

SIMULATING A BATCH PICK OPERATION WITH PUTWALL

ANYLOGIC CONFERENCE

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September 2021

DHL Supply Chain





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Background

- E-Commerce growth in 5 Years → **320%**
- Meeting customer SLAs and reducing operational cost is essential to be competitive
- Ecommerce operations
 - IB: Receive → stage → sort → Putaway
 - OB: Pick → sort → Pack → stage → Dispatch



High Throughput



Cost effective
Storage Solution



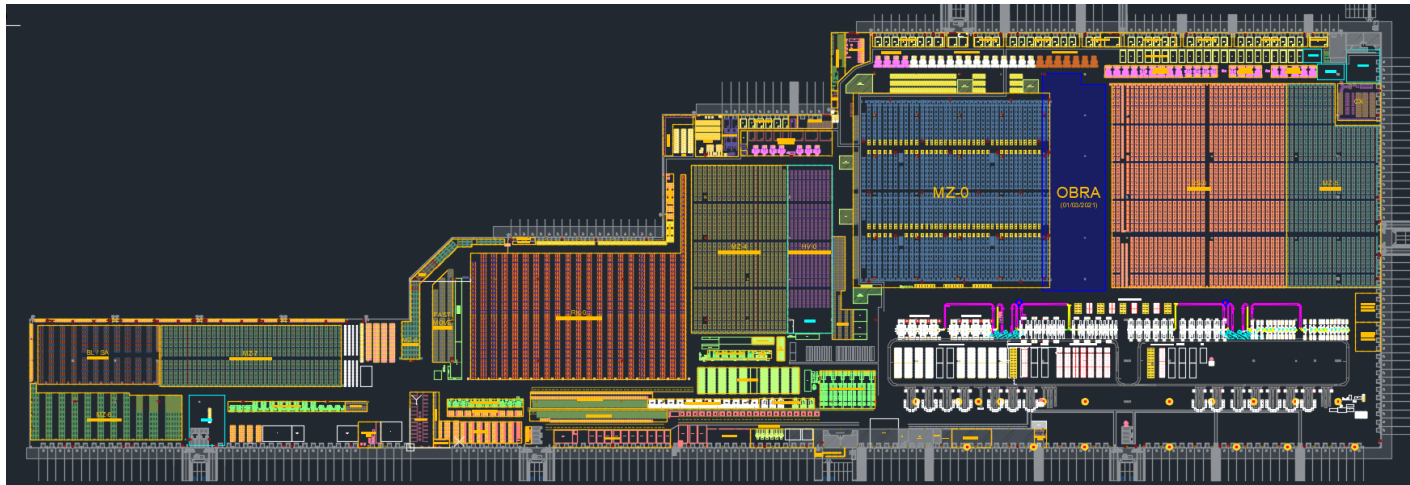
Quality product
with fast delivery

Objective

Objective: To develop a robust and smart system which can be used to test different waving strategies to optimize throughput and resource utilization

