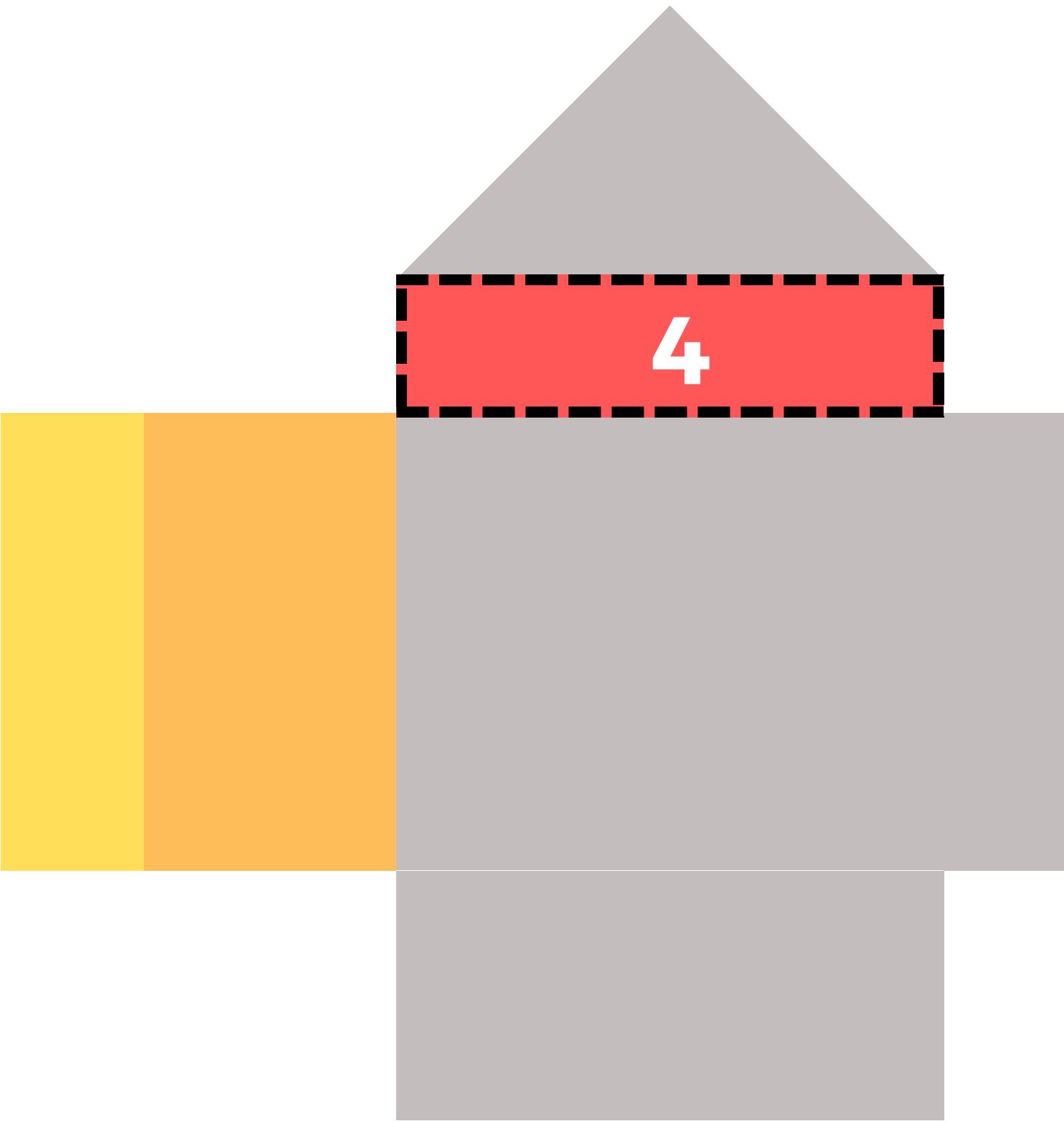
STEP 2-3

BENCHMARK CURRENT PRODUCT WITH COMPETITIVE PRODUCTS

Parameter	Ranking	1	2	3	4	5	Target Value	Improve Rate	Weight	Weight%
Economical	3		●		○		4	1	3	6
Compact	1			○	●		4	1.33	1.33	3
Reliable	5			○		●	5	1.7	8.5	17
Easy to use	4		○	●			4	2	8	16
Efficiency	4			○	●		5	1.7	6.8	13
Automatic	3	○			●		3	3	9	18
Speed	3			○	●		4	1.33	3.99	8
Connectivity	2		○			●	4	2	4	8
Accuracy	5				○	●	5	1.25	6.25	13

○ Our product

● Competitor's product: Pitney Bowes DM60



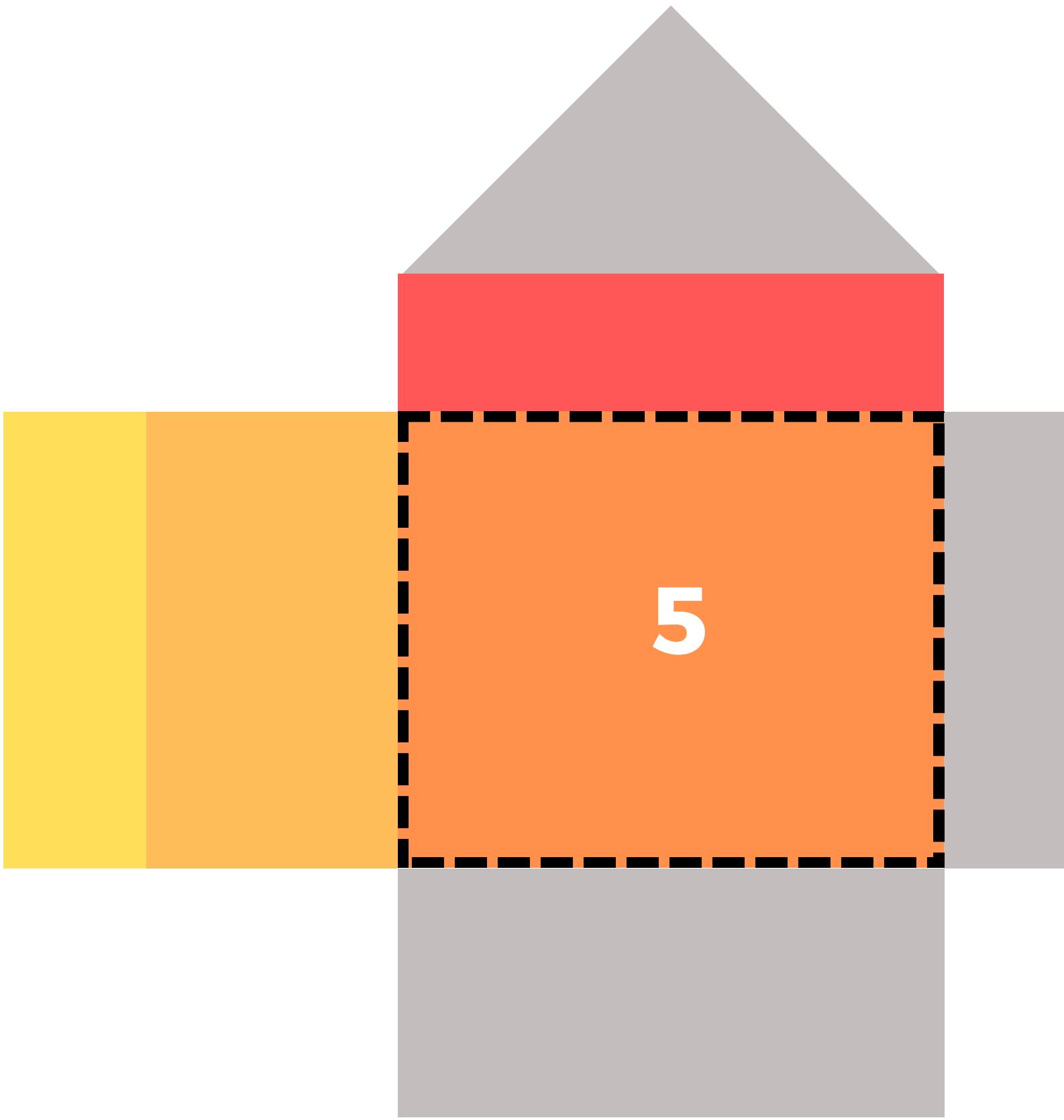
4

**Describe new product in terms of
technical Parameters**

STEP 4

DESCRIBE NEW PRODUCT IN TERMS OF TECHNICAL PARAMETERS

Parameter	Weight
Mail Size Capacity (cm ³)	4
Ink Efficiency (imprints/ml)	3
Throughput Efficiency (letters/min)	5
Print Speed (pages/min)	4
Weighing Accuracy (gram)	4
Print Resolution (dots per inch)	3
Silent Operation (dB)	4



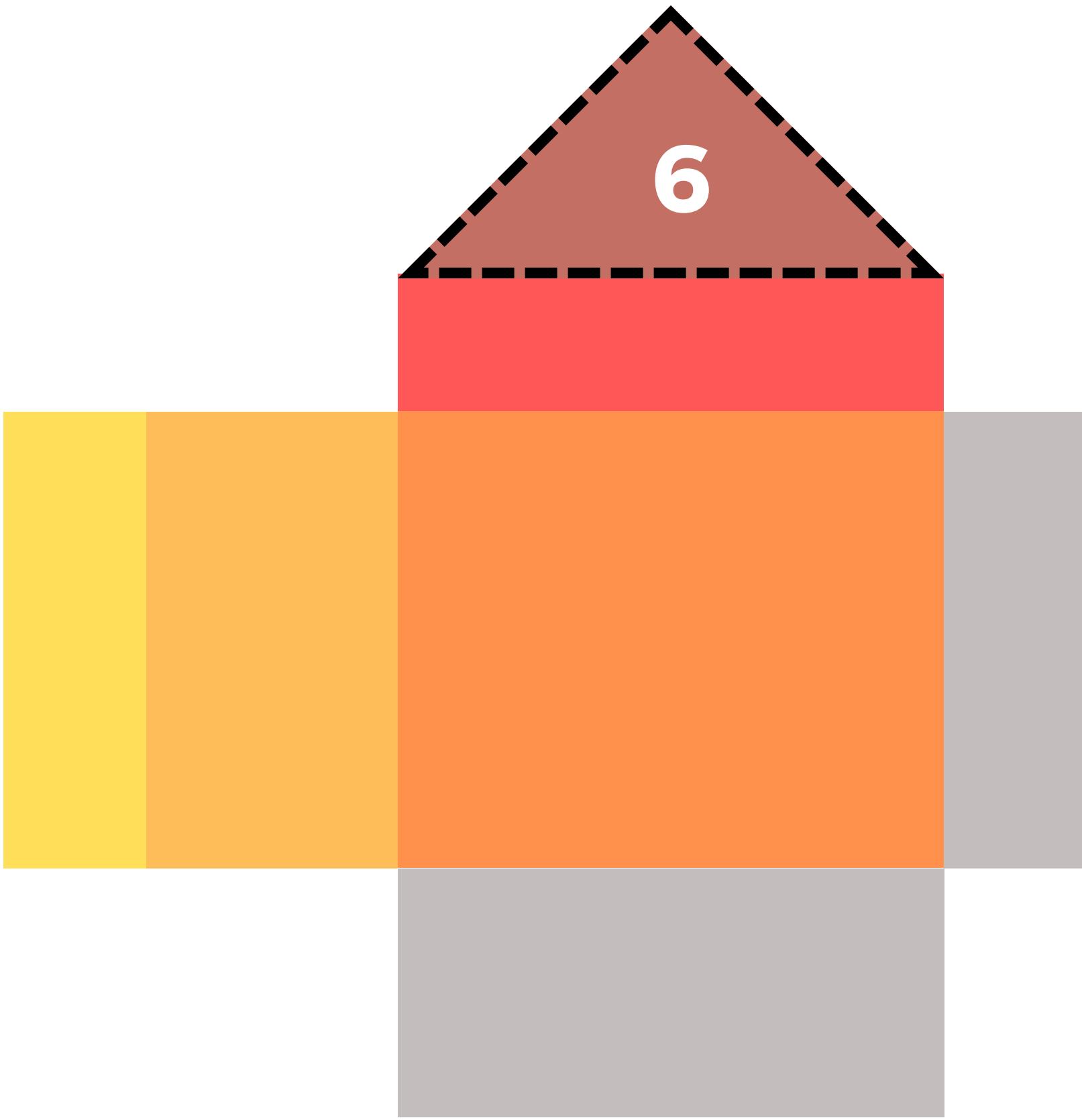
5

**Translate project objectives into
priorities for technical parameters**

STEP 5

TRANSLATE PROJECT OBJECTIVES INTO PRIORITIES FOR TECHNICAL PARAMETERS

	10 pt scale	Mail Size Capacity	Usage of Ink	Throughput (Efficiency)	Print speed	Weighing Accuracy	Print Resolution	Noise Level
Economic	4.16	9	9	3	3	3	3	9
Compact	3.33	9	1	1	1	1	1	9
Easy to use	5.83	1	1	9	1	1	1	9
Automatic	5.83	9	1	9	9	1	1	3
Reliable	9.27	3	1	9	1	9	3	1
Speed	5.00	9	3	9	9	3	9	9
Efficiency	7.50	9	9	9	9	1	3	3
Connectivity	5.83	1	1	9	3	1	1	1
Accuracy	10	1	1	1	9	9	9	1
Total		281.85	160	379.15	303.37	229.23	218.61	229.97

