Hackathon Problem Statement

Warehouse-Level Picklist Optimization for High-Throughput Fulfillment

Theme: Operations Research | Scheduling | Algorithms | Data Science

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1. Background & Motivation

Quick-commerce warehouses (dark stores) process **hundreds to thousands of orders per hour** under strict loading schedules. Orders are fulfilled by pickers who collect items from **zones, racks, and bins** using **picklists**.

Key operational challenges:

- Hard loading cutoff times
- High SKU diversity across zones
- Limited picker capacity
- Risk of wasted picking effort

Your task is to design a **Warehouse Picklist Optimization Engine** that decides **how to create and schedule picklists** to maximize fulfillment before loading deadlines.

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2. Problem Statement

You are given a **single warehouse** with the following inputs:

Orders

- Each order has:
    - A list of SKUs and quantities
    - A **loading cutoff time**
- Orders **can be split** into multiple picklists
- **Partial fulfillment is allowed and counted**

SKUs

- Each SKU is stored in a known:

    - Zone
    - Rack
    - Bin
- Each SKU has a unit weight

Pickers

- Pickers have:
    - Shift start and end times
- A picker can work on only one picklist at a time

You have to generate the following as output:

Picklists

- A picklist is a picking task executed by a picker
- A picklist:
    - Must belong to **one zone only**
    - Has limits on:
        - Maximum number of items
        - Maximum total weight

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3. Objective

🎯 **Maximize Effective Fulfillment**

Instead of a binary “order filled / not filled” objective, your goal is to maximize:

Total number of SKU units picked and loaded before cutoff times

This means:

- Partial orders **do count**
- Each SKU unit picked before cutoff contributes value

- Late-picked items contribute **zero value**

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4. Constraints

Your solution must satisfy:

1. Zone Constraint

Each picklist may contain SKUs from **only one warehouse zone**.

2. Picklist Capacity Constraints

- Maximum items per picklist (**2000 units per picklist**)
- Maximum weight per picklist (**200kg**)

3. Cutoff Time Constraint

A picklist (or part of it) contributes value **only if completed before the order's cutoff**.

Late-picked items are considered **wasted effort**.

4. Splitting Constraint

- Orders may be split into multiple picklists
- Each SKU unit must be assigned to exactly one picklist

5. Picker Constraints

- Picklists must lie within picker shift windows
- No overlapping assignments per picker

6. Fragile Constraints

- All Fragile items must be in special picklists with less limit (50Kg)

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5. Time Inputs

1. Starting Point to Zone = 2min
2. Intra zone travel time - bin to bin (30 sec)
3. SKU quantity pickup time - 5 sec per unit
4. *Unloading Time at Staging Area* = 30 sec per order
5. *Zone to Staging Area* = 2 min

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6. Example Scenario

Warehouse Order O1

- Cutoff: 10:30 AM
- SKUs:
    - Milk (Zone A): 3 units
    - Bread (Zone A): 2 units
    - Chips (Zone B): 1 unit

Execution

- Picklist 1 (Zone A): Milk + Bread → finishes at 10:10
- Picklist 2 (Zone B): Chips → finishes at 10:35

Outcome

- Milk + Bread units count toward fulfillment
- Chips unit is not loaded and contributes zero

Partial fulfillment **still creates value**.

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8. Evaluation Metrics

Solutions will be evaluated on:

1. **Total units successfully picked before cutoff (Primary)**
2. **Number of Completed Orders (Secondary)**
3. Wasted picking effort (late picklists)
4. Picker utilization
5. Scalability and runtime

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9. Deliverables

Teams should submit: {Submit Solution To Aarav Nigam}

- Problem understanding & assumptions

- Algorithm / strategy
- Implementation or simulation Code
- Results on sample data
- Key insights and trade-offs

💡 Bonus Extension

- Priority SKUs [Picklist with High Order Priority Should be Picked First

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Optimize under deadlines. Think like an operations engineer. Good luck! 🚀

