ISyE 6202 Exam 2 SOLUTIONS

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Instructions: To receive credit, your work must be justified, legible, and comprehensible. You will be graded on the quality of your answer: does it convey understanding?

sku	Picks	Flow
A	80	12.0
B	90	7.9
C	75	6.0
D	85	7.0

Table 1: Questions 1–3 refer to these skus, which are candidates for storage in a forward piece-pick area for small parts. (Picks are given in person-minutes and flows have been scaled as a fraction of the volume available in the forward pick area.) Assume that savings per pick from the forward pick area is 1 person-minute and a restock averages 3 person-minutes.

Question 1 (20 pts)**.** *Forward pick area for small parts*

Consider the skus of Table 1. Under allocations that minimize restocks:

A (5 pts). Rank the skus in order of priority for storage in the forward pick area.

Solution Compute the labor efficiency of each sku as $p_i/\sqrt{f_i}$, and sort from largest value to smallest:

sku	Labor efficiency
D	32.13
B	32.02
C	30.62
A	23.09

B (5 pts). If all four skus were stored in the forward pick area, which would be allocated the least space?

Solution Sku C would be allocated the least space because it has the least flow and therefore the smallest value of $\sqrt{\text{flow}}$.

C (5 pts). If all four skus were stored in the forward pick area, which would have the greatest pick density (picks per volume of space allocated)?

Solution Sku D: Pick density is

$$\frac{p_i}{\sqrt{f_i}/\sum\sqrt{f_j}}$$

, which is proportional to labor efficiency.

D (5 pts). Which skus should be stored in the forward pick area to maximize net benefit?

Solution Search down the list of skus to identify where net benefit is largest:

Skus	Pick savings	Restock cost	Net benefit
Φ	0.0	0.0	0.00
$\{D\}$	85.0	21.0	64.00
$\{D, B\}$	175.0	89.32	85.68
$\{D, B, C\}$	250.0	187.51	62.49

We can stop as soon as we see the total net benefit decreasing, so the solution is to store skus B and D.

Question 2 (20 pts)**.** *Forward pick area for small parts*

Consider again the set of skus described in Table 1. Under Equal Space allocations:

A (5 pts). Rank the skus in order of priority for storage in the forward pick area.

Solution There is no *a priori* ranking; the bang-for-buck of each sku depends on how many skus are to be stored in the forward pick area.

B (5 pts). If all four skus were stored in the forward pick area, which would be allocated the least space?

Solution All would be allocated the same space.

C (5 pts). If all four skus were stored in the forward pick area, which would have the greatest pick density (picks per volume of space allocated)?

Solution Sku B would have the greatest pick density $p_i/(1/4)$ because it has the most picks.

D (5 pts). Which skus should be stored in the forward pick area to maximize net benefit?

Solution Search down the list of skus to identify where net benefit is largest:

Skus	**Pick savings**	**Restock cost**	**Net benefit**
Φ	0.0	0.0	0.00
$\{B\}$	90.0	23.7	66.30
$\{D, B\}$	175.0	89.4	85.60
$\{D, B, C\}$	250.0	188.7	61.26

We can stop as soon as we see the total net benefit decreasing, so the solution is to store skus B and D.

Question 3 (20 pts)**.** *Still more on picking small parts from a forward pick area*

Consider again the set of skus described in Table 1. Assume that you have already decided to stock the forward pick area with Equal Time allocations.

A (5 pts). If all four skus were stored in the forward pick area, which would be allocated the least space?

Solution Sku C would be allocated the least space because it has the least flow.

B (5 pts). If all four skus were stored in the forward pick area, which would have the greatest pick density (picks per volume of space allocated)?

Solution In this case pick-density would be

$$\frac{p_i}{f_i / \sum f_j}$$

and so is proportional to p_i / f_i. Sku C has the largest such value.

C (5 pts). What is the labor-minimizing subset to store in the forward pick area managed by the EQT strategy?

Solution Equal Space allocations can be converted to Equal Time allocations with exactly the same total net benefit: If we use the same set of skus, the pick savings will be the same; and we proved in class that they require the same total restocks and so the total restocking costs will be unchanged and so the total net benefit will be the same. Therefore we need only use the solution we computed for Equal Space allocations, skus B and D.

D (5 pts). How much space should be allocated to each under the labor-minimizing EQT strategy?

Solution Sku D should be allocated $f_D / (f_D + f_B) \approx 0.47$ of the forward pick area and sku B should be allocated the remaining 0.53 of the space.

Question 4 (25 points)**.** *Pick-path optimization; inventory accuracy; benchmarking*

A (5 pts). Is pick-path optimization likely to be useful in Walgreens DC? Why or why not?

Solution No. Travel is so highly constrained that there is little choice about where to go next in the AKL area. The carousel area requires no travel because tubs are brought to the order-pickers; and the case-picking visits so many locations as to visit almost every aisle.

B (5 pts). What is there about the Traveling Salesman Problem (TSP) in a warehouse that makes it efficiently solvable, unlike the general TSP?

Solution There are only a few patterns of travel at the ends of each aisle that could be part of a shortest path. This number is independent of the number of locations to be visited. And the structure of the aisles is recursive (repeating), which allows the efficient (short) paths to be enumerated quickly.

C (5 pts). Give three reasons why inventory accuracy is important.

Solution

- To have accurate records for tax purposes.
- To provide good service to customers.
- To avoid the operational costs of unexpected stockouts.

D (5 pts). What are three problems in cycle-counting based on an ABC classification?

Solution

- It can be difficult to schedule.
- It can require extra work, such as when counting a sku at the start of its inventory cycle.
- It can require work to little effect, such as when counting far in advance of reordering and so far in advance of the time when physical inventory can be adjusted.

E (5 pts). Critique the two main assumptions we made to justify the construction of a synthetic warehouse with which to compare to the warehouse in question.

Solution First we assumed that the inputs and outputs of a warehouse could be meaningfully scaled. This is reasonable for some things, such as workforce or storage rack; but it become questionable for purchases such as a WMS, which does not scale.

The second assumption was that we could blend warehouses, smoothly altering the mix of inputs and outputs, which assumes that some inputs can be substituted for others at a constant exchange rate.

Question 5 (20 pts)**.** *Project*

A (5 pts). How many cranes per aisle does Walgreens use in its AS/RS? Why this number?

Solution Two, to provide redundancy: If there was only one and it broke then nothing could be picked from this aisle and stores would not be replenished for another week.

B (5 pts). What stocking policy would help reduce the number of restocks required to the AKL area of Walgreens? Explain.

Solution None of the stocking policies affect the number of restocks required, because at Walgreens restocking is a unit-load process.

C (5 pts). What is the current pick rate in the Walgreens AKL area? Choose the best answer:

1. *About 10 picks per person-hour*
2. *About 50 picks per person-hour*
3. *About 100 picks per person-hour*
4. *About 200 picks per person-hour*
5. *About 400 picks per person-hour*
6. *About 600 picks per person-hour*

Solution Choice 4 is closest: About 200 picks per person-hour.

D (5 pts). Explain how product is stored in the Walgreens AKL area. How exactly is it organized? (For example, by popularity? By affinity? By something else?) What is the reason for this organization?

Solution Product is stored by product family to speed put-away in the retail store.