ICA 18: Handling Cost Estimation

ISE 453: Design of PLS Systems — Spring 2020

1. A warehouse is being designed that will have a rectangular shape with a single I/O point located along its perimeter. Randomized block stacking will be used to store 4,800 different SKUs, each unit of which will be stacked six-high on identical 36 × 40 × 48 in. two-way pallets along 8-ft-wide down aisles. The inventory levels of the SKUs are uncorrelated and are stored and retrieved at a constant rate. The average maximum inventory level of each SKU is two hundred and fifty units, and the area used for cross aisles, etc., will equal 15% of the storage area. Assuming all of the S/R operations are single command, determine the expected distance traveled for each operation.

Lane/unit-load width	x	3.3333333	ft
Unit-load depth	y	3	ft
Unit-load height	z	4	ft
No. different items	N	4,800	
Down aisle width	A	8	ft
No. levels for stacking	H	6	
Avg max inv per item	M_i	250	
Est. max no. total units	M	600,000	= FLOOR(N*(M_i/2)+0.5,1)
Optimal lane depth	D^*	7	
Number of lanes	L	16,629	
Total area (2-D)	TA	1,385,750	ft^2
Cross aisle percentage		15%	
Total WH area (2-D)	TA'	1,593,613	ft^2
sqrt(2)*TA'	d_{SC}	1,785.28	ft

2. A new warehouse is being designed to store 3,000 different SKUs. At its peak during the year, the warehouse will hold 50,000 loads. Randomized block stacking will be used to store 36 × 36 × 36 in. pallet loads, and all of the slots in the warehouse are equally likely to be used. The pallets can be stacked six-high along 8-foot-wide down aisles. The warehouse will have a rectangular shape with a single I/O point located along its perimeter.

   (a) Determine the minimum total 2-D area need for the warehouse, assuming that the area required for cross aisles, offices, and shipping/receiving docks equals 15% of the total storage area.

   (b) Narrow-aisle reach trucks (NARs) will be used for all storage and retrieval operations truck (operator rides on truck). Loading or unloading each will require 30 seconds. Assuming all of the S/R operations are single command, determine the expected time required for each operation.

(c) If there are 250 eight-hour shifts per year and the fully burdened labor rate of a truck operator is $12.00 per hour, determine the total annual labor costs assuming an expected annual demand of 500,000 single-command moves and that the operators can perform other productive tasks when not operating a truck.

(d) If there should be enough trucks to handle a peak demand that is 50% greater than the average demand and if each NAR has an investment cost of $25,000 and will have a salvage value equal to 25% of its original cost at the end of 10 years, determine the total annual NAR cost assuming that the annual real cost of capital is 10%.

Lane/unit-load width	x	3	ft	
Unit-load depth	y	3	ft	
Unit-load height	z	3	ft	
No. different items	N	3,000		
Down aisle width	A	8	ft	
No. levels for stacking	H	6		
Est. max no. total units	M	50,000		
Optimal lane depth	D^*	3		
Number of lanes	L	4,195		
Total area (2-D)	TA	163,605	ft^2	
Item area (2-D)		75,006	ft^2	
Cube utilization (2-D)		46%		
Cross aisle percentage		15%		
Total WH area (2-D)		188,146	ft^2	(a)
	d_{SC}	613.43	ft	
	t_{LU}	0.50	min	
	t_e	2.00	min/mov	(b)
		0.03	hr/mov	
Annual demand		500,000	SC mov/yr	
Labor rate		12	$/hr	
Labor cost		199,582	$/yr	(c)
Peak demand	r_a^{peak}	375	mov/hr	
No. trucks	m	13		
Cost of Capital	(r)	10%		
Economic Life	(N, yr)	10		
Investment Cost	(IV, $)	25,000		
Salvage Percentage		25%		
Salvage Value	(SV, $)	6,250		
Eff. Investment Cost	(IV^{eff}, $)	22,590		
Cost Cap Recovery	(K_{tr}, $/yr)	3,676.48		
Total Vehicle Cost	(mK_{tr}, $/yr)	47,794.19		(d)