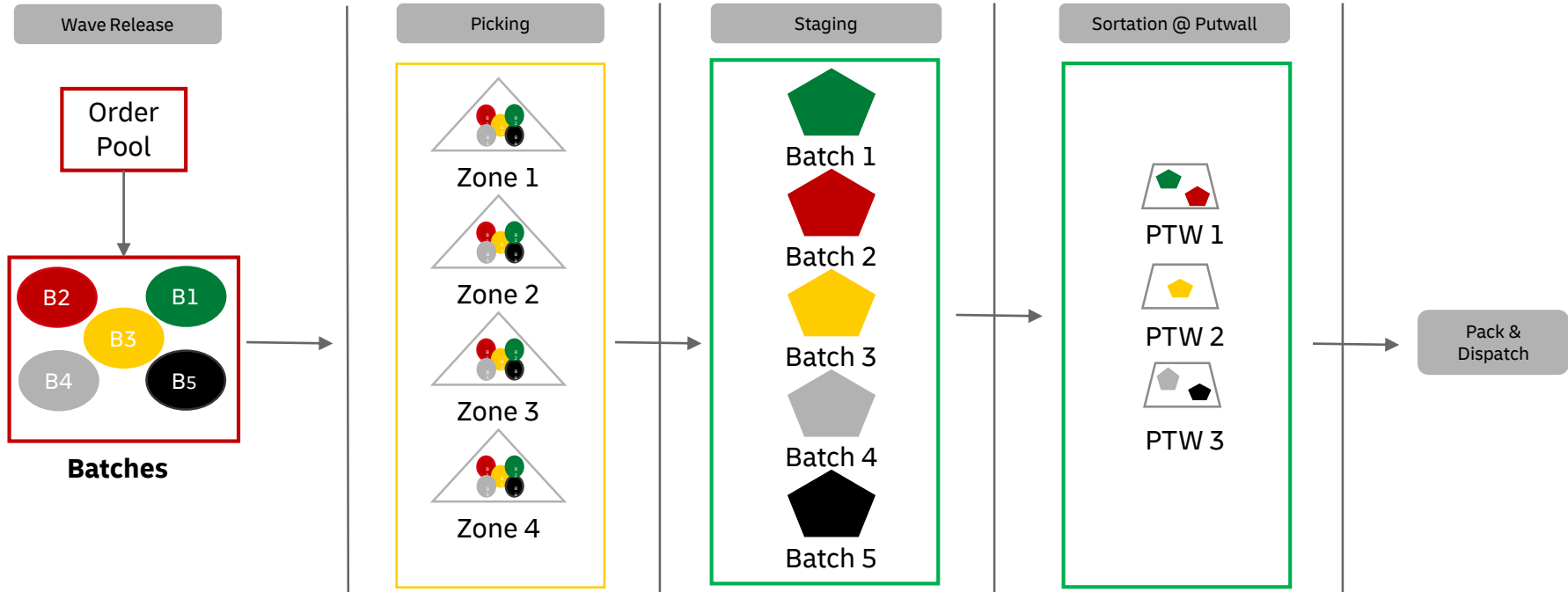
Site Operational Profile

Size Area	111,000 sq. m.	Total products	~500k
Pick Zones	12	Warehouse Storage	3 Mezzanines, 23 Putwalls with 21 cubbies each
Avg. Daily volume	~171k	Number of associates	>3000



Batch Pick Operations and Putwall

The orders are picked in multiple zones and are consolidated at the staging which further goes to Putwall for order fulfilment



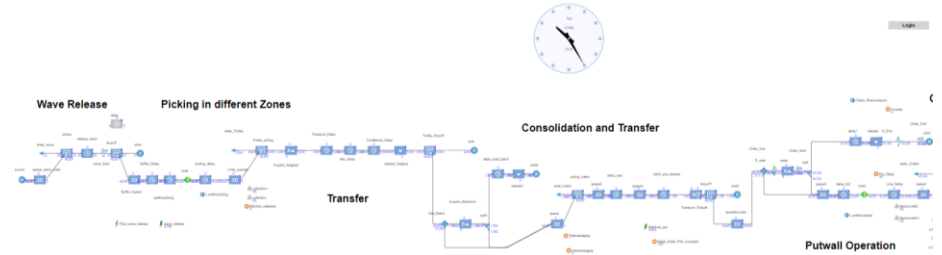
Simulation Approach

An As-is Model is built in the Phase 1 and multi-criterion dynamic wave release model is built in Phase 2

Phase - 1

As-is Model

- Wave release as per actuals
- Tests to ensure acceptable accuracy



Phase - 2

Dynamic Waving Model

- Dynamic wave release
- Simulate different waving strategies based on staging and Putwall occupancy, batches in pipeline
- Identify bottlenecks

Scenario Analysis

- How wave release affects completion time and the average queue at the staging?

Comparative Analysis

- Compare As-is and Dynamic Waving model on KPIs

Simulation Parameters and Requirements

Resource Capacity

- Total Putwalls: 21
- Cubbies per Putwall: 23
- Trolley Capacity (Totes): 6
- Picking Zones: 12
- Staging capacity (Batches): 138
- Resource per Putwall: 2
- Resources for Batch transfer: 21

Productivities

- Picking time: 10 sec/line
- Sort Batches: 3 Min/Batch
- Productivity of Packer: 45 sec/Order
- Productivity of Putter: 5 sec/qty
- Travel velocity resources: 0.6 m/s
- Avg. batches per wave: 23
- Avg. Orders per batch: 14
- Avg. batches per trolley: 6
- Avg. orders per wave: 1000

Requirements

- Picking happens simultaneously in multiple zones which is shown by respective Cart ID
- 1 batch always goes to 1 Putwall given that atleast 5 Putwall cubbies are available
- The travel distance calculation in Multiple zones was based on difference in bay and Aisle combination



Data

Table 1: Captures transaction information: Wave ID, Order ID, Batch ID, Card ID, Tote ID etc

Table 2: Zone wise Aisles

Table 3: Zone wise Aisle Length and Centre to Centre distance to calculate the distance to be travelled based on the current position