Output Format to Match

`{date}_{Picklist_no}.csv`

`Output Columns`
`SKU`
`Store`
`Bin`
`Bin Rank`

Summary.csv

Output Column	Meaning
Picklist_date	Date of Picklist
picklist_no	Assigned picklist number
picklist_type	bulk / multi order / fragile etc.

stores_in_picklist	All stores included (comma separated)

Important Notes

1) POD is same as Store
2) Bulk Picklist are picklists where all items are same SKUs
3) Multi Order Picklist are picklists where different SKUs are also there
4) Fragile Picklists are picklists with Fragile Items.
5) The metric `Pods_per_picklist_in_that_zone` is a crucial feature. It indicates the number of distinct store orders that may be included within a single picklist for the specified zone.

Input Data

Order Data:
https://drive.google.com/file/d/1odmG9IXsWJYWHeU69MlSiC6U0YMdzILC/view?usp=drive_link

Dataset Columns Provided

Column Name	Description
dt	Date of Order
location_code	Warehouse Location
order_id	Order ID (each order to tagged to a store)
sku	Item ID
order_qty	Quantity
zone	Warehouse Zone
bin_rank	Numeric rank of bin location
order_tag	Normal/ Others

store_id	Store to which order to be sent
floor	Warehouse Floor
rack	Warehouse Rack
aisle	Warehouse Aisle
pods_per_picklist_in_that_zone	No. of Orders one can pick in a single Zone (due to cart size constraints)
Length	Length of item in cm
Width	Width of item in cm
Height	Height of item in cm
Weight	Weight
pod_priority	This can be used to prioritize the group for picking basis the order p1 > p2> p3

Picking Starts at 9PM Everyday

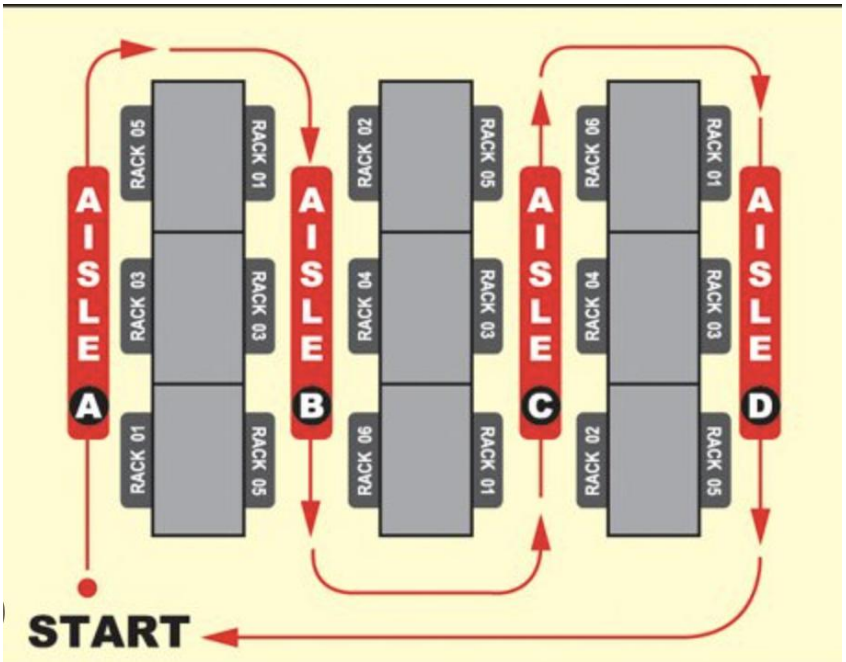
Pod Priority	Cutoff Time
P1	11:30 PM
P2	02:00 AM
P3	04:00 AM