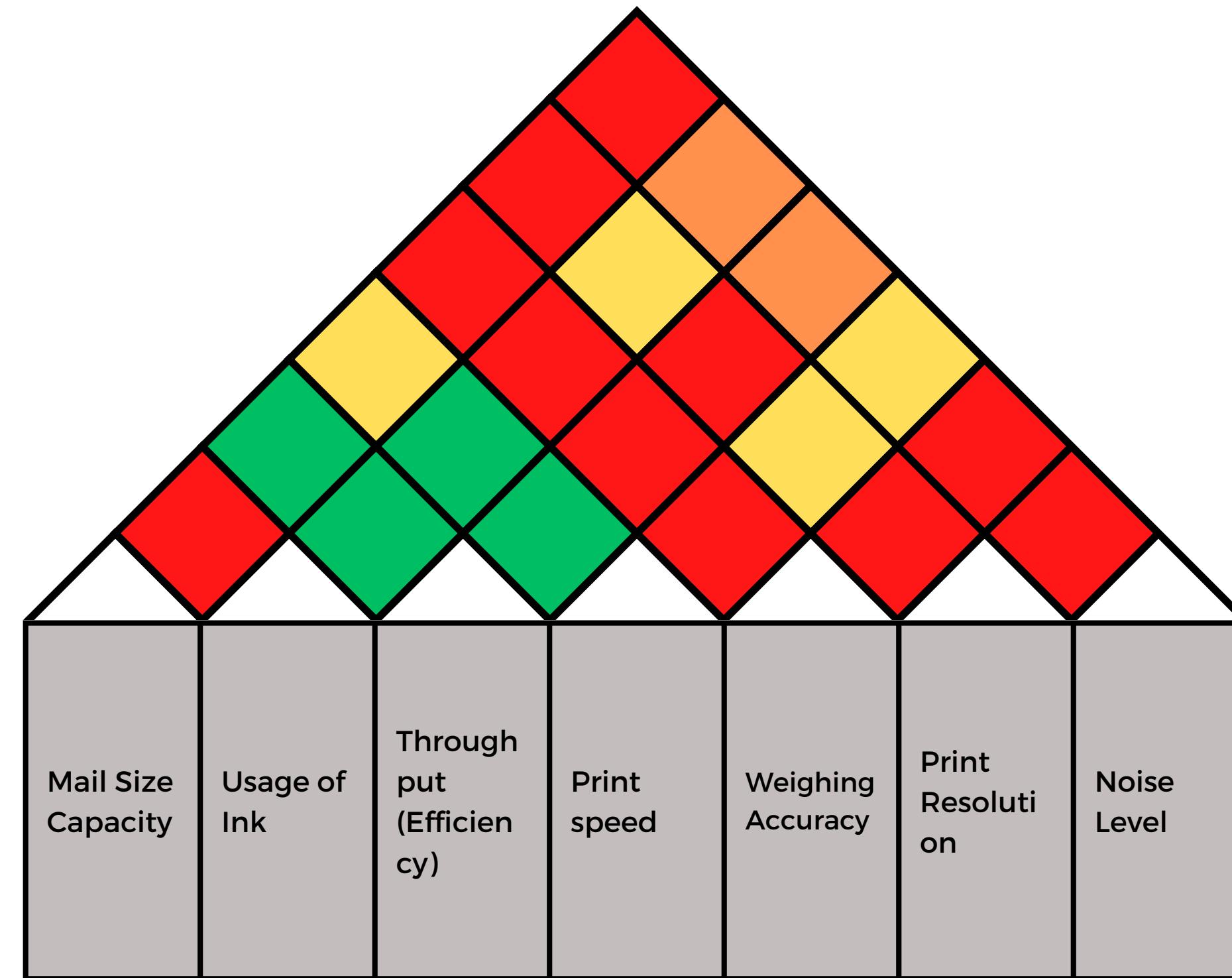


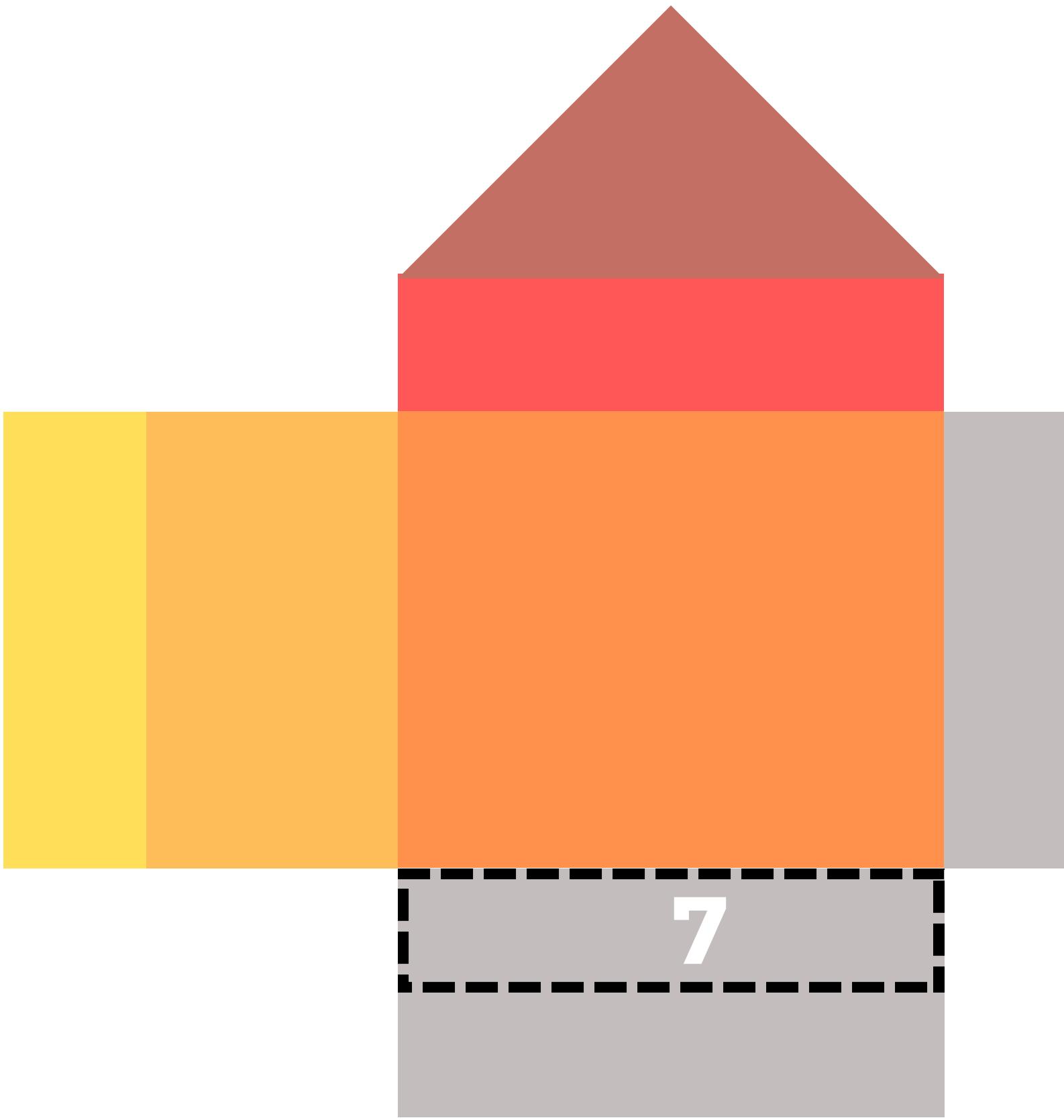
6

**Make nature and strength of
interactions between parameters
explicit**

STEP 6

MAKE NATURE AND STRENGTH OF INTERACTIONS BETWEEN PARAMETERS EXPLICIT





7

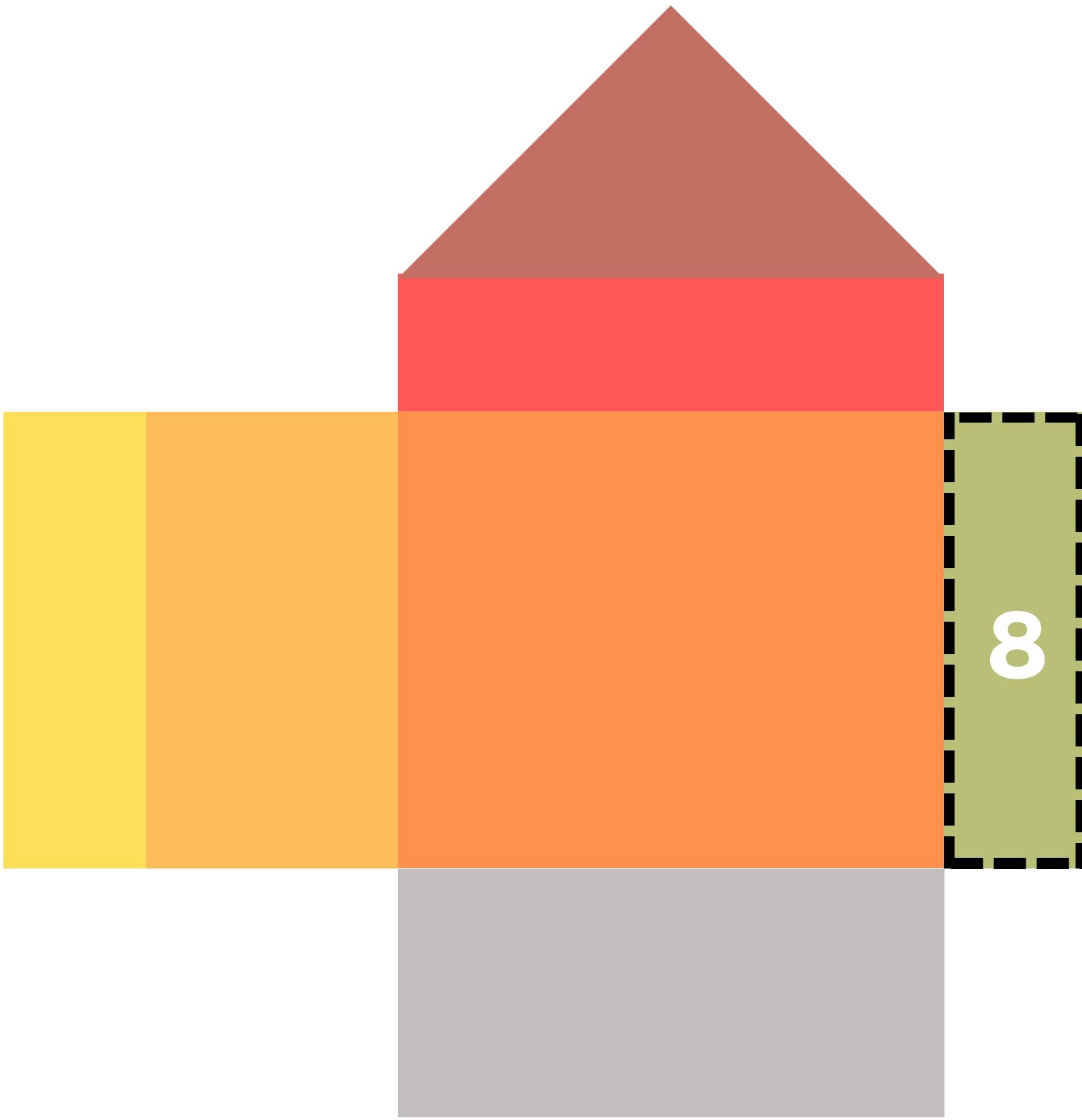
Analyse current/competitive
products to establish target values

STEP 7

ANALYSE CURRENT/COMPETITIVE PRODUCTS TO ESTABLISH TARGET VALUES

Parameter	Weight	1	2	3	4	5	Target Value	Improve Rate	Weight	Weight%
Mail Size Capacity	4						4	1	4	10
Ink Efficiency	3						4	2	6	14
Throughput (Efficiency)	5						5	1.7	8.5	20
Print speed	4						4	2	8	19
Weighing Accuracy	4						4	1	4	10
Print Resolution	3						4	2	6	14
Silent Operation	4						4	1.33	5.32	13

*<https://issuu.com/fpusa/docs/postbase-mini-2-brochure?fr=sMDE1NDQwODcy>



8

**Seek feasibility of intended
improvements (benefit vs cost)**

STEP 8

SEEK FEASIBILITY OF INTENDED IMPROVEMENTS (BENEFIT VS COST)

Parameter	Methods probable for improvement
Mail Size Capacity (cm)	No need for improvement
Ink Efficiency (imprints/ml)	A better designed nozzle can help (if we are using a conventional printer, according to HP) More ink capacity ensures less frequent changes (added imprints)
Throughput Efficiency (letters/min)	Throughput is dependant on print speed, as well as print drying. Automation of the other associated processes, such as weighing and sorting by destination are possible avenues for improving speed of processing letters.
Print Speed (pages/min)	One should use adaptive printing modes, but may cause legibility issues. Novel methods like LIFT and high speed laser processing are much faster but very costly.
Weighing Accuracy (gram)	No need of improvement
Print Resolution (dots per inch)	Using higher quality LASERS such as The vertical-cavity surface-emitting laser (VCSEL) reduces dot overlap and help provide finer details.
Silent Operation (dB)	Sound Damping Enclosures, rubberised components,

<https://www.hp.com/us-en/shop/tech-takes/sustainable-ink-for-printing>

<https://lexingtoninstitute.org/increased-productivity-key-to-postal-services-success/>

<https://www.sciencedirect.com/topics/engineering/laser-induced-forward-transfer>



9

**Develop plan for the product involved
(targets, priorities, relationships)**

STEP 9

DEVELOP PLAN FOR THE PRODUCT INVOLVED (TARGETS, PRIORITIES, RELATIONSHIPS)

Measurement Unit	Package Capacity (cm ³)	imprints/ml	letters/day	pages/min	g	dots per inch (dpi)	dB
Our product	-----	----	200	---	----	---	70
Competitor's product	25.4 x 35.6 x 0.65	190	50	17	0.1-0.2	<600	55
Target Value	25.4 x 35.6 x 0.65	150	250	20	0.1	600	55

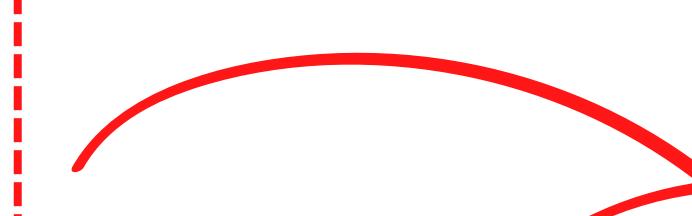
<https://postroom-online.co.uk/compatible-blue-francotyp-postalia-fp-postbase-mini-ink-cartridge/>
<https://issuu.com/fpusa/docs/postbase-mini-2-brochure?fr=sMDE1NDQwODcy>
<https://www.amazon.in/>
<https://www.mailcoms.co.uk/franking-machines/fp-mailing/postbase-mini-franking-machine/#:~:text=This%20machine%20is%20suited%20for,items%20of%20mail%20a%20minute.>

INPUT-OUTPUT STATES

INPUT/OUTPUT RELATIONSHIP

INPUT STATE:

1. Sorting from a randomised list is a hassle, whether it is sorting for destination, or sorting for beat-wise.
2. Tracking a lost package is a hassle.
3. Authentication is done with much manual effort- stamping seals on the day of delivery.
4. Dates need to be changed manually.
5. Items need to be scanned manually for validity, it is a time-consuming and tedious process.
6. Items to be processed, tend to have faulty information.
7. Postal workers required to constantly move back and forth around the post office for limited tasks.



OUTPUT STATE:

1. Package gets scanned quicker and reliably
2. Smoother operations for postal workers in one place.
3. Authentication is done with less manual effort.
4. tracking a lost package is easier.
5. Dates are corrected with ease.
6. Information on task completion for postal workers.

SNPS

SOLUTION-NEUTRAL PROBLEM STATEMENT

Expectations:

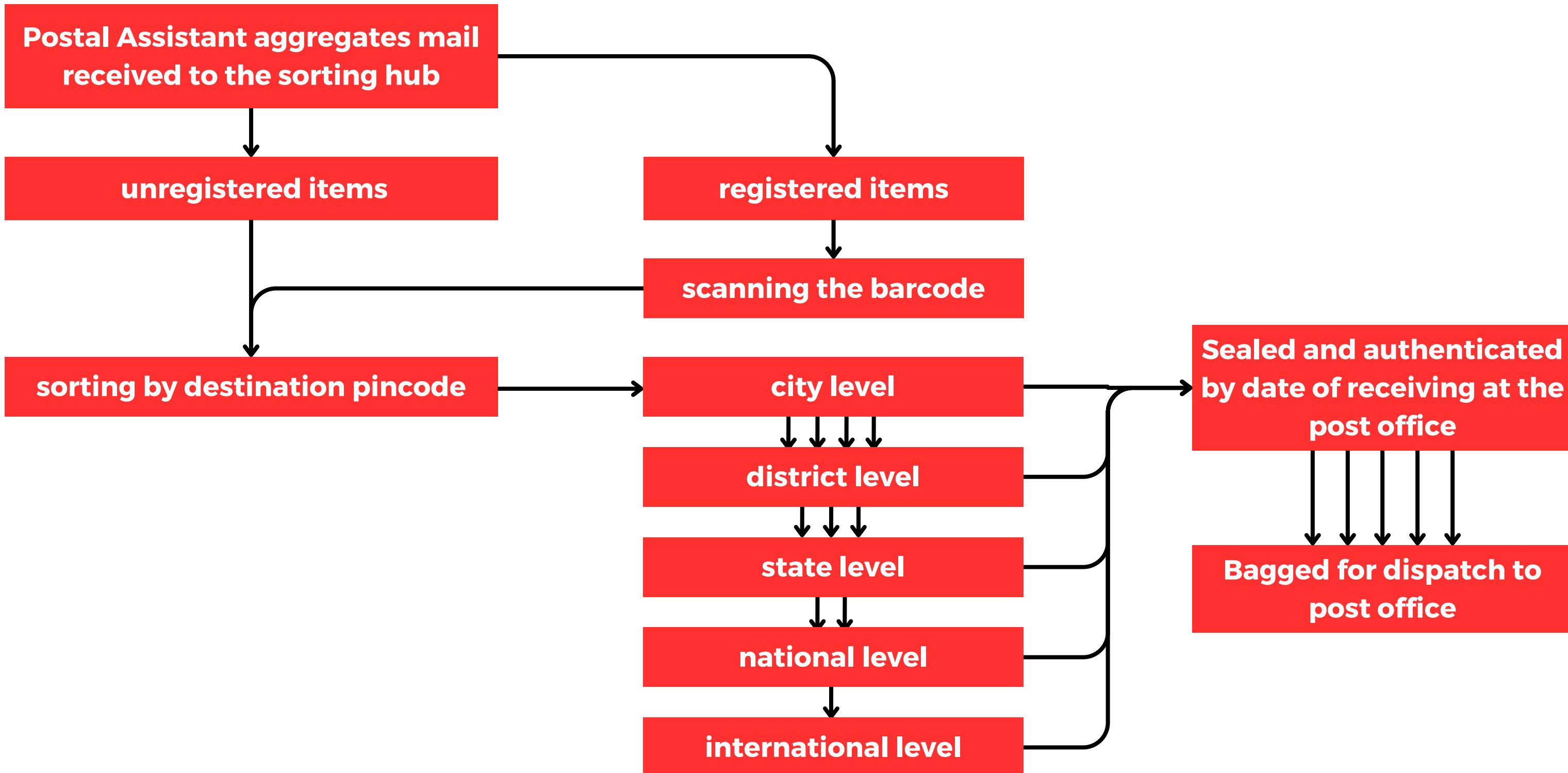
1. Helps authenticate quicker.
2. Less manual effort required
3. Consistency, reliability & accuracy of mark
4. Easy to use
5. Reduce number of tasks in task hierarchy
6. Allows for consolidated and smooth operation
7. Less wait time for customer and user
8. Able to cater to different needs, such as weight of package, size of package, postage requirement, ability to mark on varied surfaces that packages come in.

SNPS:

India Post requires a retrofit solution for postal workers in their Head Post offices, that is efficient, user-friendly, reliable and ensures accurate scanning, sorting and authentication of diverse types of mail and packages.

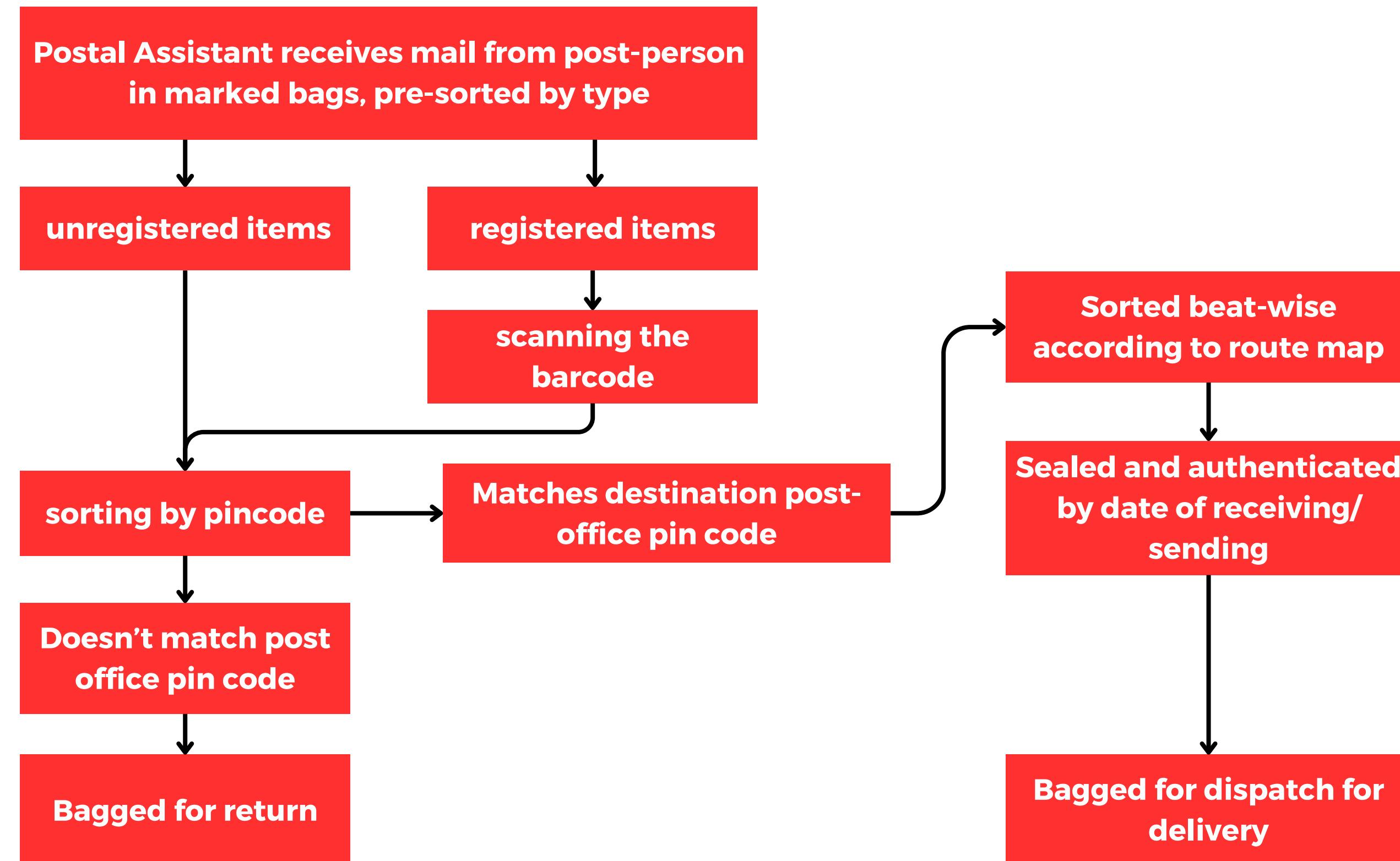
PROCESS FUNCTION STRUCTURE

INBOUND MAIL SORTING & AUTHENTICATION



PROCESS FUNCTION STRUCTURE

OUTBOUND MAIL SORTING & AUTHENTICATION



DESIRED FUNCTION STRUCTURE

Scan the item for address and/or barcode

Validate the item

Segregation action performed based on condition

Segregated item collected in compartments matching condition

Transfer mark of authentication on item

BRAINSTORMING

FUNCTION 1: SCAN THE ITEM FOR ADDRESS AND/OR BARCODE

1. **Make it a QR code for scanning.**
2. **Implementation of AI based OCR.**
3. **Camera based identification setup.**
4. **Multi-directional scanner for variety of orientations of surfaces.**
5. **Divide the letters by their zones.**
6. **Employ a person who can read it.**
7. **No change.**
8. **Magnify all the addresses, so that it can be easier to read.**
9. **Use AI-Assistant such as Alexa.**
10. **Change the shape of the envelopes based on destination.**
11. **Scanning glasses.**
12. **Inspect barcodes manually.**
13. **Throw them in a bucket manually.**
14. **Using flashlight to scan it manually.**
15. **Metal detector to scan the barcode.**
16. **Don't use postage stamp, use different weights in envelope.**
17. **Manually write down the barcode numbers.**
18. **Unique music for every destination.**

BRAINSTORMING

FUNCTION 2: VALIDATE THE ITEM

1. Send pigeon on address.
2. Google search each address.
3. Have an address database with all possible addresses.
4. Cross check it with randomly generated addresses.
5. Randomly say, that doesn't sound like a real address to me.
6. If you know the neighbouring streets, you know the address is valid.
7. Contact the sender or receiver to verify.
8. Bio-metric validation.
9. Make them write the address twice.
10. Validate the item by rolling the dice.
11. Digitally printed label, can be sorted on the route-map.
12. Sending item to magic fortune teller for validation.
13. Have a drone go to the address and check validity.
14. Asking a stranger for their opinion.
15. Time-travel, and going to see if it is the right sender.
16. Add the GPS plus code.

BRAINSTORMING

FUNCTION 3 : SEGREGATION ACTION PERFORMED BASED ON CONDITION

1. Colour them according to the destination.
2. Scanning the item based on pin codes.
3. Shoot the items to each receptacle.
4. Robotic arm picks it up and puts it somewhere.
5. Sorting the item based on number of vowels in the address.
6. Ribbon by destination.
7. Sort by weight.
8. Sort by language written for address
9. Using tags such as fragile, priority
10. Tell each letter to go sit where it belongs.
11. Automated mechanical system based on size, shape, etc.
12. Adding chips, autonomous identification system.
13. Put a packet of Kheer in the IISc bucket.
14. Scent tagging the mail.
15. Segregation based on favourite colour.
16. Each letter converts into pigeons.
17. Different shapes for segregation.

Segregated item collected in compartments matching condition

Problems as given	Goals as Understood
<ul style="list-style-type: none"> • Difficult to have segregated mails, chance of mixing up, due to distance. • Slow and tiring process because of manual work. • All the letters look the same. • Standards may not be followed, as customers and postal workers may make mistakes. • It's a boring process, people might get carried away. • It's a tedious effort, to collect mail. • Illegible font, or handwriting. • Need for distinct compartmentalisation for effective use. • Inconsistency in number of mails for different destination population. • More prone to faulty segregation , due to human errors. 	<ul style="list-style-type: none"> • Faster processing • Less manual effort • Less error • Making it less tedious • Making it easily distinguishable

Segregated item collected in compartments matching condition

Example - EX: Less error	Examination - EXAM: Dictatorship	Force Fit - FF
<ul style="list-style-type: none"> • machine • specialised workers • army • accuracy • reliability • rockets • nuclear power station • mathematics • calculators • precision • dictatorship • monopoly • automation • surgical procedure • microscope 	<ul style="list-style-type: none"> • adolf hitler • monopoly • control • order • elements of design • injustice • fixed • predefined • prejudiced • restricted • more scope of economic development • forced • less freedom • rigid • unethical • narcissistic • uniformity 	<ul style="list-style-type: none"> • standardisation • self validation • restricted access • centralised system • incentive for more accuracy • background knowledge • severe punishments for error

Transfer mark of authentication on item

Problems as given	Goals as Understood
<ul style="list-style-type: none">• Lot of manual effort required to make the indent.• The date has to accurate/fitting.• Legibility of the authentication.• Safe indentation without damaging package contents.• Indentation may lead to RSIs for worker.• Need to wait for the ink to dry.• The device is likely to get damaged from the impact force.• It can be easily duplicated, leading to security concerns.• Repetitive and boring.• Ink has to be reapplied frequently.	<ul style="list-style-type: none">• clear and distinct authentication• non replicable• easier to carry out, less effort• more ergonomically fit• efficient continuity of task.

