Simulation Modeling of a Warehouse Operation

Department of Industrial & Systems Engineering, IE 3100, System Design Project

Wyeth

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Summary

Wyeth (Singapore) has forecasted a projected increase in demand in the near future and wants to assess the current warehouse operation to better utilize their existing infrastructure. With the increased demand, operational deficiencies such as insufficient resources to facilitate the movement of materials within the warehouse will certainly surface. However the solution may not be as simple as adding more resources to handle the increased demand for there is a lot of interdependencies between the processes in the warehouse.

Starting from the current production capacity of 85 million pounds, the production capacity by will be progressively increased by 10 million pounds. Thereafter, for each increase, recommendations will be made for every bottleneck identified in the system.

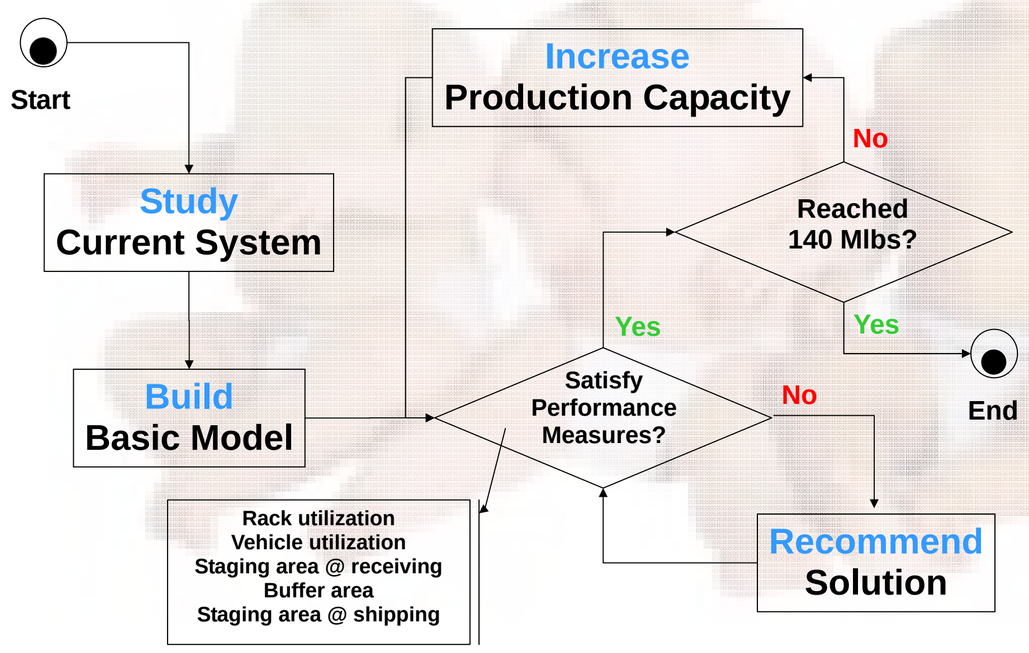
Problem Definition

With the projected increase demand to 140 million pounds of milk formula a year, process deficiencies within the warehouse operation could potentially impede its capability to meet the forecasted demand.

Objective

To study the impacts of increased demand on current internal environment (warehouse) and to propose recommendations to ameliorate possible bottlenecks associated with the increased demand.

Methods and Approach



Performance Measures

Rack Utilization – If the dwelling times of the materials are to be similar to the basic model, the rack utilization of the materials will increase with the increased output capacity. Rack utilization enables us to see the capability of the current racks to accommodate all the materials, and also justify the number of additional racks for the additional materials.

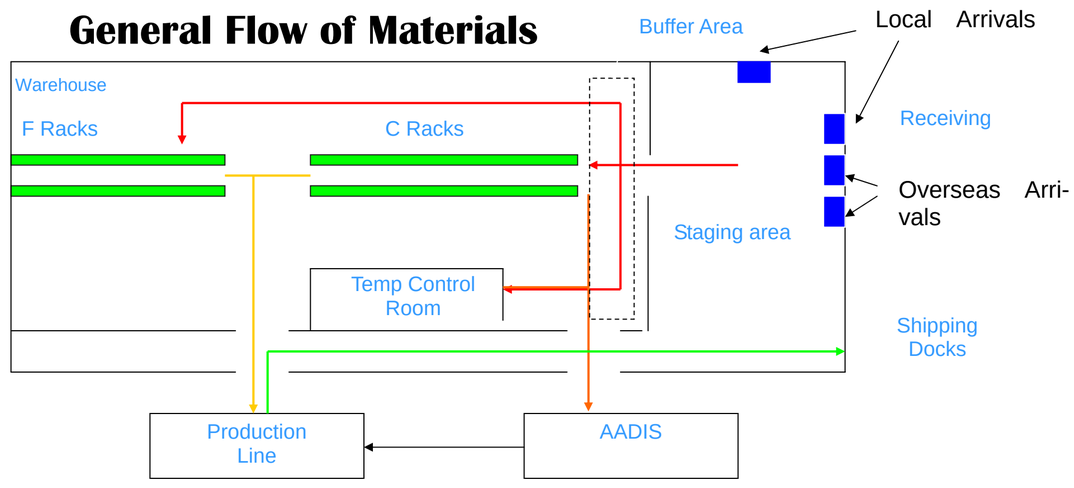
Utilization of vehicles – With the projected increase in production capacity, we expect the vehicle utilization to increase as well. Monitoring this would help us identify when the number of vehicles becomes a bottleneck in the system.