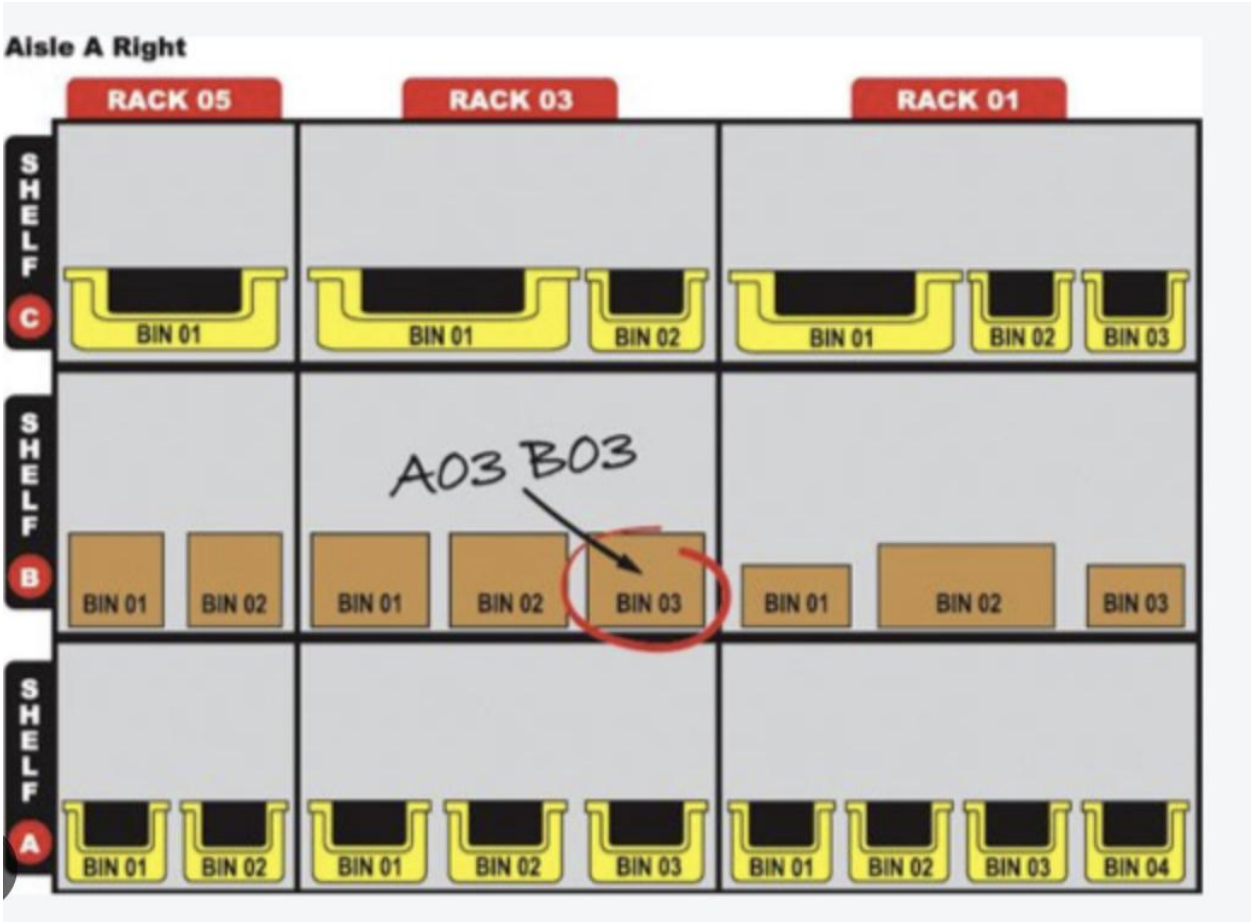
P4	06:00 AM
P5	07:00 AM
P6	09:00 AM
P9	11:00 AM

Pickers Shifts

Shift Name	Shift Time	Number of Pickers (in this shift)
Morning Shift	08:00 AM - 05:00PM	40
General Shift	10:00 AM - 07:00 PM	30
Night Shift 1	08:00 PM - 05:00 AM	45
Night Shift 2	09:00 PM - 07:00 AM	35

Images for Better Visualization




Aisle A Right
RACK 05
RACK 03
RACK 01
SHELF C
SHELF B
SHELF A
BIN 01
BIN 02
BIN 03
BIN 04
A03 B03