Transfer mark of authentication on item

Example - EX: Clear, distinct authentication	Examination - EXAM: Snowflake design	Force Fit - FF
<ul style="list-style-type: none"> • passport/ ID • finger print/ DNA • currency • roll no/ sr no. • Address • standards • snowflake design • cymatics pattern • cryptocurrency • symbols • password • qr code • pattern 	<ul style="list-style-type: none"> • Hexagon • Unique • Temporary • UFO • Emergent • Fragile • Small • Natural • White • Skiing • Intricate • Fractal • Crystallise 	<ul style="list-style-type: none"> • Stacked clearly • 2 step verification • Non replicable • OTP • Classified information • Recognisable • Tampering assessment • Compact/ fitting • Intuitive • smooth operation • Self referencing • Self sufficient • End to end encryption

MORPHOLOGICAL MATRIX

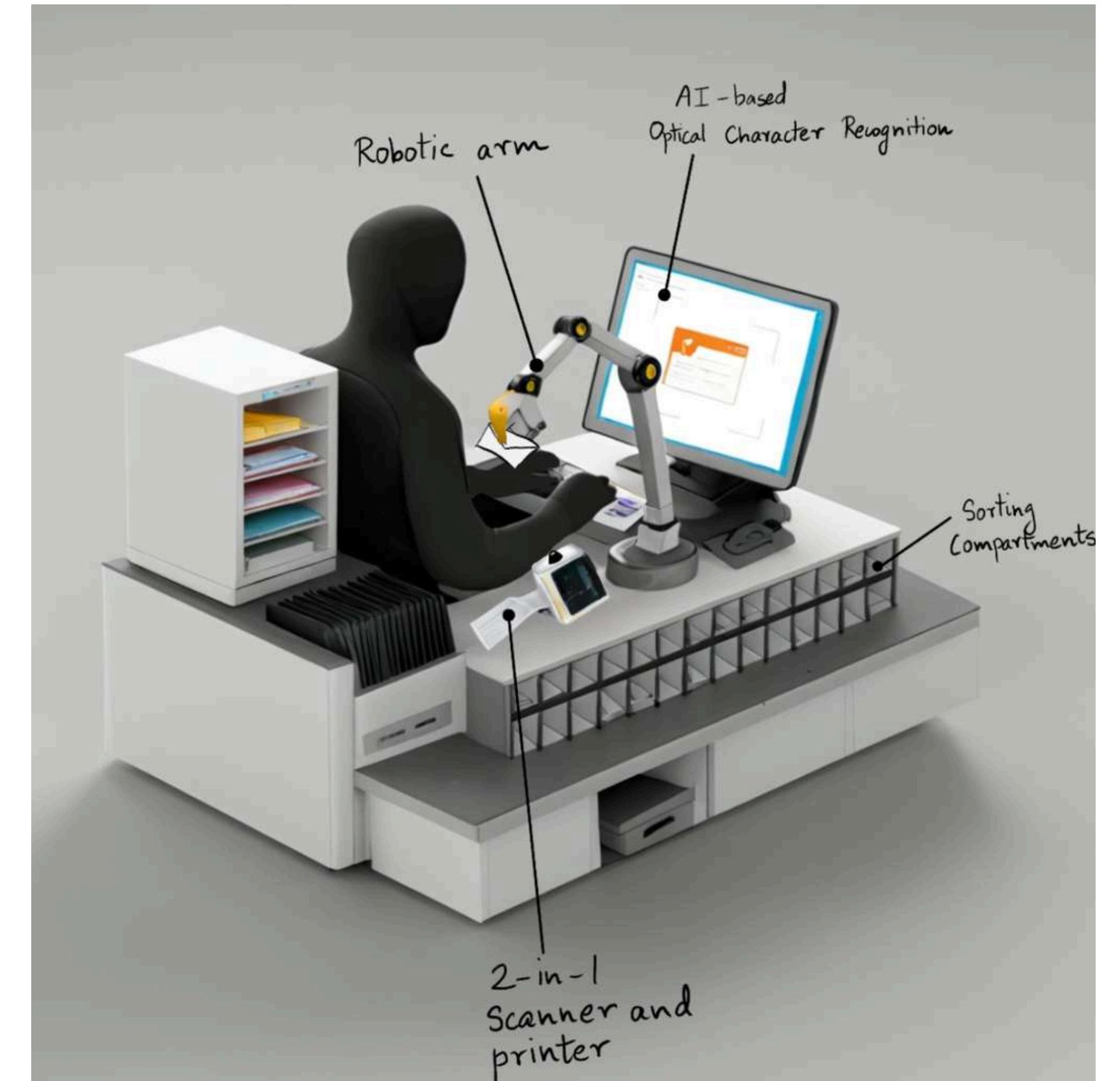
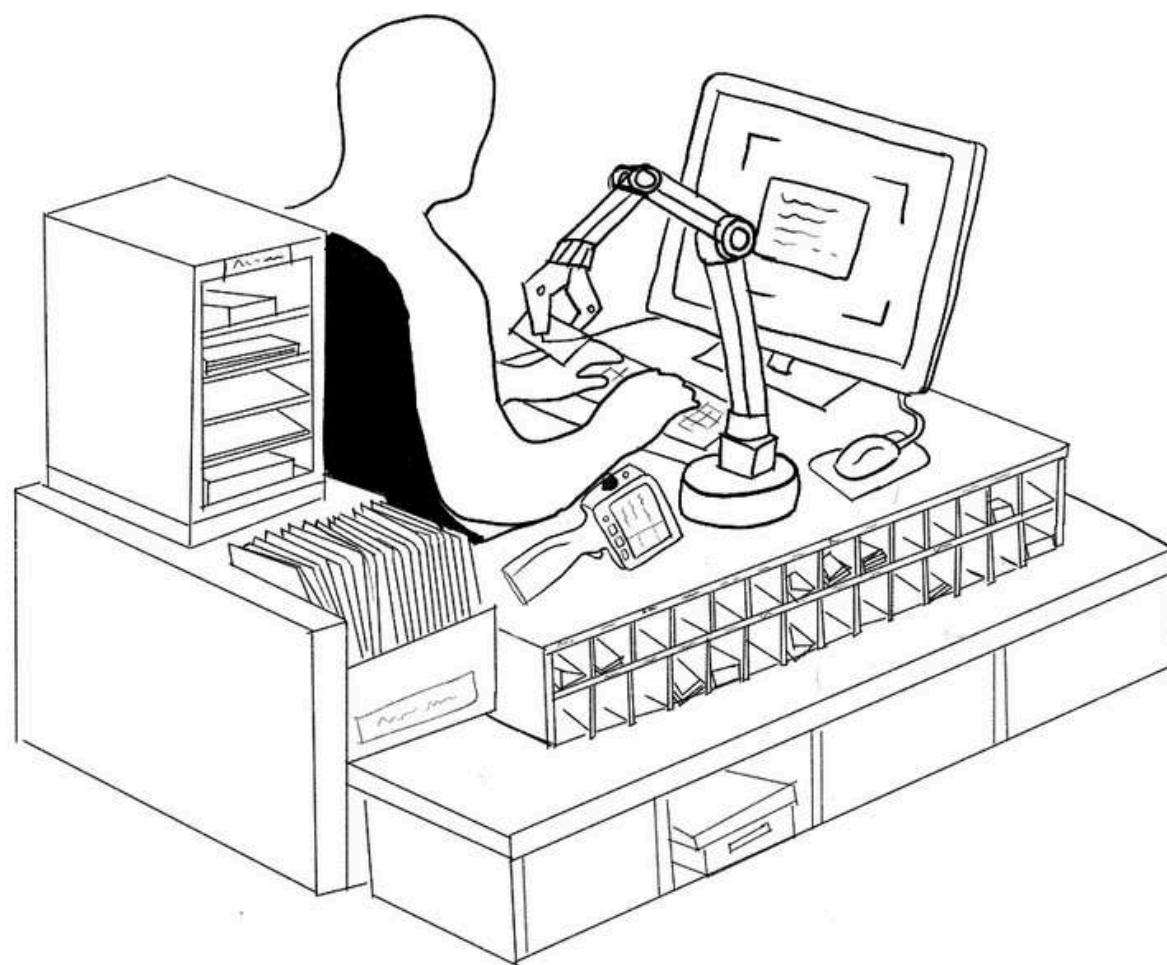
Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT 1

Scan	Validate	Segregate	Collect	Authenticate
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CONCEPT 1

- Camera based scanning setup
- Address database available to validate
- AI-based OCR to make sorting decisions
- Robotic arm for actual sorting of mails
- Compact authentication system
- Computer to integrate all functions

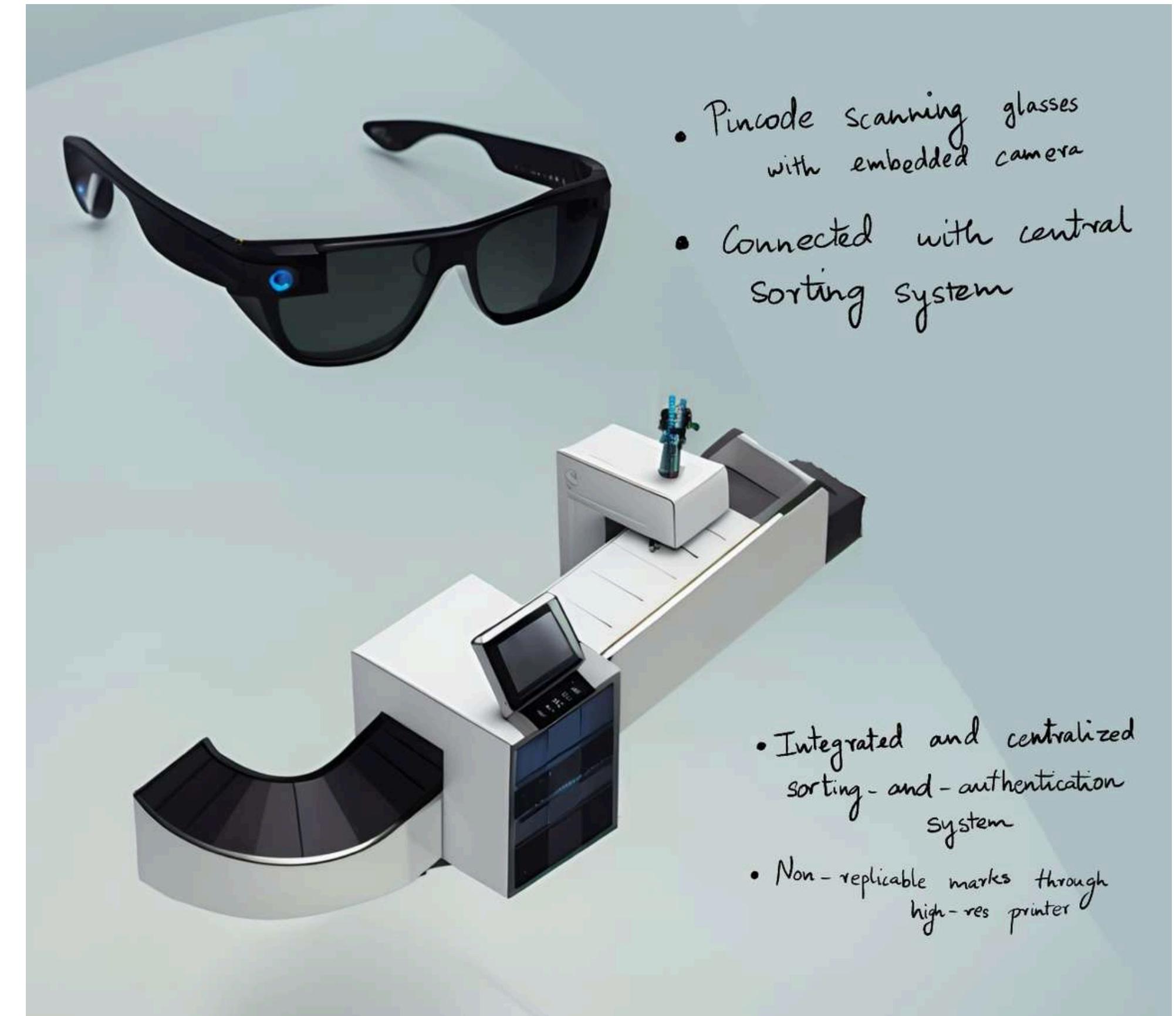
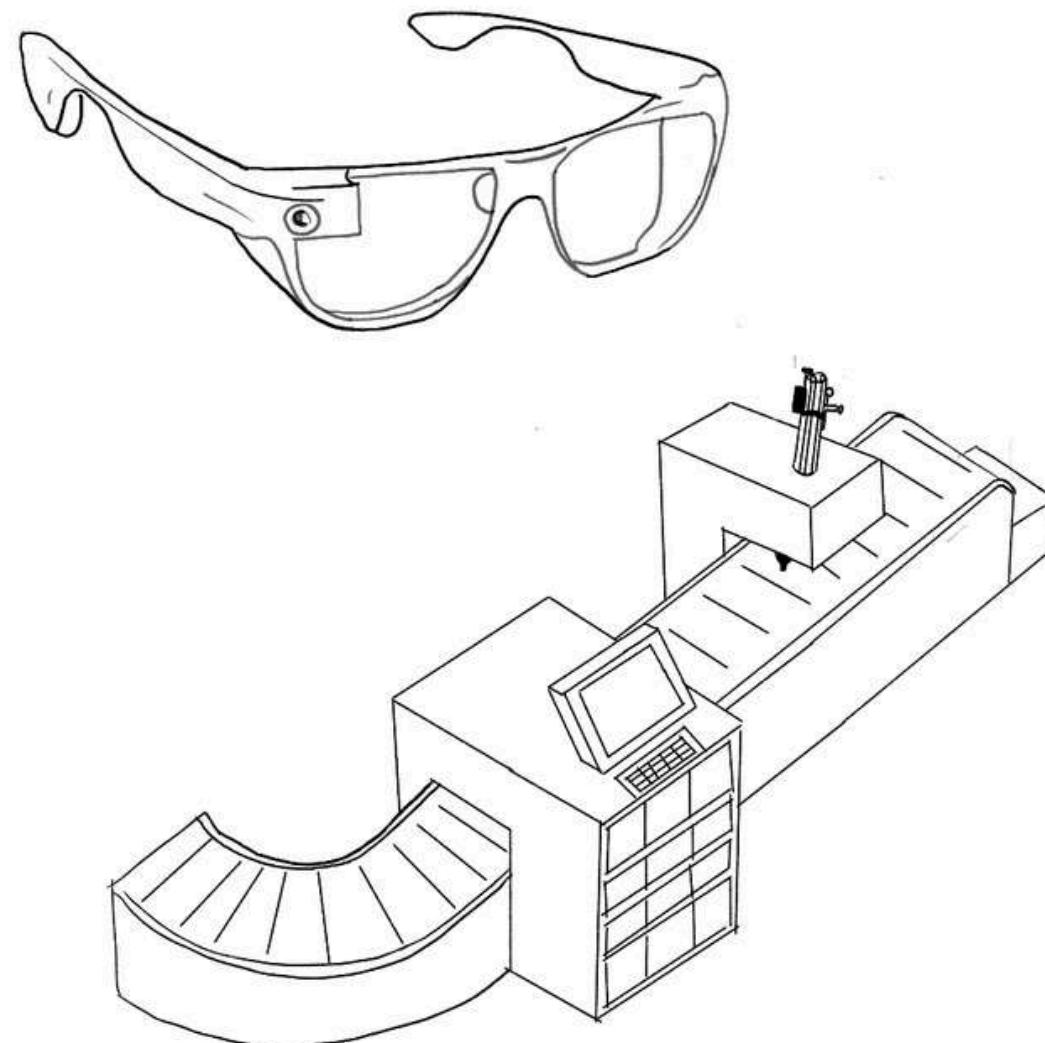


CONCEPT 2

Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT 2

- Scanning glasses with pincode scanner
- Digital labels on mails for easy scanning
- Centralized and integrated system
- Non- replicable authentication marks

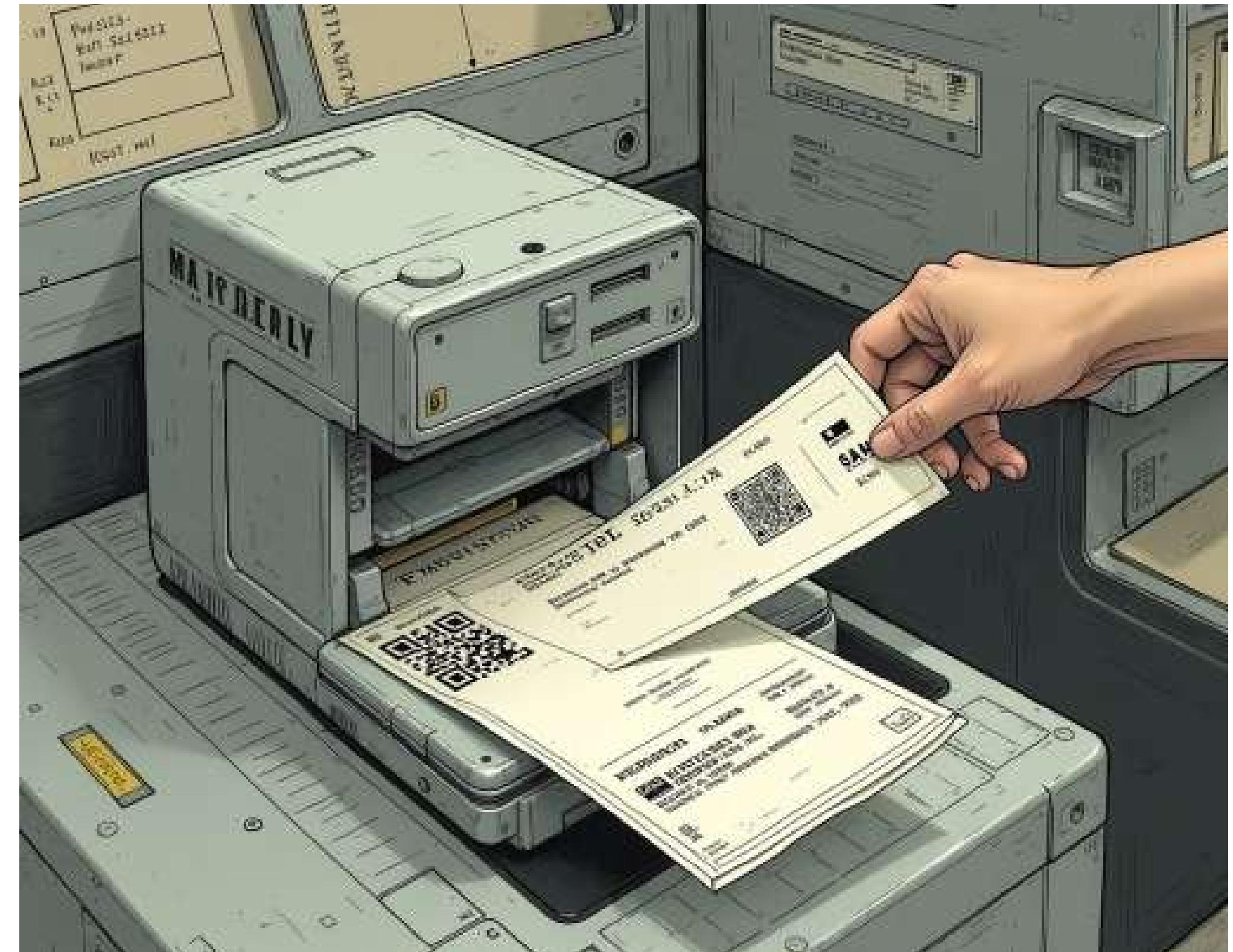
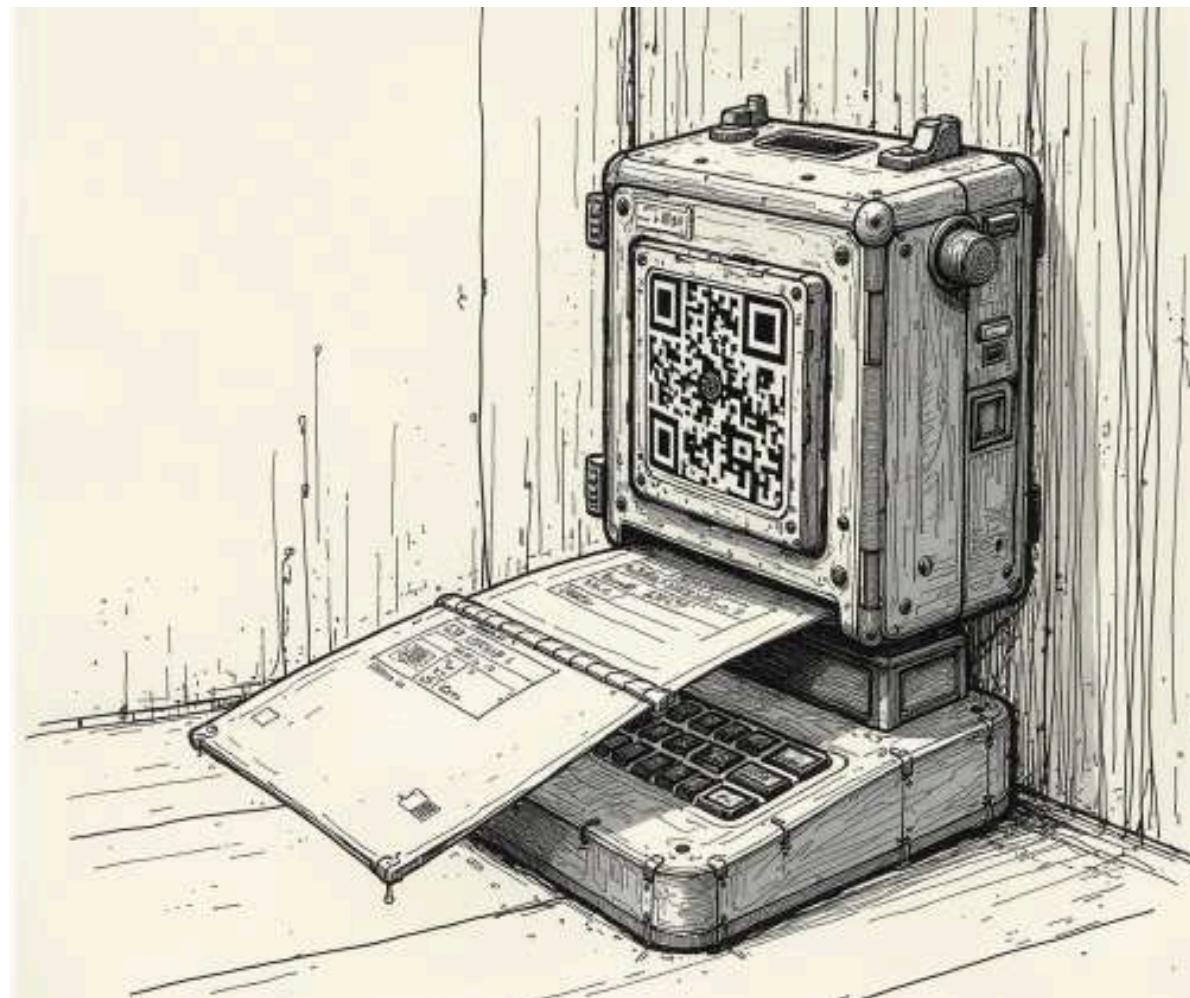