Probability of Receiving area with more than 50 pallets – If the probability is more than 20%, it would suggest that there is considerable congestion at the receiving area. Hence improvement is desired, and this can be improved by adding more RCs or adding more space by opening up docks.

Probability of Buffer area with more than 80 pallets— If the probability is more than 20%, it would suggest considerable congestion at the buffer area. This is probably due to TSP not putting away pallets fast enough. And this can be improved by adding TSPs.

Average maximum number of pallets at shipping dock— the maximum number of pallets at shipping docks occurs at the beginning of the day because the trucks need to go to external warehouse to unload the goods. The average maximum number of pallets at shipping dock exceeding 80 indicates the seriousness of congestion at the beginning of each day. This can be improved by assigning a night driver to prevent the build up of finished goods overnight or by opening up docks to accommodate all of them.

Current Situation



Vehicle Allocation

0730 to 1930	1930 to 2345	2345 to 0730
4 RC allocated to receiving	No receiving at night (5 RCs working)	No receiving at night (3 RCs working)
1 RC for transporting FG	At least 1 RC for transporting FG	1 RC for transporting FG
3 RC for issuing	2 RCs for issuing	1 RC for issuing
4 TSPs in C racks, 2 TSP in F racks, each takes care of 4 racks	2 – 3 TSPs whose priorities are issuing	1 TSP whose priority is issuing

Note: RCs refer to the fork-lifts which moves pallets of raw materials from staging area to the warehouse, and from the warehouse to AADIS and production lines.
TSPs move pallets within warehouse, from the Put-drop area to racks and vice versa

Model Output Analysis

Operation Efficiency	85 Mlb	95 Mlb	105 Mlb	105 Mlb (sol)	115 Mlb	115 Mlb (sol)	125 Mlb	125 Mlb (sol)	140 Mlb	140 Mlb (sol1)	140 Mlb (new dock)
RC Utilization	52.58%	58.87%	65.95%	53.52%	55.59%	55.74%	63.89%	57.96%	61.96%	62.60%	64.97%
TSP Utilization	50.15%	53.49%	60.38%	61.14%	72.17%	62.48%	66.63%	58.36%	69.03%	56.11%	55.96%
% Put away	100.0%	100.0%	98.26%	100.0%	100.0%	100.0%	100.0%	100.0%	98.98%	100.0%	100.0%
% Issued	100.0%	98.17%	98.14%	96.29%	97.91%	97.90%	98.32%	97.86%	98.86%	98.86%	97.71%
Probability of receiving staging exceeds 50	1.60%	7%	25%	10%	18.60%	17.80%	34.40%	16.80%	35.30%	18.20%	0.00%
Probability of buffer exceeds 80	0.00%	0.20%	3.90%	6.10%	27.40%	3.93%	13.90%	17.10%	53.70%	18.50%	4.14%
ave. max # of pallets at shipping area	27.49	45.06	64.73	64.73	85.06	85.06	105.84	105.84	137.03	137.03	137.03
RM rack utilization	65.79%	73.53%	79.86%	81.28%	89.02%	89.02%	96.76%	96.76%	108.34%	108.37%	108.37%
cans & packaging rack utilization	76.58%	85.58%	92.95%	94.59%	103.60%	103.60%	112.61%	112.61%	126.09%	126.13%	126.13%

Conclusion

Model #	Output capacity (million pounds)	Additional RCs	Additional TSPs	Additional wrapper	New docks
1	85	0	0	0	0
2	95	0	0	0	0
3	105	0	0	0	0
3 solution	105	RC_receiving	0	0	0
4	115	RC_receiving	0	0	0
4 solution	115	RC_receiving	TSP_can	0	0
5	125	RC_receiving	TSP_can	0	0
5 solution	125	2 RC_receiving	TSP_can & TSP_packaging	0	0
6	140	2 RC_receiving	TSP_can & TSP_packaging	0	0
6 solution	140	2 RC_receiving	TSP_can &TSP_packaging &TSP_refer	1	0
6 solution with new docks	140	2 RC_receiving	TSP_can &TSP_packaging &TSP_refer	1	1

For this study, at each increment of 10 million pounds in production capacity, we analyzed the performance measures, identified bottlenecks, proposed solutions and implemented the solutions. As such, Wyeth would be able to gauge at which point they would need to increase their resources, their racking capacities or their staging area capacities.

From our analysis, we note that we can address any bottlenecks by a combination of increasing vehicles, increasing wrappers, increasing racking capacities or increasing staging capacities. We found that racking capacity needed to be increase at 115 million pounds for cans and packaging and at 140 million pounds for RM if the same dwelling time is to be maintained. Congestion at staging areas and the buffer can generally be addressed by adding RCs and wrapper or TSPs respectively. However, when demand reaches 140 million pounds, opening up new docks seem like a better solution. This is because adding more vehicles might actually lead to transportation congestion whereas adding new docks will address the bottlenecks but not add to the physical constraints.

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