CONCEPT 3

Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT 3

- Scanning device with QR scanner
- QR helps in identifying the sender's and receiver's information.
- Distinct segregation level may appear on the screen itself.



CONCEPT 4

Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT 4

- An authenticating machine that automatically prints the authentication seal.

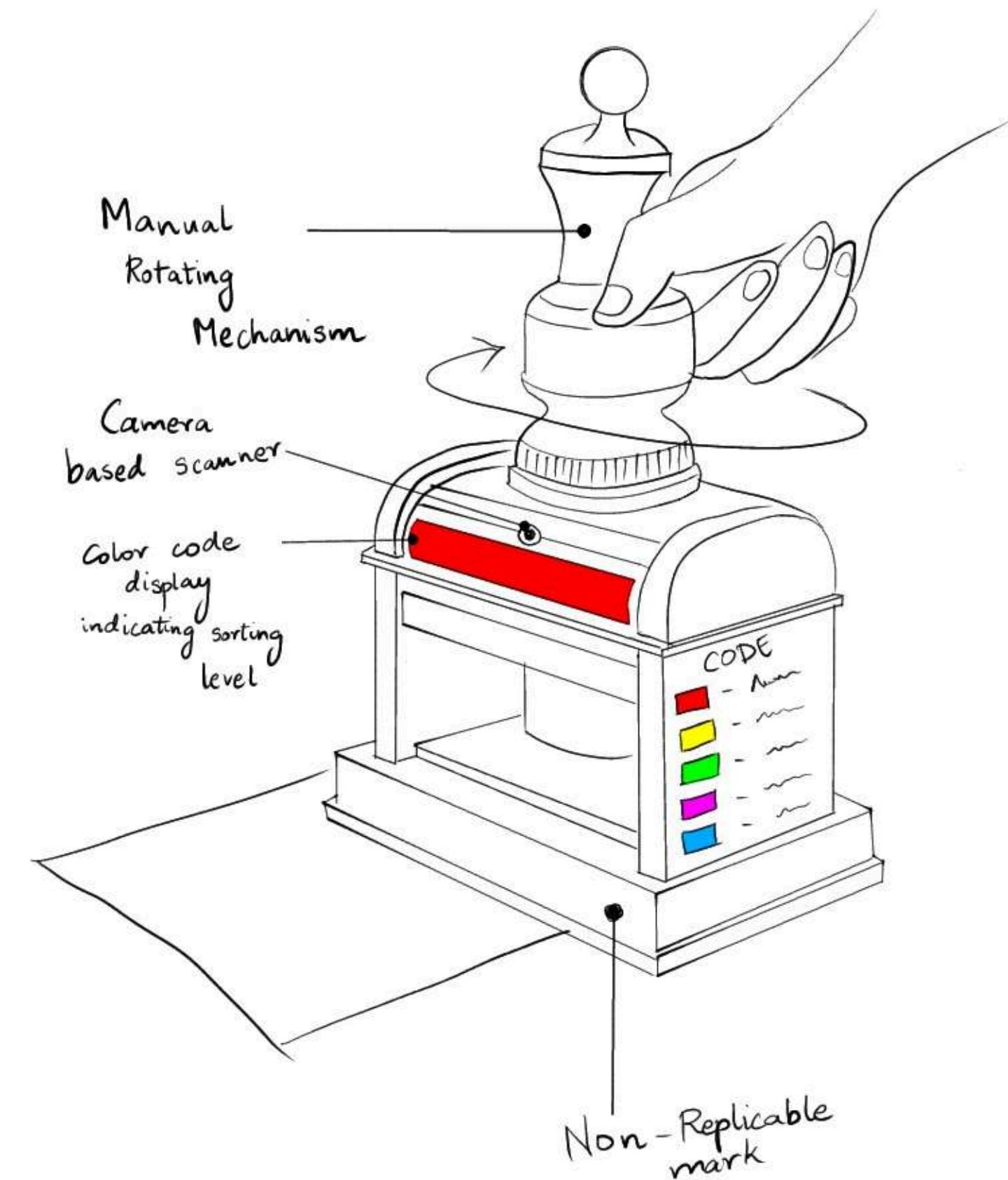
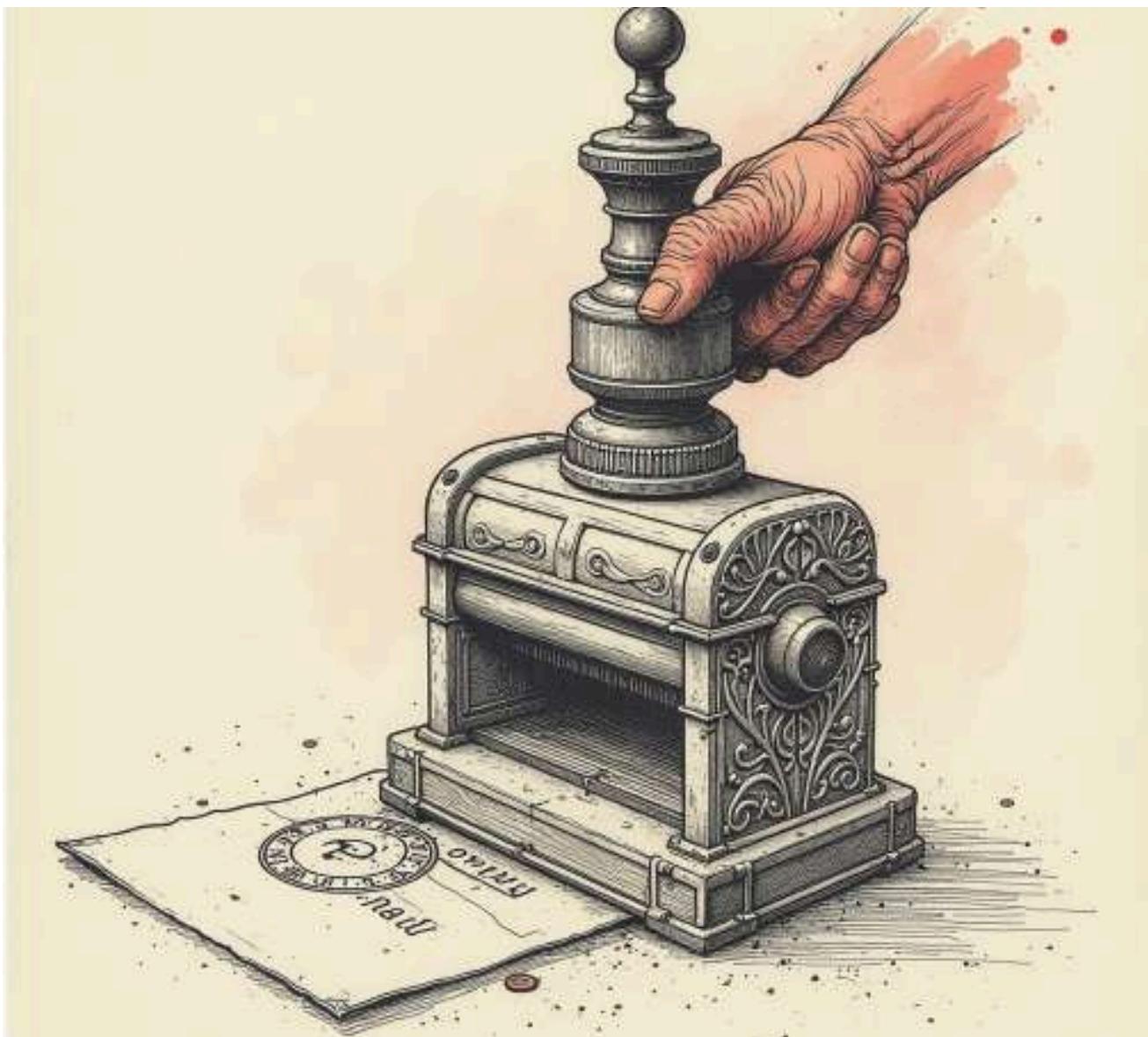


CONCEPT 5

Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT 5

- A manually rotating device that would reduce physical effort for authentication.
- The authentication can also be digitally printed with a compact device.

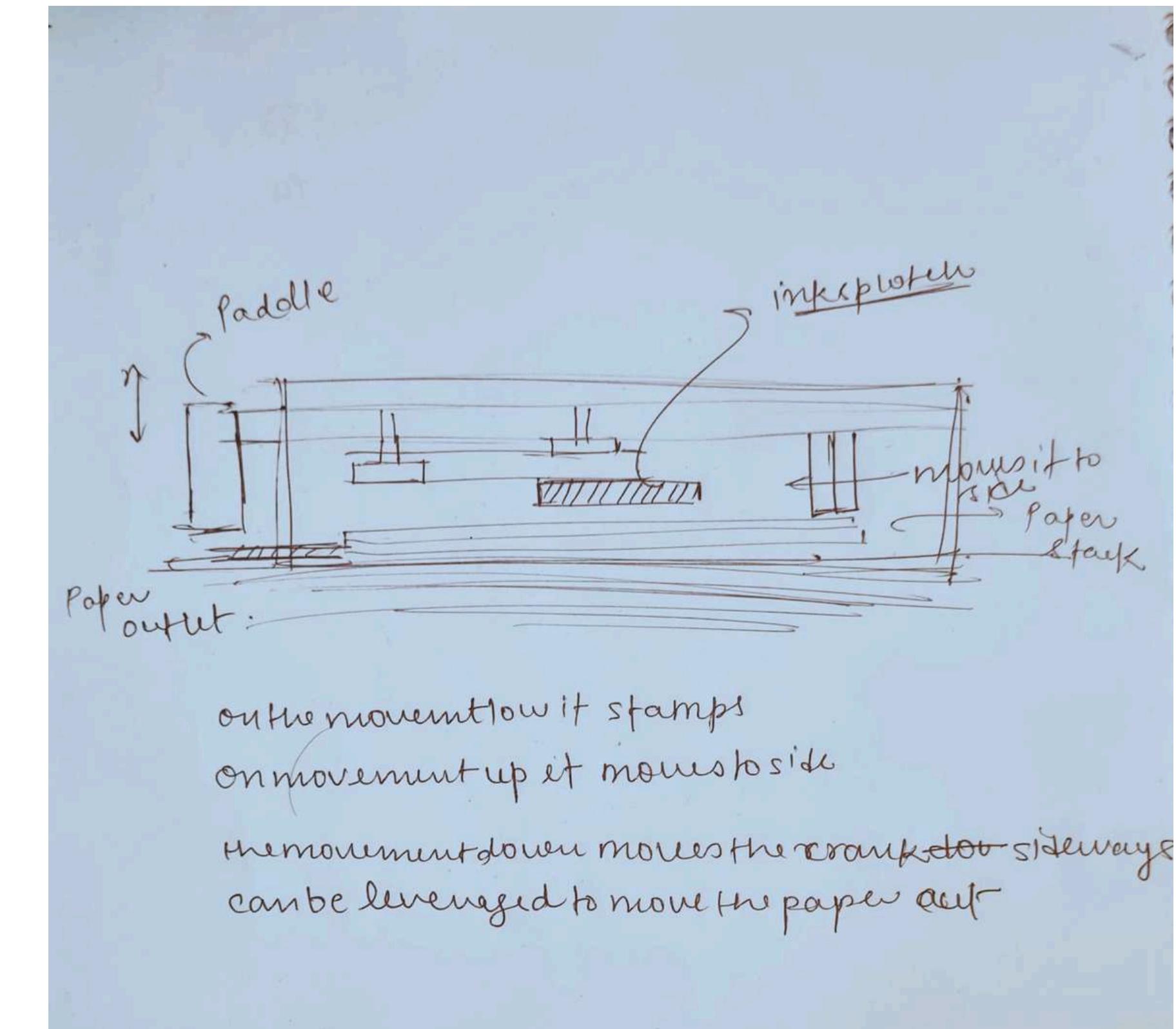
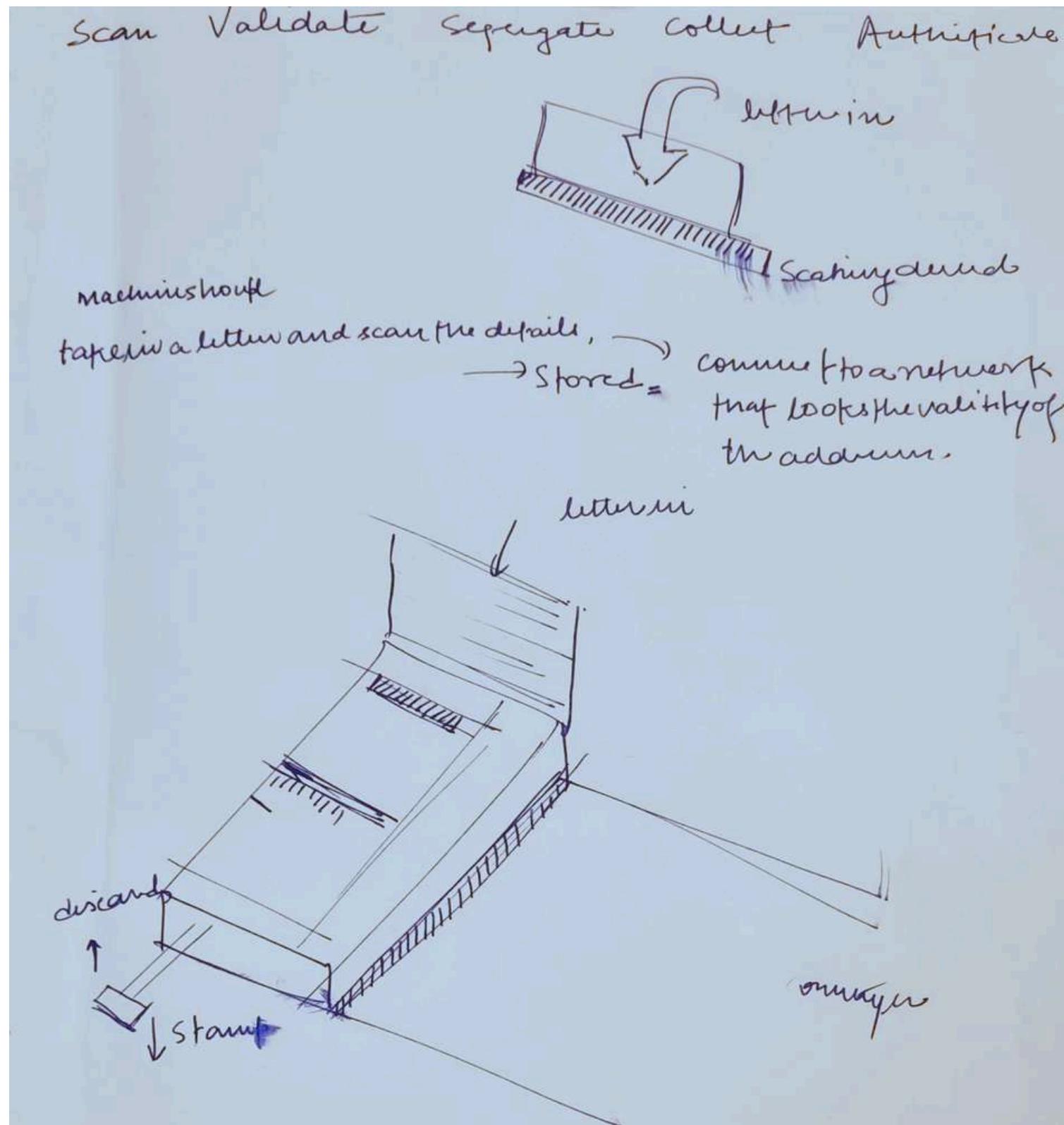


CONCEPT 6

Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT IDEA 6

Manual press for franking and validation that has a scanner

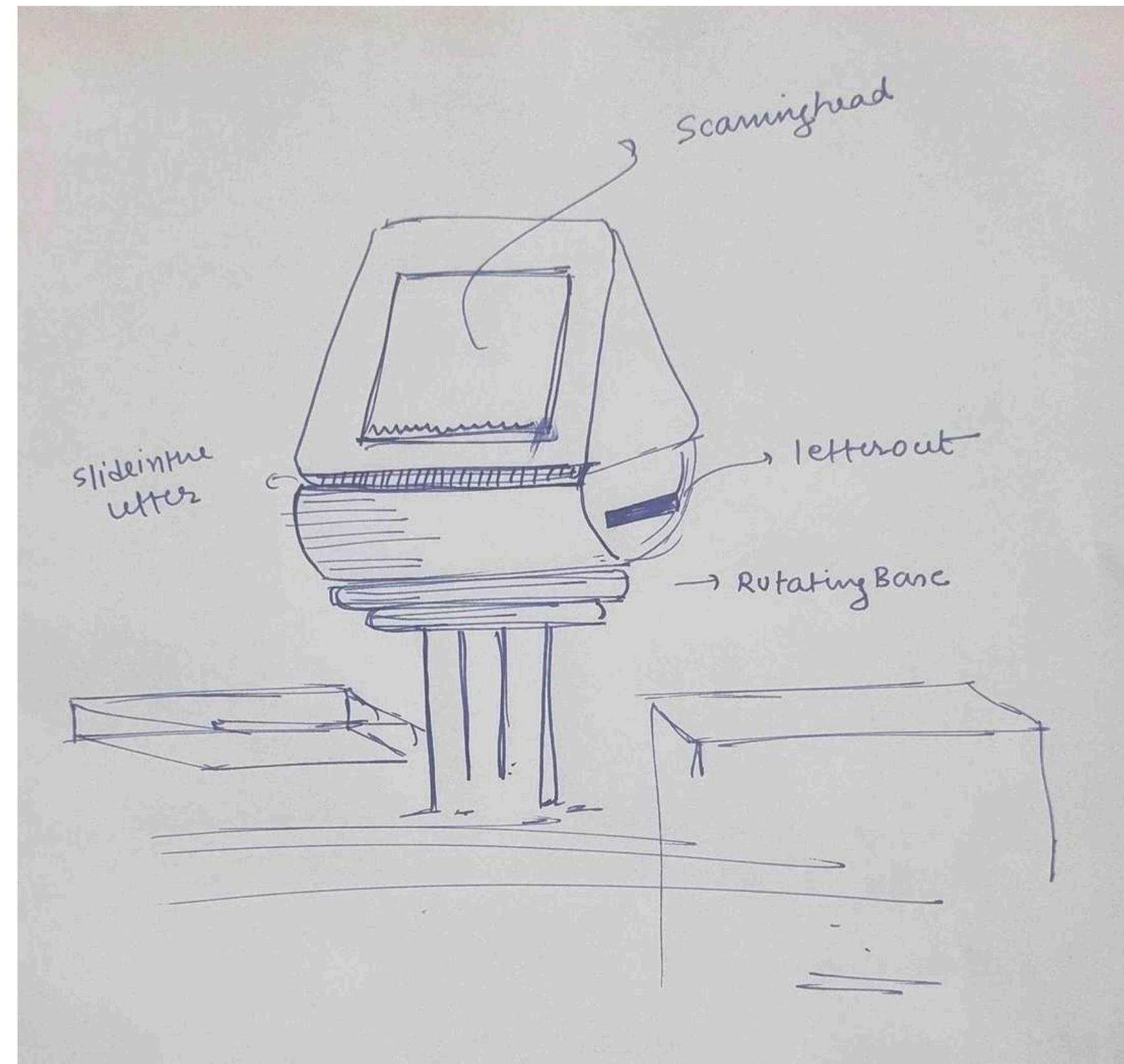


CONCEPT 7

Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT IDEA 7

ROTATING HEAD DISTRIBUTER WITH A SCANNING HEAD



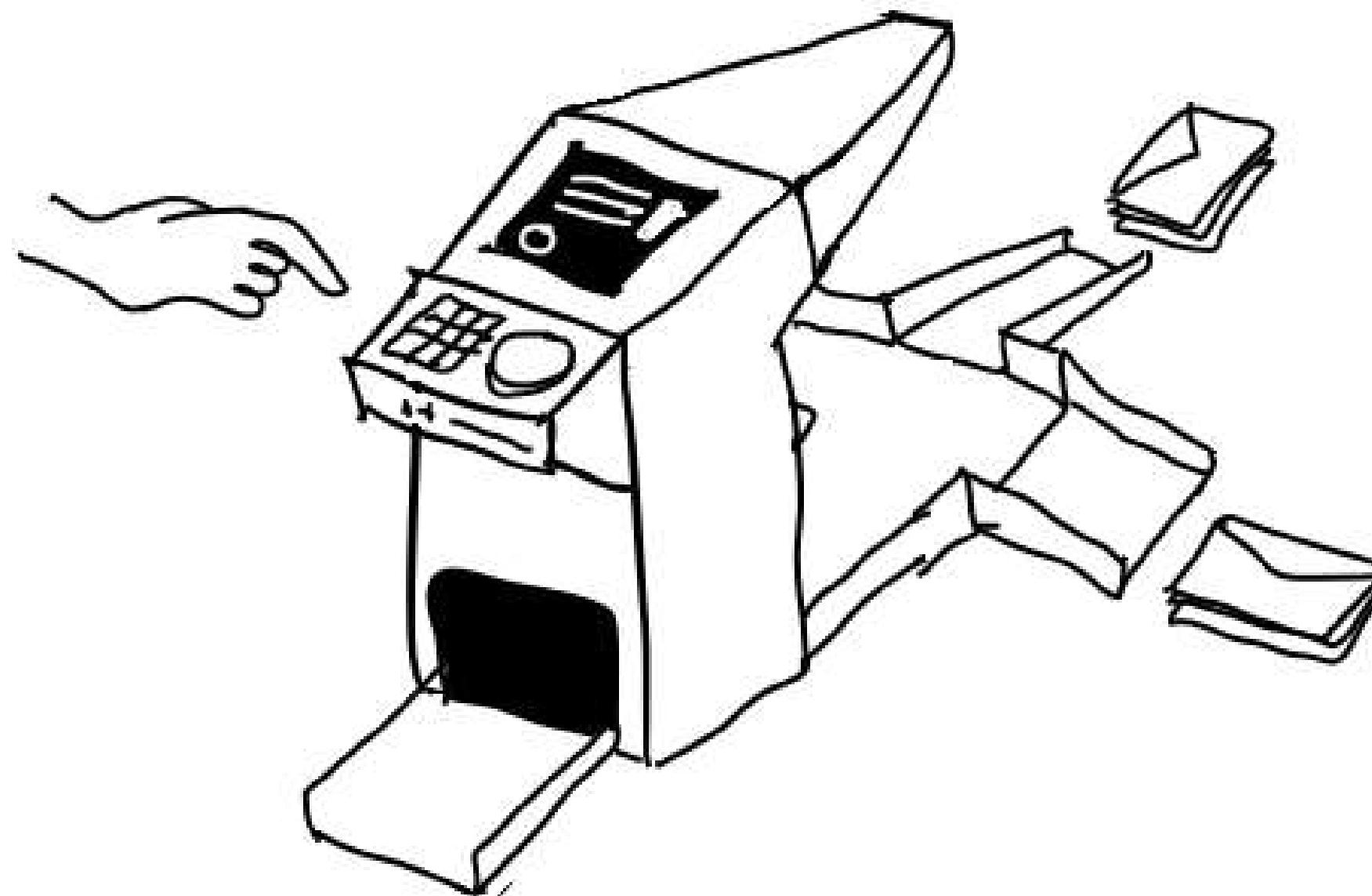
CONCEPT 8

Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT IDEA 8

ROTATING HEAD DISTRIBUTER WITH A SCANNING HEAD

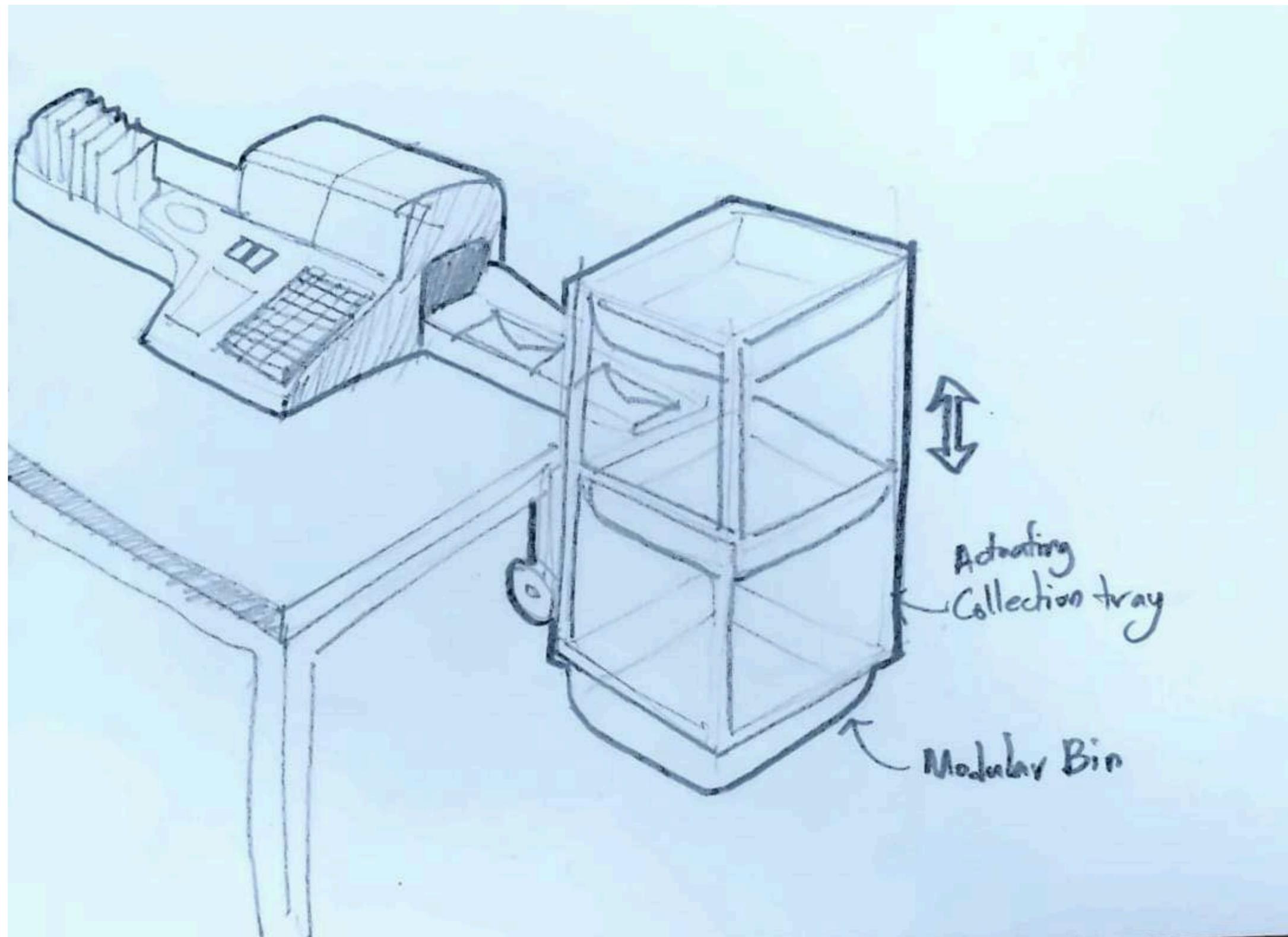
- A device that is a centralised sorting, that does a trinary sorting action, with 3 possible outcomes.
- It scans, validates, sorts, and authenticates.



CONCEPT 9

Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT IDEA 9



A bin based scanning, sorting, validating and authenticating device, where the bins are tagged and actuated based on the sorting condition, with a centralised sorting command.

CONCEPT 10

Scan	Validate	Segregate	Collect	Authenticate
Make it a QR code for scanning.	Have an address database with all possible addresses.	Colour them according to the destination.	Robotic arm picks it up and puts it somewhere.	2 step verification
Camera based identification setup.	Bio-metric validation.	Scanning the item based on pin codes.	Self-Validation	Non replicable
Scanning glasses.	Digitally printed label, can be sorted on the route-map.	AI-based OCR	Centralized system	Tampering assessment
Self-aligning scanner head	Add geographical plus code	Have different stamps, based on destination.	Standardization	Compact/ fitting

CONCEPT 10

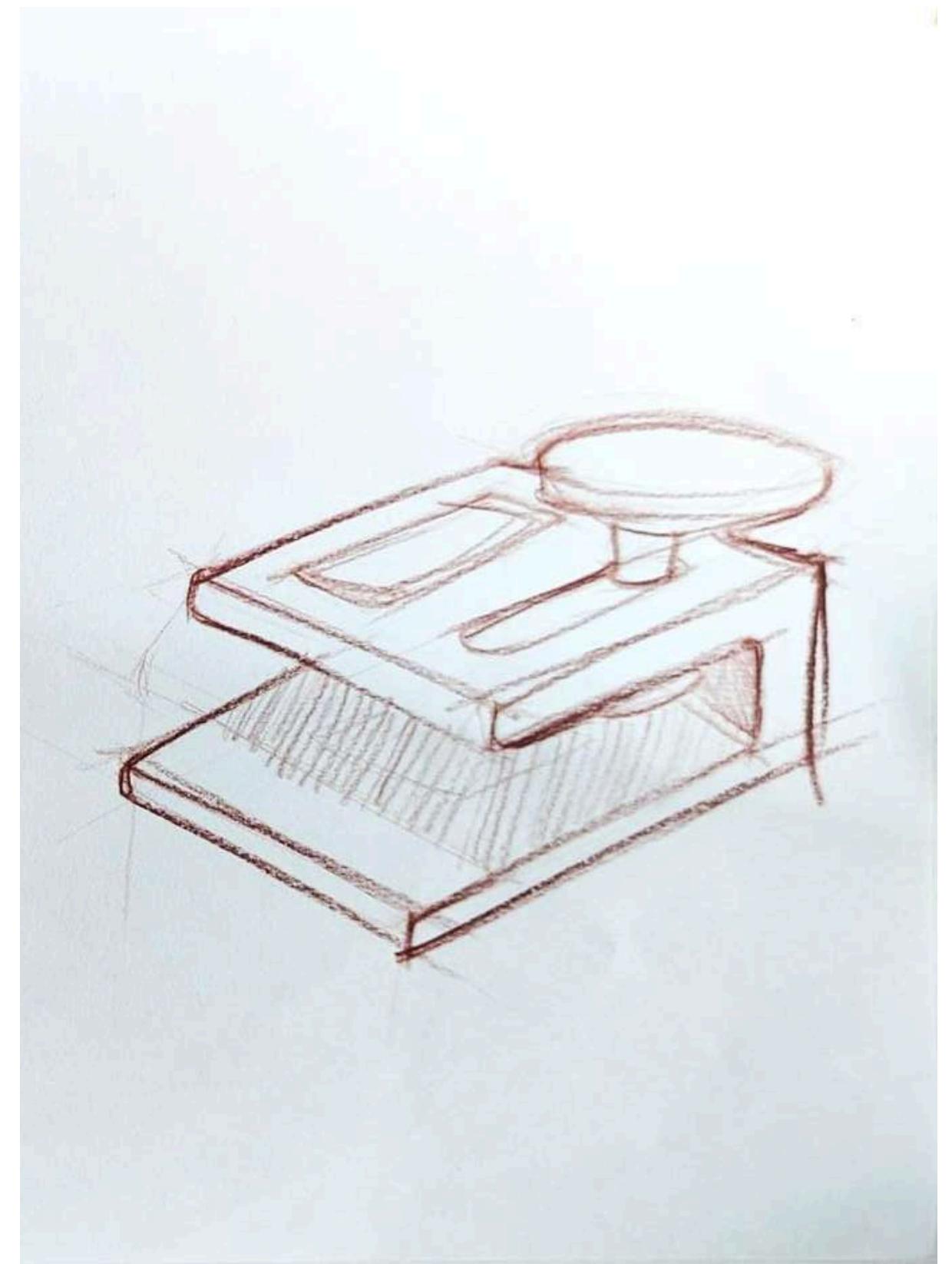
- A device that does segregation using AI-based OCR , Bio-metric validation of letters and Robotic arm picks it up and puts it somewhere.



CONCEPT 1

ERGONOMIC SORTING AND SEALING ASSISTANT

- ocr recognition through camera (placing it manually in the container)
- computer screen validates (black- unvalid), assigns segregation method based on color, displays color (10).
- authenticate it manually
- put in the colored bin
- ocr recognition. (pincode + Address)
- code for displaying color according to address.
- stamp it by pumping it
- colored bins



MATHEMATICAL SIMULATION

INPUT PARAMETER CALCULATION

Seal Force:

The force required for a seal stamp depends on the following factors:

- **Material of the letter:** The thickness and type of paper affect how much force is needed.
- **Indentation depth:** The depth of the indentation or ink impression desired.
- **Contact area:** The size of the seal (e.g., a circular seal with diameter).

$$F_{seal} = P \cdot A$$

Where,

- P : Pressure required for stamping (depends on the paper and ink type). Let's assume 1.5 MPa (a common pressure for stamping).
- A: Contact area of the seal. For a circular seal of diameter d,

$$A = \pi \left(\frac{d}{2} \right)^2$$

- Assuming a seal diameter of d=2 cm: $A = \pi \left(\frac{2}{2} \right)^2 = \pi \text{ cm}^2 \approx 3.14 \text{ cm}^2$

$$F_{seal} = 1.5 \times 10^6 \text{ N/m}^2 \times 3.14 \times 10^{-4} \text{ m}^2 = 471 \text{ N}$$

MATHEMATICAL SIMULATION

LIST OF INPUT PARAMETERS

Parameter	Symbol	Unit	Value
Number of mails to process	$N(\text{mail})$	mails	User-defined
Average processing time per mail	$T(\text{proc})$	seconds/mail	8 - 12 seconds
Camera scanning time	$T(\text{scan})$	seconds	1 - 2 seconds
OCR and AI sorting time	$T(\text{sort})$	seconds	1 - 2 seconds
Color code display time	$T(\text{color})$	seconds	0.5 - 1 second

MATHEMATICAL SIMULATION

LIST OF INPUT PARAMETERS

Parameter	Symbol	Unit	Value
Color code display time	T(color)	seconds	0.5 - 1 second
Manual stamping time	T(stamp)	seconds	2 - 4 seconds
Seal force applied	F(seal)	Newtons (N)	400 - 500 N
Operator efficiency factor	$\eta(op)$	-	0.8 - 0.9

MATHEMATICAL SIMULATION

OUTPUT PARAMETER CALCULATION

1) Processing time per mail:

$$T_{proc} = T_{scan} + T_{sort} + T_{color} + T_{stamp} = 1.5 + 1.5 + 0.7 + 3 = 6.7 \text{ seconds/mail}$$

2) Total processing time:

$$T_{total} = N_{mail} \times T_{proc} = 500 \times 6.7 = 3350 \text{ seconds} \approx 55.83 \text{ minutes}$$

3) Throughput rate: $R_{throughput} = \frac{N_{mail}}{T_{total}/3600} \times \eta_{op}$

Including operator breaks: $R_{throughput} = \frac{3600 \times \eta_{op}}{T_{proc} + \frac{T_{break}}{60}} = \frac{3600 \times 0.85}{6.7 + \frac{10}{60}} = 417 \text{ mails/hour}$

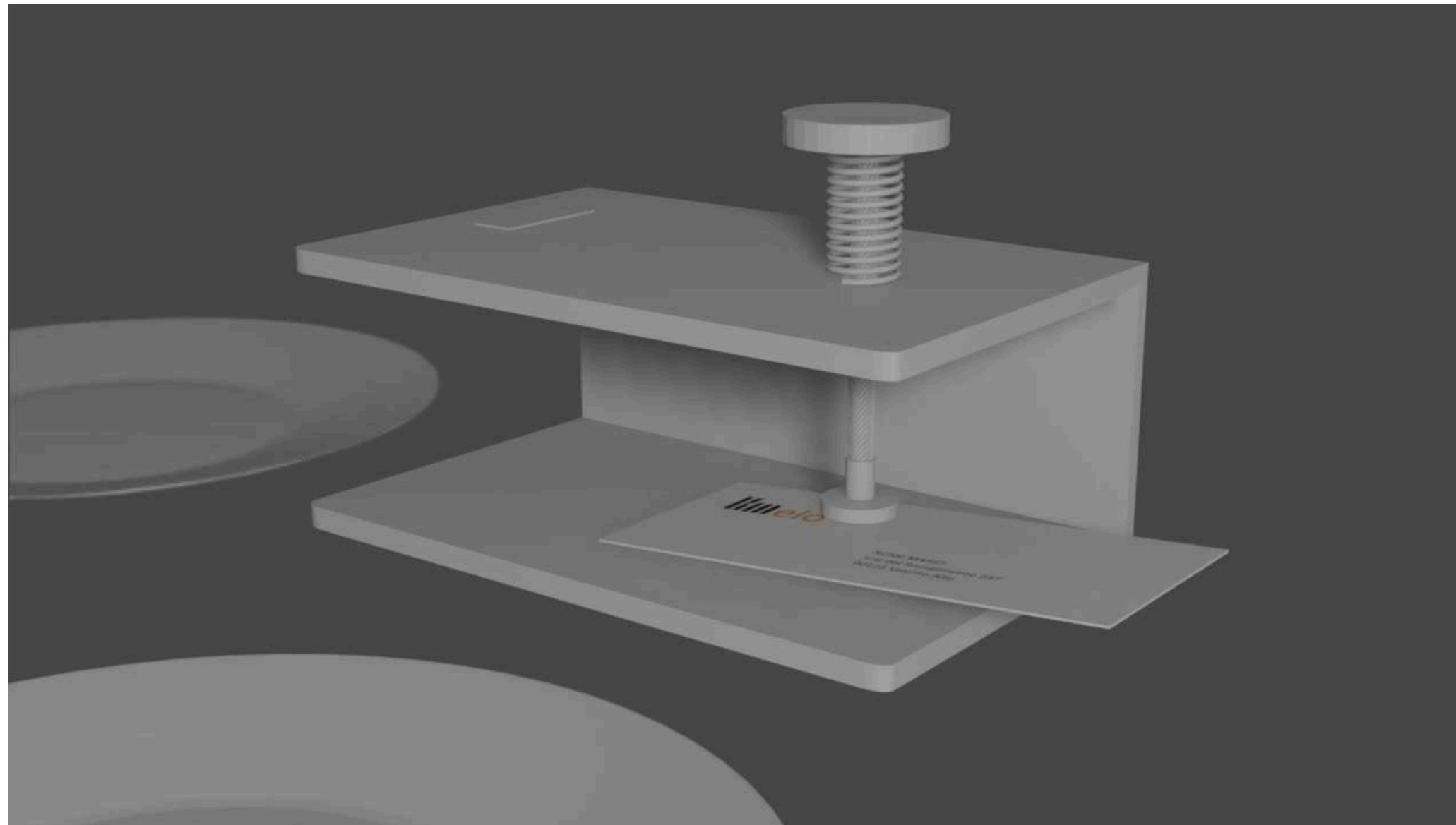
4) Effort estimation (Work per mail): $W_{effort} = F_{seal} \times d_{seal} = 400 \times 0.015 = 6 \text{ Joules}$

Where d_{seal} is the estimated displacement of the manual press handle in meters, around 0.01 - 0.02m

5) Total work done: $W_{total} = W_{effort} \times N_{mail} = 6 \times 500 = 3000 \text{ Joules}$

VIRTUAL SIMULATION

ERGONOMIC SORTING AND SEALING ASSISTANT



- placing all (30) the letters in the loading tray
- ocr recognition through camera on bottom
- authenticate if valid
- dispatch roll it out to the correct tray (10).
- 30 letters.

OBSERVATIONS

ERGONOMIC SORTING AND SEALING ASSISTANT

- Sorting of the mail is done manually
- Handle is to be made wider to distribute pressure of contact area, making a more comfortable operation.
- Customised data set must be trained to have a lesser error rate and higher throughput value for validating the mail.
- Ink reservoir must be contained within the stamp.

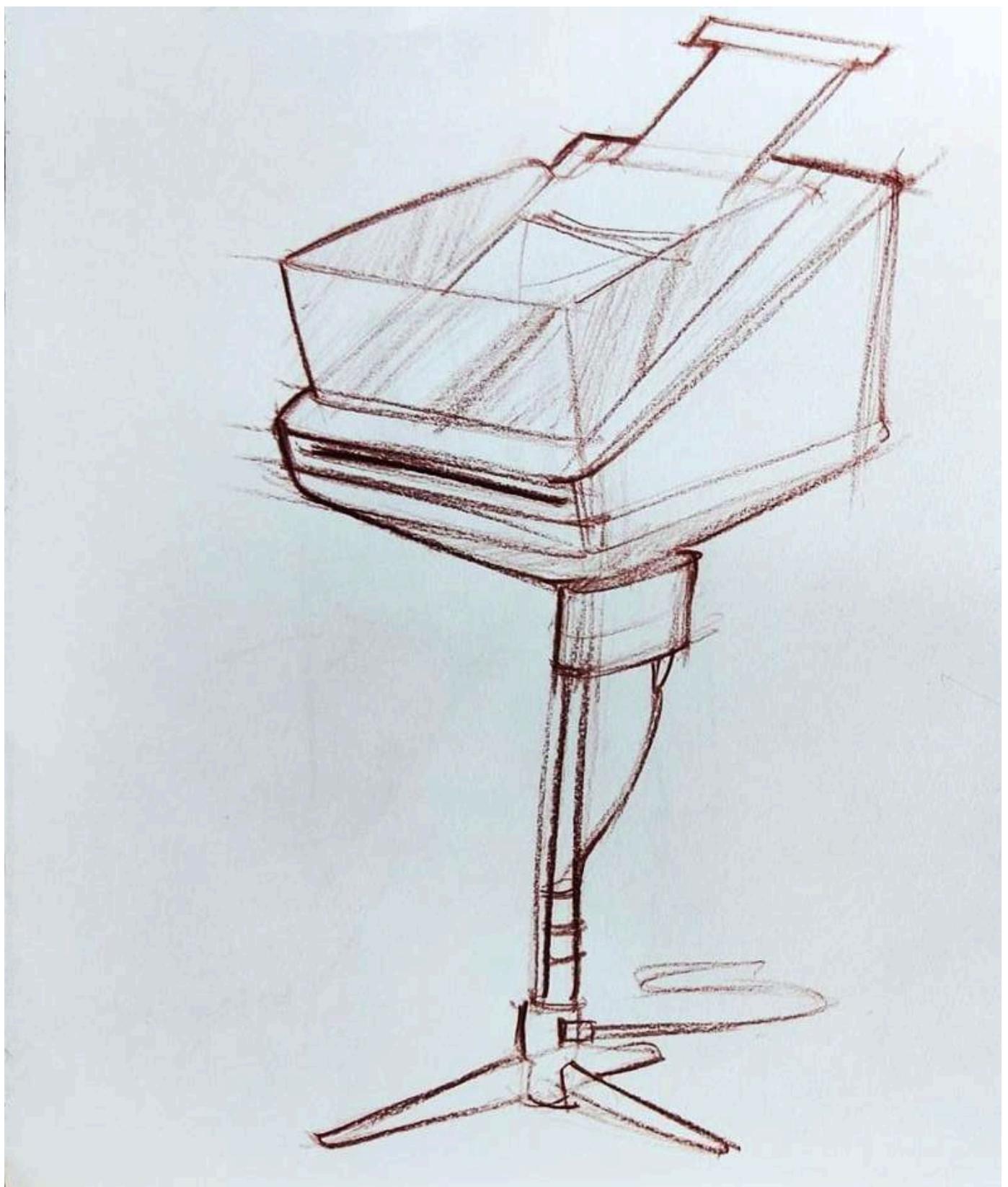
CONCEPT IDEA 2

ROTATING HEAD DISTRIBUTER WITH A SCANNING HEAD

- placing all (30) the letters in the loading tray
- ocr recognition through camera on bottom
- authenticate if valid
- dispatch roll it out to the correct tray (10).

30 letters.

- ocr recognition. (pincode + Address)
- compare it with the existing database, and validate it.
- authenticate the mail with printed label on the envelope
- adjust the opening of machine to the correct tray
- rolls out the letter



MATHEMATICAL SIMULATION

LIST OF INPUT PARAMETERS

Category	Parameter	Symbol	Unit	Value
System Input	Number of compartments	N	-	12
	Letters per batch	M	letters	10
	Letter length	L	cm	20
	Letter width	W	cm	10
	Letter thickness	h	cm	0.2

MATHEMATICAL SIMULATION

LIST OF INPUT PARAMETERS

Category	Parameter	Symbol	Unit	Value
Motion Parameters	Roller speed	$v(\text{roller})$	cm/s	To be calculated
	Servo speed	RPM(servo)	RPM	3000-5000
Scanning and Sorting	Scanning time	$T(\text{scan})$	s	0.3
	OCR processing time	$T(\text{ocr})$	s	0.5
	AI sorting time	$t(\text{sort})$	s	0.2

MATHEMATICAL SIMULATION

LIST OF INPUT PARAMETERS

Category	Parameter	Symbol	Unit	Value
Printing Parameters	Inkjet printing speed	$v(\text{print})$	m/min	130
Rotating Head Distributor	Max rotational speed	$\omega(\text{max})$	degrees/s	180
	Angular displacement	Θ	degrees	Variable (0-360)
	Rotation time	$t(r)$	s	Variable
Mail Pushing	Pushing speed	$v(\text{push})$	cm/s	8

MATHEMATICAL SIMULATION

OUTPUT PARAMETER CALCULATION

1) Printing time

- The Skyfire SF600 has a printing speed of 130 m/min, which is 216.67 cm/s.
- Width of the letter (W) = 10 cm.

• Printing time per letter: $t_{print} = \frac{W}{v_{print}} = \frac{10 \text{ cm}}{216.67 \text{ cm/s}} \approx 0.046 \text{ s}$

2) Roller speed

- Since printing occurs as the letter moves, the roller speed must match or be slightly lower than the printing speed
- For a conservative approach, the roller speed can be set slightly lower than printing to ensure consistent printing without smudging.

$$v_{roller} = 200 \text{ cm/s}$$

3) Rotational Head Alignment

- Angular displacement θ to reach the desired compartment:
where k is the index of target compartment

$$\theta = \frac{360^\circ}{N} \times k,$$

- Time t_r for the distributor head to rotate: $t_r = \frac{\theta}{\omega_{max}}$

- For k = 6, $\theta = \frac{360}{12} \times 6 = 180^\circ$, $t_r = \frac{180}{180} = 1 \text{ s}$

MATHEMATICAL SIMULATION

OUTPUT PARAMETER CALCULATION

4) Total processing time per letter

Considering the time for scanning, OCR, sorting, printing, rotating, and pushing:

$$t_{total} = T_{scan} + T_{ocr} + t_{sort} + t_{print} + t_r + t_{roll}$$

$$t_{total} = 0.3 + 0.5 + 0.2 + 0.092 + 1 + 2.5 = 4.592 \text{ s}$$

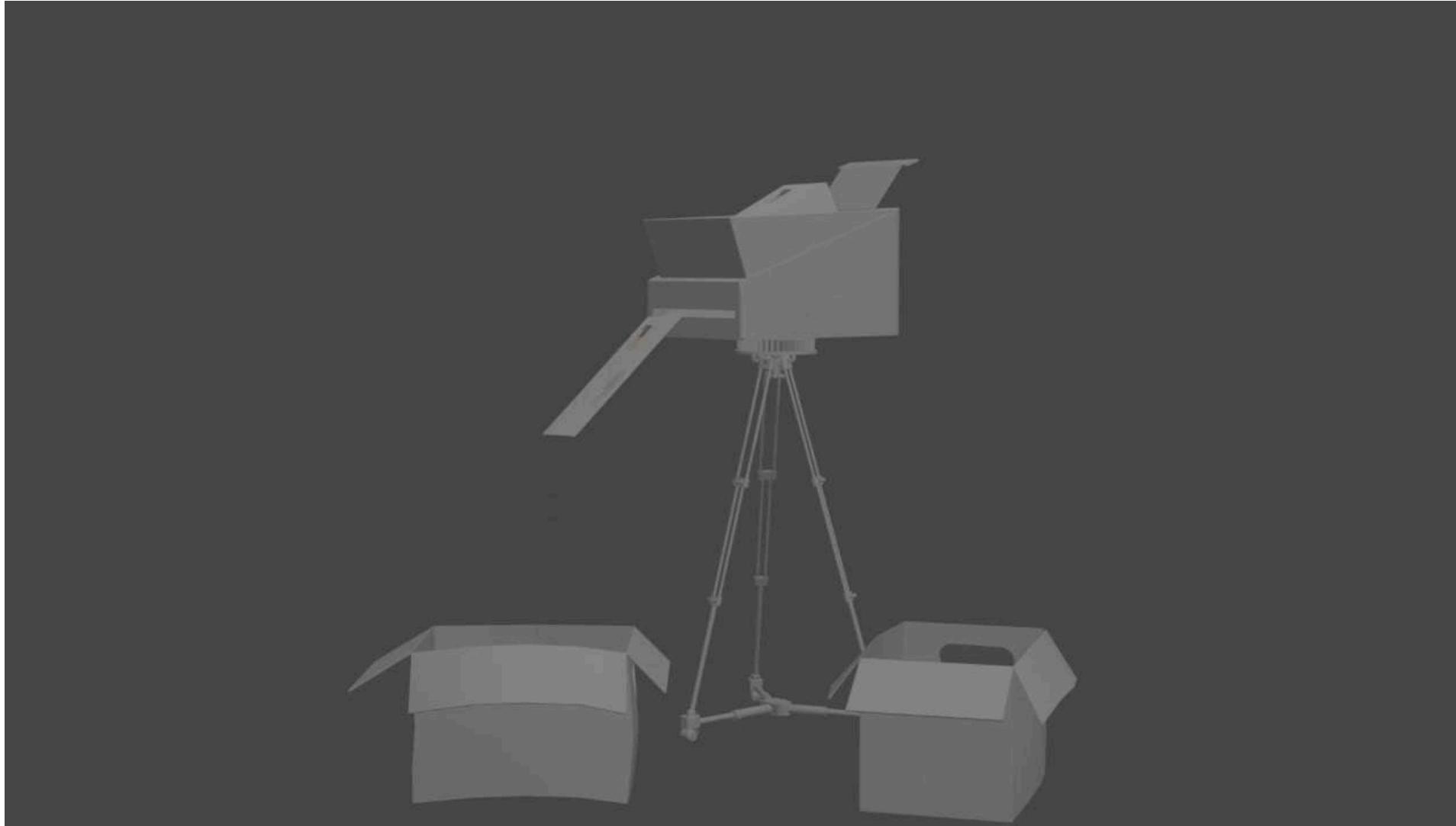
5) Throughput rate:

Throughput in letters per second: $R = \frac{1}{t_{total}} = \frac{1}{4.592} \approx 0.218 \text{ letters/s}$

Throughput per hour: $R_{hour} = 0.218 \times 3600 \approx 785 \text{ letters/hour}$

VIRTUAL SIMULATION

ROTATING HEAD DISTRIBUTER WITH A SCANNING HEAD



- placing all (30) the letters in the loading tray
- ocr recognition through camera on bottom
- authenticate if valid
- dispatch roll it out to the correct tray (10).

30 letters.

Reading the letter

In [100...]

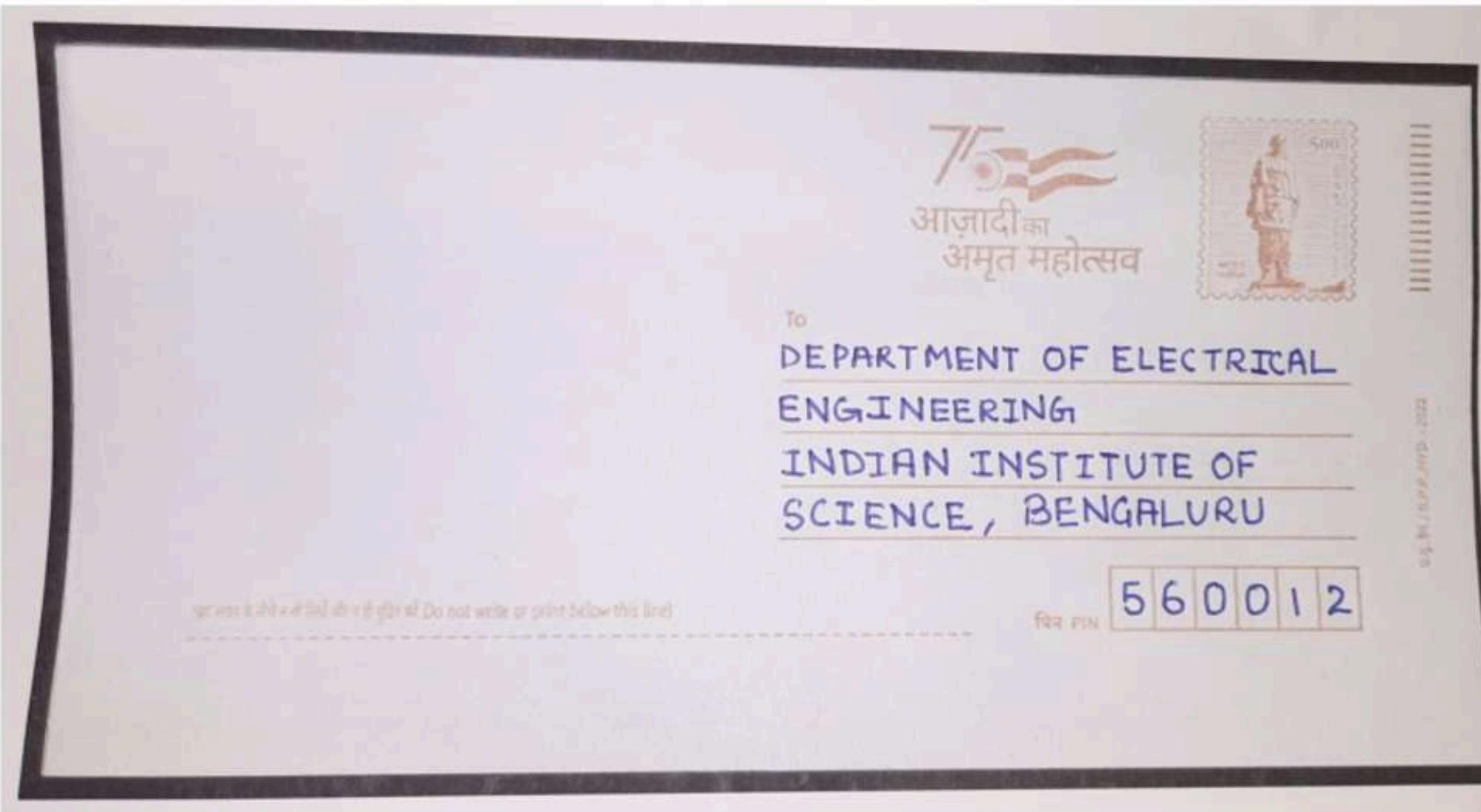
```
# Load the image
image_path = image_path1 # Replace with your image file
image = cv2.imread(image_path)
display_image(image, title="Original Image")

# Step 1: Convert to Grayscale
gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
display_image(gray, title="Grayscale Image")

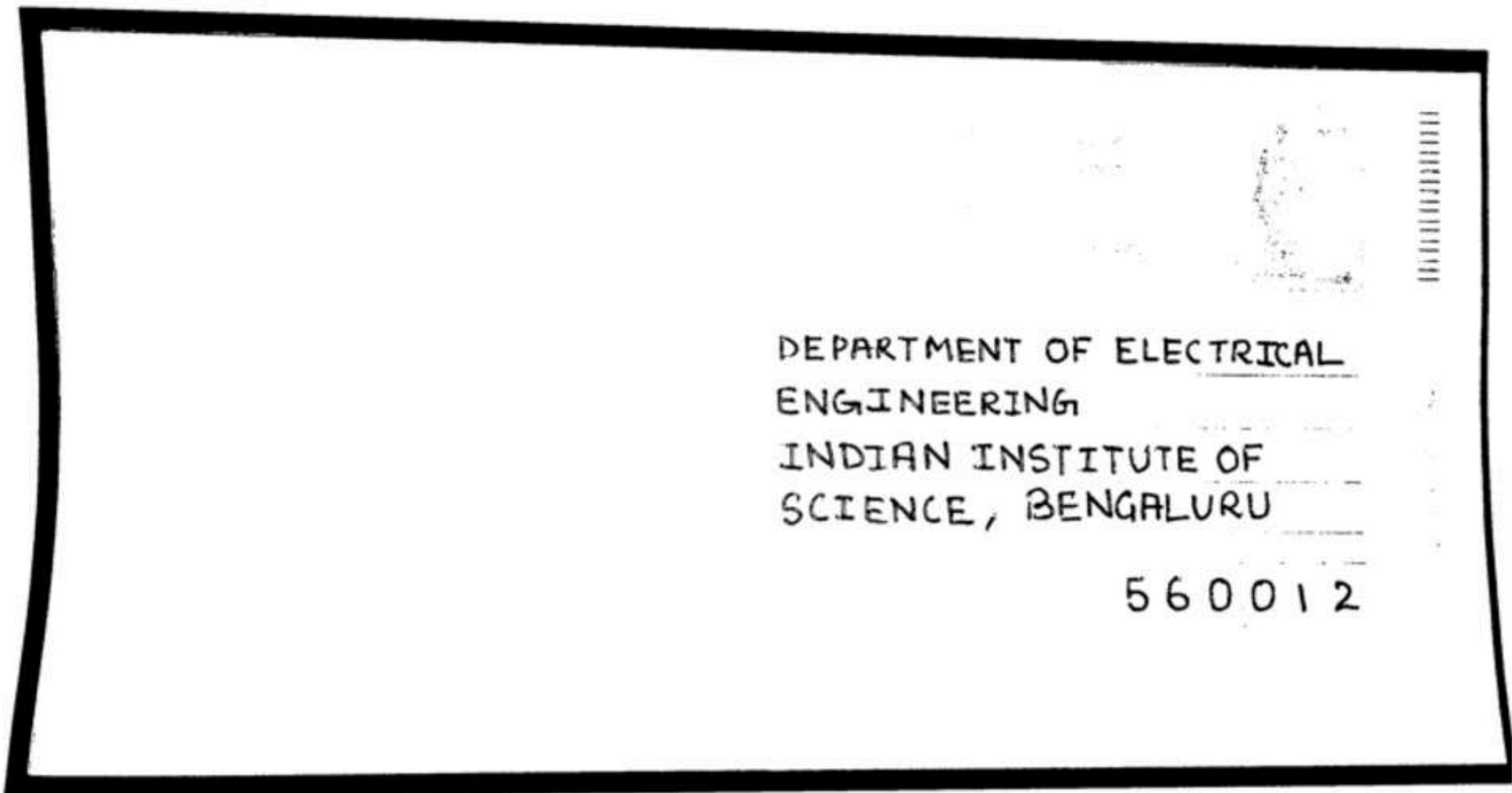
# Step 2: Apply Thresholding
_, binary_image = cv2.threshold(gray, 128, 255, cv2.THRESH_BINARY | cv2.THRESH_OTSU)
display_image(binary_image, title="Binary Image (Thresholded)")

# Step 3: Denoise the Image (Optional)
denoised_image = cv2.medianBlur(binary_image, 3)
display_image(denoised_image, title="Denoised Image")
```

Original Image



Denoised Image



Extracting text

In [103...]

```
# Step 4: Perform OCR
text = pytesseract.image_to_string(gray)
print("Extracted Text:\n")
print(text)
```

Extracted Text:

HET

DEPARTMENT OF ELECTRICAL
ENGINEERING

INDIAN INSTITUTE OF
SCLENCE, BENGRLU RU

Making decision in which color box to put letter / how much to rotate and eject letter

```
def process_paragraph(paragraph):
    # Normalize the paragraph: remove extra newlines and spaces, and convert to lowercase
    normalized_paragraph = ' '.join(paragraph.split()).lower()

    # Define the target strings in lowercase
    targets = {
        "electrical engineering": ("blue", (0, 0, 255), "ROTATE 36 DEGREE AND EJECT THE LETTER"),
        "computational and data sciences": ("green", (0, 255, 0), "ROTATE 72 DEGREE AND EJECT THE LETTER")
    }

    found = False
    for term, (color_name, rgb_color, message) in targets.items():
        if term in normalized_paragraph:
            if color_name == "blue":
                blue = r"C:\Users\91810\Downloads\blue.jpg" # Replace with your image file
                image = cv2.imread(blue)
                display_image(image, title="Put the letter in blue box / ROTATE 36 DEGREE AND EJECT THE LETTER")
                found = True
            if color_name == "green":
                green = r"C:\Users\91810\Downloads\green.jpg" # Replace with your image file
                image = cv2.imread(green)
                display_image(image, title="Put the letter in green box / ROTATE 72 DEGREE AND EJECT THE LETTER")
                found = True

    if not found:
        print("No matching terms found.")

# Example input
paragraph = text

# Call the function
process_paragraph(paragraph)
```

Put the letter in blue box / ROTATE 36 DEGREE AND EJECT THE LETTER



EVALUATION:

OBSERVATIONS BASED ON SIMULATIONS

- Physical simulation helped in detailing out the contents of the conceptual design, in terms of process required, steps to be followed and requirements of the mechanisms.
- Virtual simulation helped in testing out the feasibility of the products through coding and settle on the aesthetic value of final product within constraints.
- Mathematical model helped in comparing the efficiency of the two devices effectively.

FMEA - CONCEPT 1

Process Step	Potential Failure Mode	Potential Failure Effect	Potential Causes	SEV	OCC	RPN	Action Recommended
Camera based scanning of address on mail	FOV insufficient to capture entire address.	Address unable to be captured, scanning halted.	Larger envelope sizes with addresses out of FOV of camera.	7	4	28	Mechanism to adjust FOV of camera. Camera with wider FOV to be utilised.
	Illumination insufficient to capture legible address.	Lot of image noise, leading to illegibility of address.	Camera ISO sensitivity not sufficient for the task.	6	3	18	Provide illumination to the envelope by incorporating a light fixture in the device.
OCR by computer	Illegible address	Address unable to be detected. scanning halted.	Low contrast of text, illegible handwriting, orientation of envelope	6	5	30	Enhance software preprocessing to improve text contrast.
	Processor malfunction		Failure of computer, faulty connection to computer	9	2	18	Ensure reliable connections; use a higher-quality processor.

FMEA - CONCEPT 1

Process Step	Potential Failure Mode	Potential Failure Effect	Potential Causes	SEV	OCC	RPN	Action Recommended
Display of colour code based on destination	LED displays wrong destination colour code.	Unreliable sorting of mail	Improper training of AI model. Hardware malfunction	7	4	28	Improve AI training; test against edge case.
Manual stamping for authentication	Mechanical failure	Unable to authenticate	Wear and Tear of mechanical components	6	2	12	Regular maintenance.
	Illegible mark of authentication	No legible proof of authentication	Insufficient force applied, insufficient ink level.	2	3	6	Monitor ink and pressure.
Manual matching of mail to destination compartments	Mail is sorted to wrong compartment	Erroneous sorting of mail	Human error-fatigue, distractions	7	3	21	Introduce alerts for incorrect sorting.

FMEA - CONCEPT 2

Process Step	Potential Failure Mode	Potential Failure Effect	Potential Causes	SEV	OCC	RPN	Action Recommended
Loading stack of letters to tray	Letters are not oriented facing down	Address side of envelope not available to be scanned	Human error in loading correctly	7	3	21	Add guide system, or automated flipping mechanism with sensors
Digital image scanner based scanning of address on mail	improper orientation of envelope on scanning bed	Address illegibility	Envelope may be displaced from scanning bed due to irregularities in the form/shape of envelope. Improper loading.	8	3	24	Clamp or suction mechanism, alignment rails
OCR by computer	Illegible address	Address unable to be detected. scanning halted.	Low contrast of text, illegible handwriting, orientation of envelope	6	5	30	Enhance software preprocessing to improve text contrast.
	Processor malfunction		Failure of computer, faulty connection to computer	9	2	18	Ensure reliable connections; use a higher-quality processor.
Validating address by comparison with database	False positives, False negatives in validation	Erroneous sorting	Robustness of address database may be insufficient. AI may not be trained sufficiently.	5	2	10	Dynamic database, Regular updation, user feedback

FMEA - CONCEPT 2

Process Step	Potential Failure Mode	Potential Failure Effect	Potential Causes	SEV	OCC	RPN	Action Recommended
Choice of sorting compartment based on destination	Incorrect choice of compartment	Erroneous sorting	Improper training of AI model.	7	4	28	Improve AI training; test against edge case.
	Inadequate number of choices for sorting mail	Inadequate sorting	Space constraints	8	4	32	Introduce more trays.
Orientation of sorting head to correct sorting compartment	Electro-mechanical failure	Erroneous sorting	Servo motor failure, faulty electrical wiring	8	2	16	Regular maintenance, fault detection mechanism
	Calibration of hardware	Mismatched orientation of intended compartment and actual compartment	Sorter gets shifted around without recalibration, accidental shifting.	8	3	24	Periodic calibration, real-time position feedback
Printing of authentication seal on mail	Illegibility of print	No legible proof of authentication	Printerhead malfunction, Printer ink not sufficient.	7	2	14	Add a low-ink detection mechanism; ensure the printer is well-calibrated and serviced periodically to avoid feed issues.
Ejecting the letter out to compartment	Electro-mechanical failure	Mail gets jammed in the ejector.	Faulty mechanical components, roller, motor. Mail too thick to be rolled out.	8	2	16	Ensure chute is designed with adequate tolerances; implement sensors to detect and clear jams automatically.

FMEA - CONCEPT 1

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FMEA - CONCEPT 1

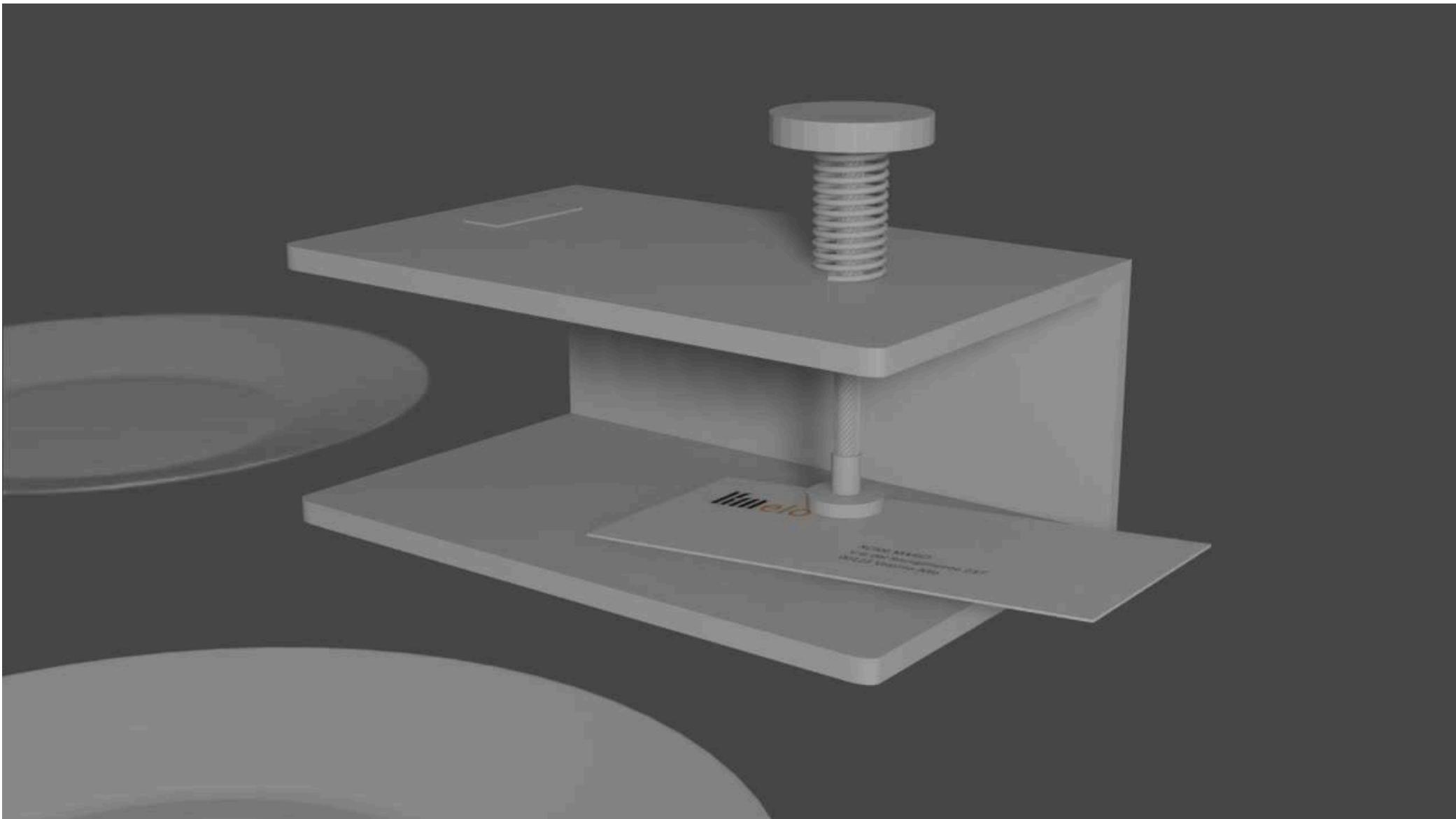
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FMEA - CONCEPT 2

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	Calibration of hardware	Mismatched orientation of intended compartment and actual compartment	Sorter gets shifted around without recalibration, accidental shifting.	8	3	24	Periodic calibration, real-time position feedback
Printing of authentication seal on mail	Illegibility of print	No legible proof of authentication	Printerhead malfunction, Printer ink not sufficient.	7	2	14	Add a low-ink detection mechanism; ensure the printer is well-calibrated and serviced periodically to avoid feed issues.
Ejecting the letter out to compartment	Electro-mechanical failure	Mail gets jammed in the ejector.	Faulty mechanical components, roller, motor. Mail too thick to be rolled out.	8	2	16	Ensure chute is designed with adequate tolerances; implement sensors to detect and clear jams automatically.



CONCEPT 1

OCR Based colour coding and stamping assistant

INNOVATION SITUATION QUESTIONNAIRE

RESOLVING CONTRADICTIONS

USING PRINCIPLES OF TRIZ

UF: OCR has good accuracy in reading the address in standard format

HF: Throughput get reduced

16. Partial or excess actions

Instead of scanning entire address **just scan pincode**

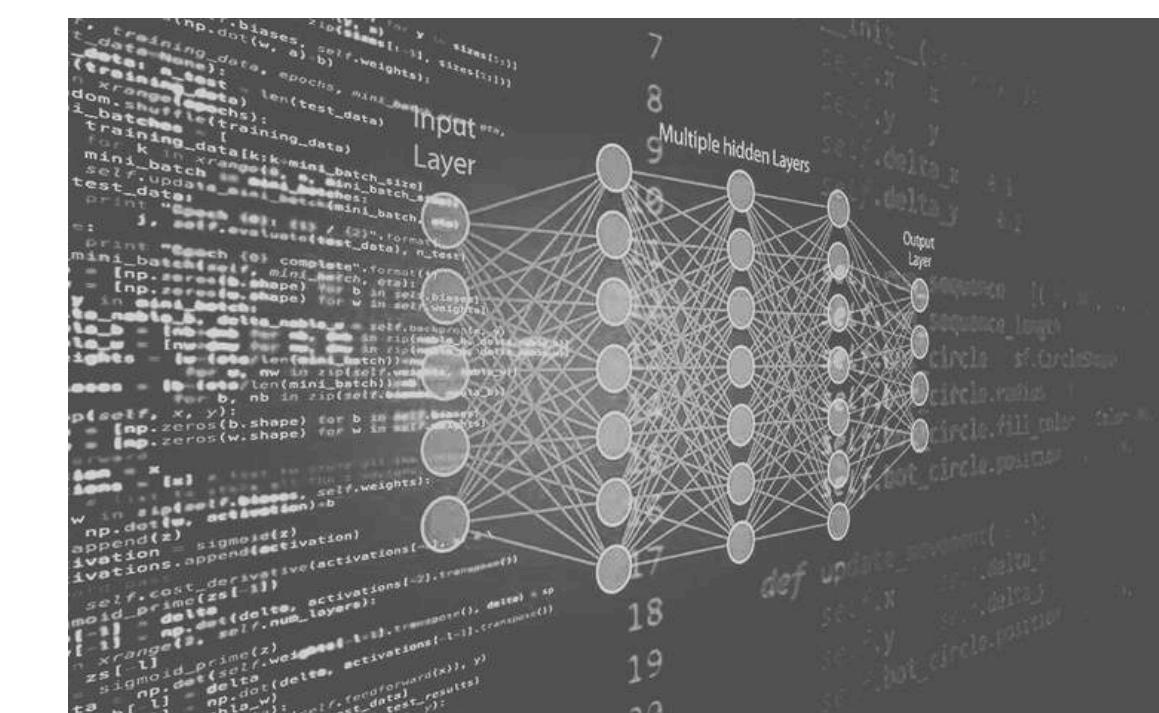
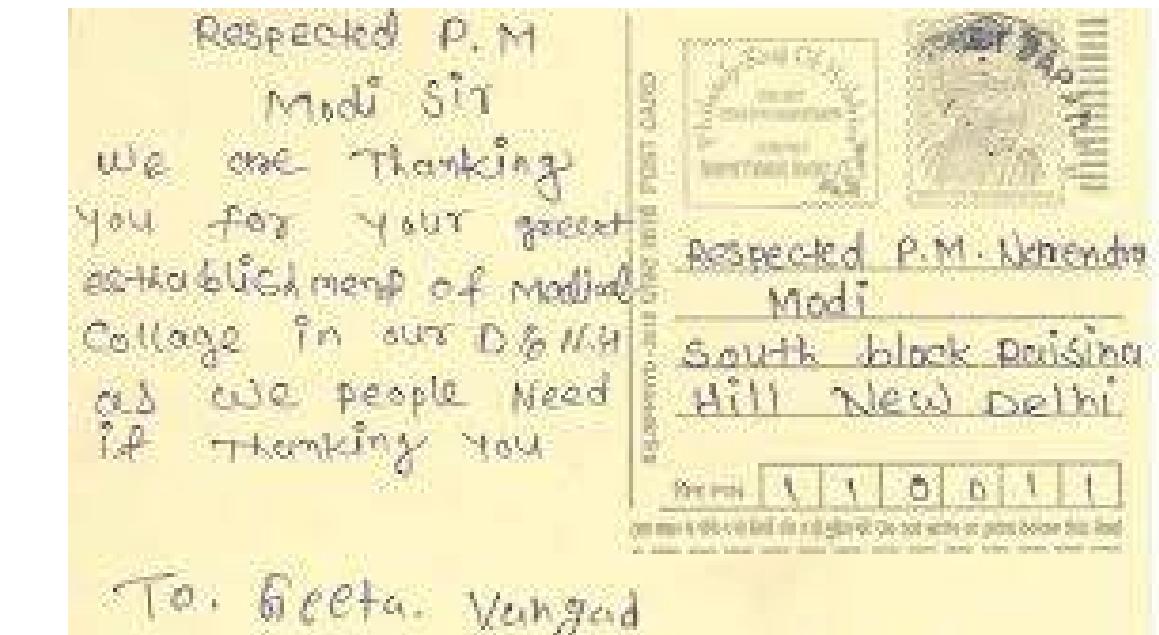
- more accuracy as well as faster processing.

10. Preliminary Action

Pre-process the letters to remove noise and ensure clear visibility of the address - speeds up the text recognition

3. Local Quality

Use specialized OCR : Need to train the ML model for texts of postal letter, for high-accuracy for complex text data.

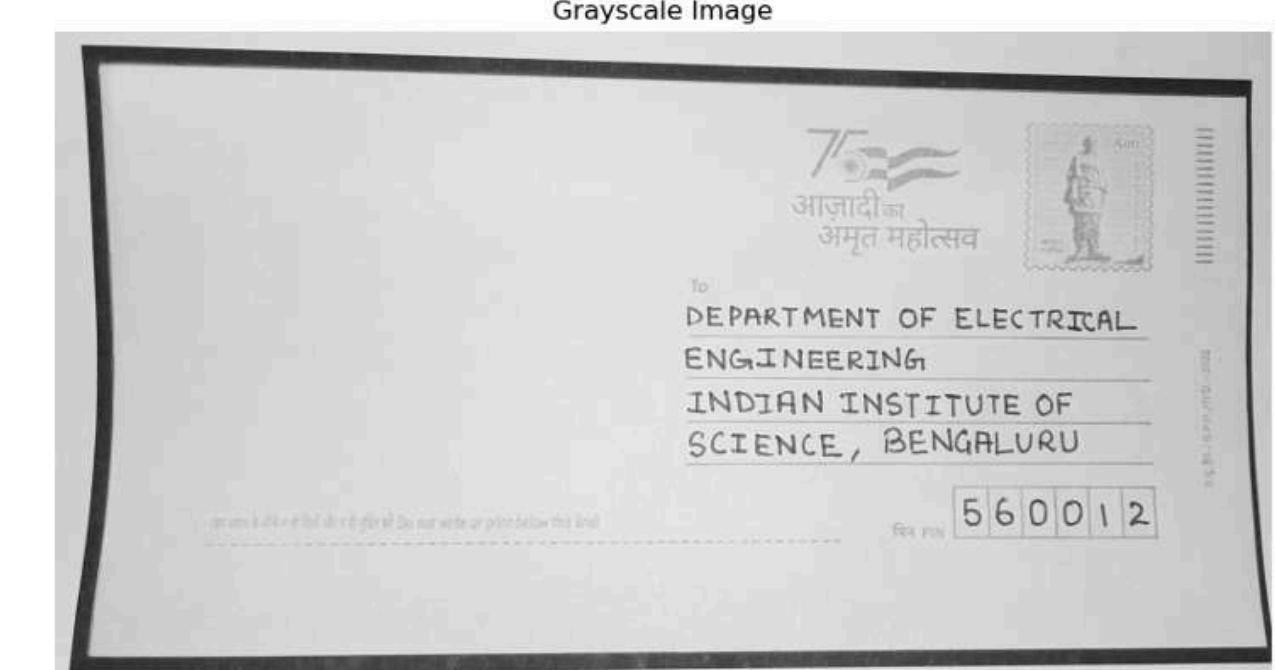
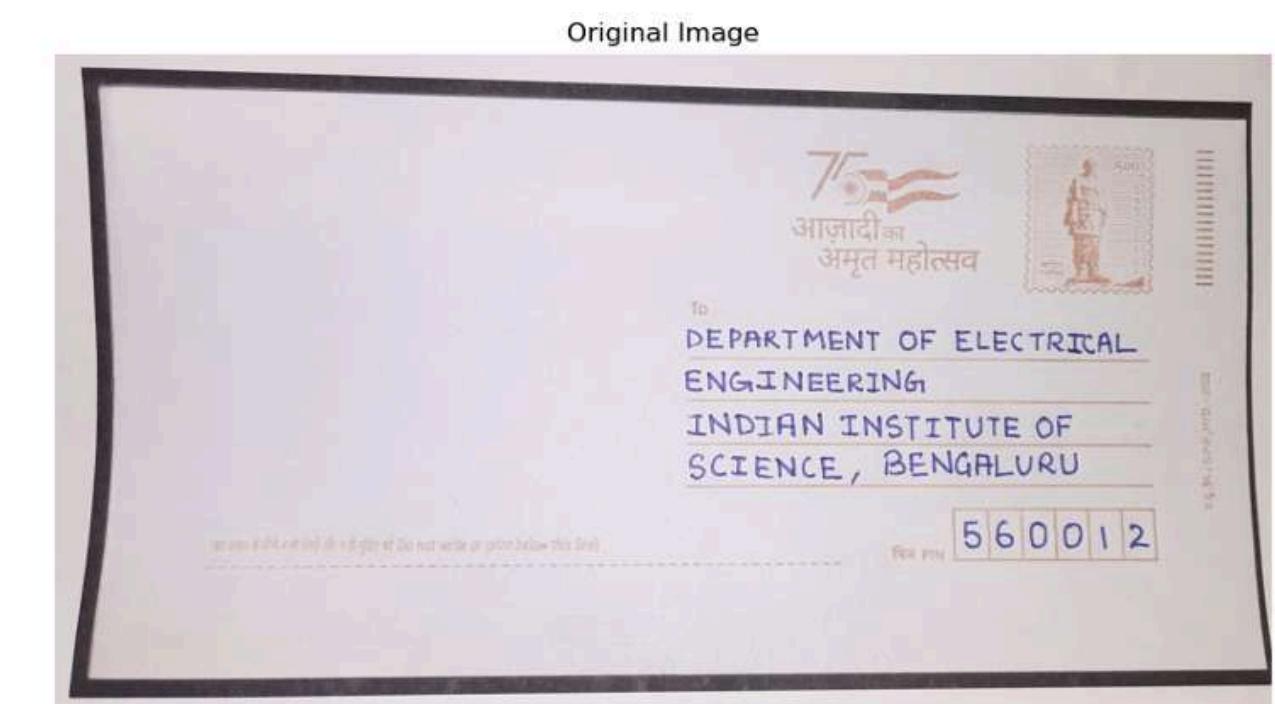
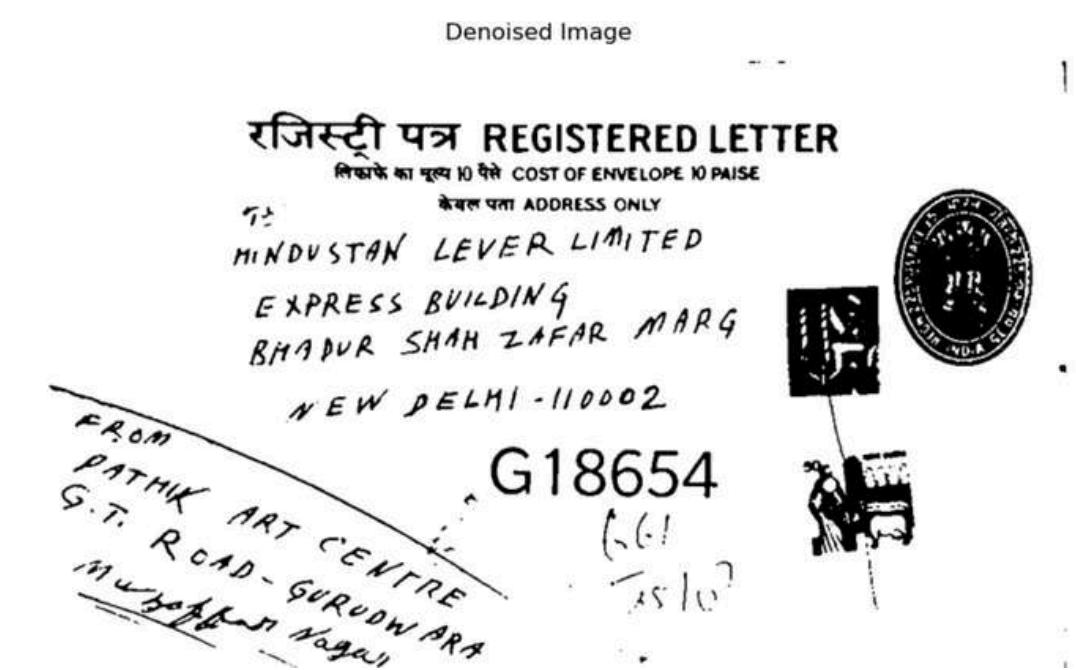


RESOLVING CONTRADICTIONS

USING PRINCIPLES OF TRIZ

Partial action and Preliminary action

- just scan pincode
- Improved pre-processing



EXISTING SYSTEM & ENVIRONMENT

STUDY

Q. Function of system

A. Primary useful function (PUF): Reliable sorting and authentication of mail

Q. Purpose of performing PUF

A. For fast and accurate dispatch of mail to destination

EXISTING SYSTEM & ENVIRONMENT

STUDY

Q. System Functioning- Dynamic state

A.

1. Manual loading of stack of letters to collector tray on sorting head
2. Digital image scanner based scanning of address on mail
3. OCR by computer
4. Validating address by comparison with database
5. Choice of sorting compartment based on destination
6. Orientation of sorting head to correct sorting compartment
7. Printing of authentication seal on mail
8. Ejecting the letter out to matching compartment
9. Mail worker collects the sorted mail

EXISTING SYSTEM & ENVIRONMENT

STUDY

Q. Interaction with supersystem, other systems?

A. Interaction with mail -

1. Mail is fed into the device, scanned and marked with a visible mark, rolled out into correct compartment.
2. Placed on a floor, connected to a computer
3. Plugged to an electrical power source
4. Postal worker interacts with machine by feeding and removing mail.

EXISTING SYSTEM & ENVIRONMENT

STUDY

Q. Natural system surrounding it?

- Clean, dry, well-lit environment,
- Space to access the device, and place the trays
- No audible noise between the sealing device and the envelope while stamping
- Normal ambient temperature and pressure

UNDERSTANDING THE DRAWBACKS

STUDY

Problem to be resolved

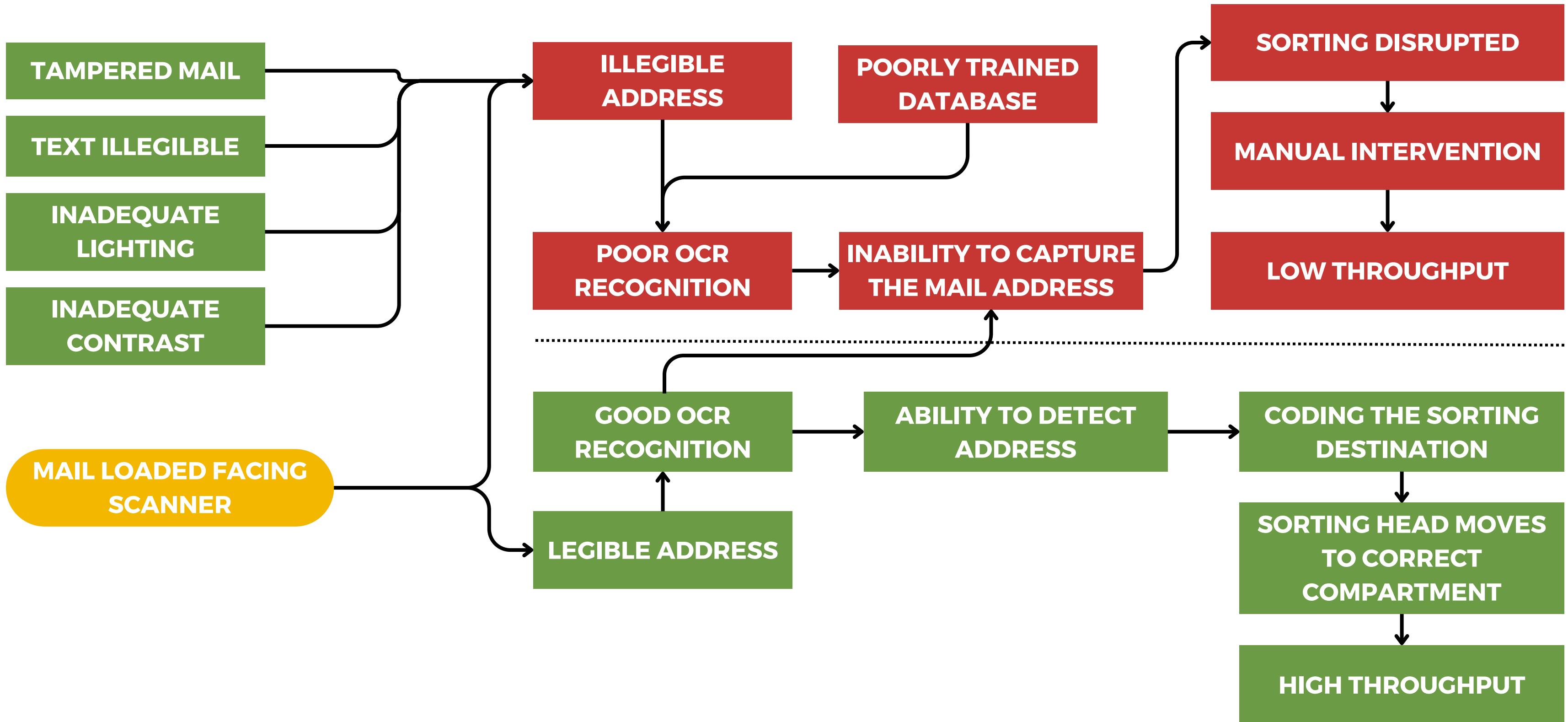
- PHF: Inadequate number of outputs for sorting mail.

Mechanism causing the problem

- Lack of space->Need for compact system->Not enough trays in current state->inadequate sorting choices

INFORMATION ABOUT THE PROBLEM SITUATION

CAUSE - EFFECT ANALYSIS



INFORMATION ABOUT THE PROBLEM SITUATION

H I S T O R Y

Q. Undesired consequences of unresolved problem

A.

- Slower sorting process due to sorting bandwidth (lesser sorting compartments)
- Higher frequency manual intervention required to reload mail.

INFORMATION ABOUT THE PROBLEM SITUATION

H I S T O R Y

Q. Evolution of problem

A.

- The system sorted mail up to eight categories at a time in one place, but to get a higher throughput rate we needed more bandwidth.
- Conventional methods were to increase the space to accommodate more trays, but it needs to be sorted.

INFORMATION ABOUT THE PROBLEM SITUATION

S Y S T E M C H A N G E S

Q. Decisions that changed the system to one with problem

A.

- Decision to have increase the categories to sort the mail into.
- Decision to automate the process of scanning and sorting of mail.

IDEAL VISION OF SOLUTION

The solution is ideally a black box with an input tray and a number of output trays. The black box decides the number of sorting conditions based on the diversity of the mail that is input and sorts into the decided number of sorting trays, and the trays are collected to be put into bags.

RESOURCES AVAILABLE

STUDY

Materials available

- Paper
- Ink
- Inkwell
- Stamp
- Human resource
- Information scanner
- Table
- Collection bag
- Computer system
- Artificial lighting
- Automatic Stamping tool
- Scanner
- Printer
- Rotating head
- Rooler/Motor
- Display for color code

Sources of Energy available

- Chemical Energy between Ink and Paper
- Energy use by man to work
- Energy due to rotation of rotating head distributor
- Energy due to motion of roller
- Electric energy used by the device
- Electromagnetic radiations
- Impact force
 - Important consideration for successful imprint
- Friction

System/Environmental attributes

- The Ink has a tendency to dry on its own
 - The property can be leveraged to assess when it is okay to stack papers over one another
- Time in hand to complete the tasks: 10PM-3PM
- A space of two work tables
 - Usually the reason of mixup or letter losses

CHANGING THE SYSTEM

STUDY

Q. Allowable changes

A.

- Mechanism of printing seal
- Size of the system (within certain limits)
- Level of automation
- Changing software/algorithms
- Scanner, OCR system can be changed
- No. of sorting compartments
- Layout of system components
- Mechanism of interaction with system

CHANGING THE SYSTEM

STUDY

Q. Limitations, what can't be changed?

A.

- Mail has to be sorted by destination.
- Mail must be authenticated for delivery to take place.
- Mail has to be delivered on the date of authentication at the last node (Sub-Post Office)
- Date and location must be authenticated.
- Solution cannot occupy space beyond existing post office solution (retrofitting)

CRITERIA FOR SOLUTION SELECTION

S U C C E S S C R I T E R I A

Desired Technological Characteristics	Desired economic characteristics
<ul style="list-style-type: none">• High accuracy and reliability in stamping, sorting, and authentication.• High level of integration and minimal interference between components.• Scalability and durability for long-term use and increased mail volume.	<ul style="list-style-type: none">• Cost-effective design to keep the system affordable for customers to purchase.• Low operational and maintenance costs for long-term use.
Expected Degree of Novelty	
<ul style="list-style-type: none">• Improvements for refining existing processes.• Balance between cost-effective upgrades and competitive innovation.	

RESOLVING CONTRADICTIONS

U S I N G P R I N C I P L E S O F T R I Z

UF: Increasing number of trays for higher throughput

HF: Solution might not be compact

1. Segmentation

- Break the radial structure into modular components that can be rearranged or stacked vertically. **Introduce tiers of trays** with vertical stacking while keeping the **radial structure** compact.

13. Separation of Spaces:

- Divide the sorting area into zones based on usage frequency. Frequently used trays can remain at hand level, while less used ones are placed in less accessible zones.

25. Self-Service:

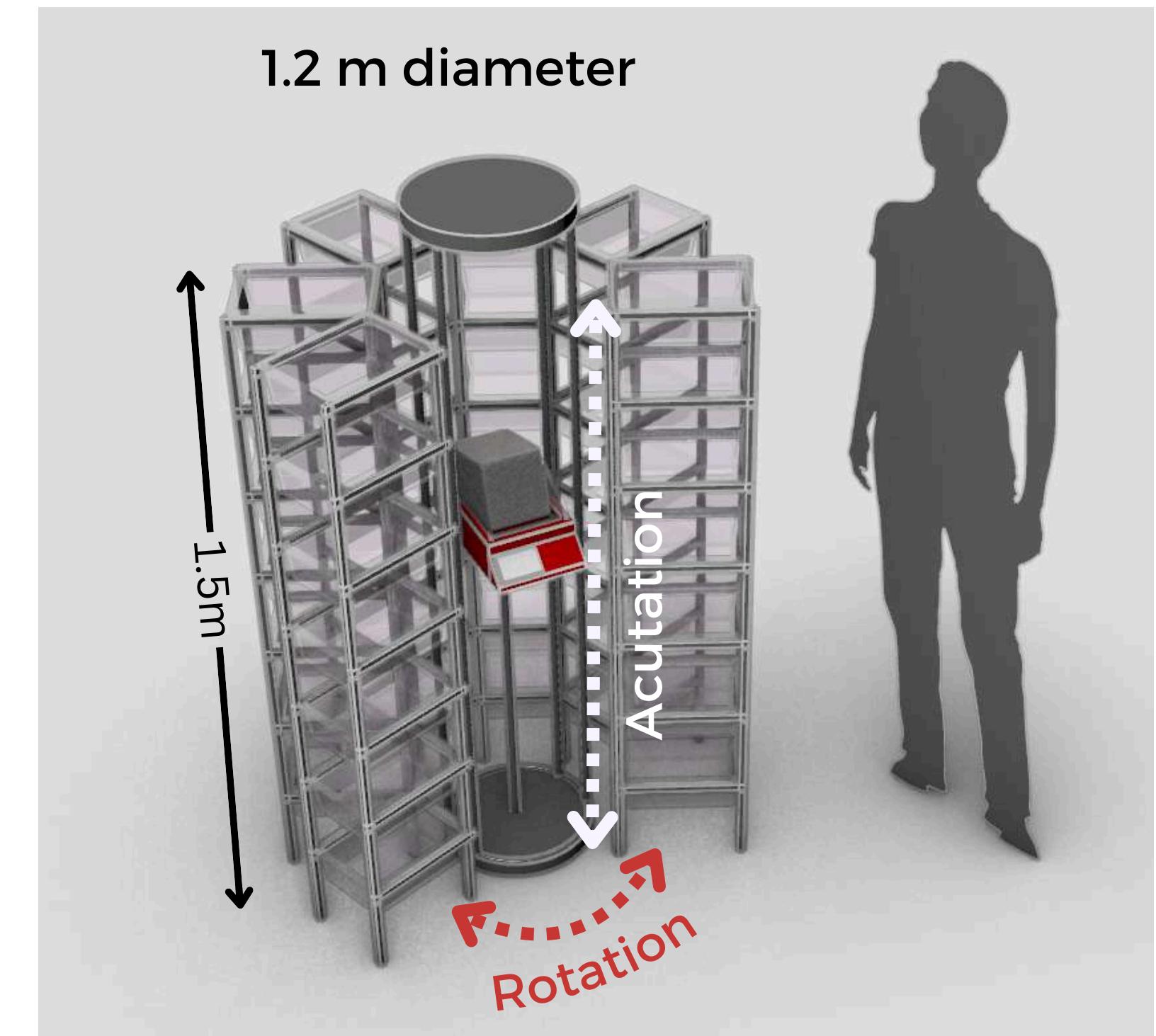
- Implement rotating or carousel mechanisms so trays move to the operator, reducing the need for extra space to access them.

RESOLVING CONTRADICTIONS

USING PRINCIPLES OF TRIZ

Segmentation

- A multi-tiered, **rotating sorter** with **vertically adjustable levels** and subdivided trays.
 - The operator loads mail into a **central feeder**, and the system rotates and dispenses sorted mail into trays by category. Dynamic partitions within trays allow sorting for subcategories.
-
- Multiple levels of trays
 - Adjustable head height of the rotation
 - Compartmentalization
 - More frequent destinations stay low, less frequent high



COMPARISON OF CONCEPTS

	C1 Size of system (cm³)	C2 Throughput (mails/hr)	C3 Manual effort for stamping (J/hr)	C4 Sorting Accuracy (%)	C5 Ink efficiency (imprints/ml)
A1	$20 \times 15 \times 15 = 4500$	400	40	97	300
A2	Machine: 30 X $20 \times 25 = 15000$ System: 120 x $120 \times 150 = 2160000$	650	0	97	185
Target	15000	500	35	98	150

LEXICOGRAPHICAL RULE

ORDINAL METHOD

	C1 Size of system (cm ²)	C2 Throughput (mails/hr)	C3 Manual effort (J/hr)	C4 Sorting Accuracy (%)	C5 Ink efficiency (imprints/ml)
Rank	5	2	3	1	4
A1	1	2	2	1	1
A2	2	1	1	1	2

DATUM METHOD - PUGH MATRIX

ORDINAL METHOD

	C1	C2	C3	C4	C5	SUM OF +	SUM OF -	SUM OF S
A1	+	-	-	S	+	2	2	1
A2	-	+	+	S	-	2	2	1

WEIGHTED OBJECTIVES METHOD

C A R D I N A L M E T H O D

Sr. No.		K1	K2	K3	K4	K5	SUM	Weightage	ki
1	Size of system	0	0.5	0	0	0.5	0.05	5	
2	Throughput	1	0	0	1	2	0.2	20	
3	Manual effort	0.5	1	0	1	2.5	0.25	25	
4	Sorting accuracy	1	1	1	1	4	0.4	40	
5	Ink efficiency	1	0	0	0	1	0.1	10	

WEIGHTED OBJECTIVES METHOD

C A R D I N A L M E T H O D

	C1 Size of system (cm²)	C2 Throughput (mails/hr)	C3 Manual effort (J/hr)	C4 Sorting Accuracy (%)	C5 Ink efficiency (imprints/ml)	
A1	4500	400	40	97	300	
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	C1 Size of system (cm²)	C2 Throughput (mails/hr)	C3 Manual effort (J/hr)	C4 Sorting Accuracy (%)	C5 Ink efficiency (imprints/ml)	SUM
ki	5	20	25	40	10	
A1	9	3	4	4	9	375
A2	5	8	9	4	7	640

SELECTION OF CONCEPT

	Concept 1	Concept 2
Lexicographical	1	1
Datum	1	1
Weighted Objective	2	1

SELECTED DESIGN

C A R D I N A L M E T H O D