Table 1: Transaction information

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
1	Line_Order	WaveN	Order_ID	SKU_ID	Sum of Qt	Pick Time	Start_Time	Aisle	Task_Origin	Unique_ID	Tote ID	BatchID	Se	Horizontal Displacement	Priority	Wave_Hour	
2	Order 40469118258_THGI261431	W2300	Order 40469118258	THGI26143	3	3/23/21 12:28 AM	3/23/21 12:00 AM	1 RS-0	C_W2300_2_1-6	C_W2300_2_1-6_W23001	1	0	1	3/23/21 12:00 AM			
3	Order 40468275313_FFIA643803	W2300	Order 40468275313	FFIA64380	6	3/23/21 12:26 AM	3/23/21 12:00 AM	3 BL-0	C_W2300_16_1-6	C_W2300_16_1-6_W23001	1	2	1	3/23/21 12:00 AM			
4	Order 40469129985_DJZZ290307	W2300	Order 40469129985	DJZZ29030	3	3/23/21 12:44 AM	3/23/21 12:00 AM	7 MZ-5	C_W2300_1_1-6	C_W2300_1_1-6_W23001	1	6	1	3/23/21 12:00 AM			
5	Order 40467977612_ONCS5225511	W2300	Order 40467977612	ONCS52255	2	3/23/21 12:54 AM	3/23/21 12:00 AM	11 RS-0	C_W2300_2_1-6	C_W2300_2_1-6_W23001	1	10	1	3/23/21 12:00 AM			
6	Order 40469137508_UMEF4826415	W2300	Order 40469137508	UMEF48264	2	3/23/21 12:17 AM	3/23/21 12:00 AM	15 MZ-5	C_W2300_1_1-6	C_W2300_1_1-6_W23001	1	8	1	3/23/21 12:00 AM			
7	Order 40467717066_FRDZ4545428	W2300	Order 40467717066	FRDZ45454	3	3/23/21 12:40 AM	3/23/21 12:00 AM	28 MZ-4	C_W2300_12_1-6	C_W2300_12_1-6_W23001	1	17	1	3/23/21 12:00 AM			
8	Order 40459730436_DWHQ9926562	W2300	Order 40459730436	DWHQ99265	2	3/23/21 12:38 AM	3/23/21 12:00 AM	62 MZ-0	C_W2300_3_1-6	C_W2300_3_1-6_W23001	1	1	1	3/23/21 12:00 AM			
9	Order 40468056161_GTXC1750162	W2300	Order 40468056161	GTXC17501	1	3/23/21 12:40 AM	3/23/21 12:00 AM	62 MZ-0	C_W2300_3_1-6	C_W2300_3_1-6_W23001	1	0	1	3/23/21 12:00 AM			
10	Order 40468679244_PGZF9665062	W2300	Order 40468679244	PGZF96650	2	3/23/21 12:46 AM	3/23/21 12:00 AM	62 MZ-0	C_W2300_3_1-6	C_W2300_3_1-6_W23001	1	0	1	3/23/21 12:00 AM			
11	Order 40468926644_YHQG2508862	W2300	Order 40468926644	YHQG25088	12	3/23/21 12:33 AM	3/23/21 12:00 AM	62 MZ-0	C_W2300_3_1-6	C_W2300_3_1-6_W23001	1	0	1	3/23/21 12:00 AM			
12	Order 40468796085_UVNU7445962	W2300	Order 40468796085	UVNU74459	5	3/23/21 12:49 AM	3/23/21 12:00 AM	62 MZ-2	C_W2300_5_1-6	C_W2300_5_1-6_W23001	1	1	1	3/23/21 12:00 AM			
13	Order 40468926644_YHQG2508866	W2300	Order 40468926644	YHQG25088	13	3/23/21 12:26 AM	3/23/21 12:00 AM	66 MZ-0	C_W2300_3_1-6	C_W2300_3_1-6_W23001	1	4	1	3/23/21 12:00 AM			
14	Order 40468056161_UKPK1090769	W2300	Order 40468056161	UKPK10907	1	3/23/21 12:35 AM	3/23/21 12:00 AM	69 MZ-0	C_W2300_3_1-6	C_W2300_3_1-6_W23001	1	3	1	3/23/21 12:00 AM			
15	Order 40467513684_QOZH7081681	W2300	Order 40467513684	QOZH70816	2	3/23/21 12:37 AM	3/23/21 12:00 AM	81 MZ-0	C_W2300_3_1-6	C_W2300_3_1-6_W23001	1	12	1	3/23/21 12:00 AM			
16	Order 40466400202_EAFF0073683	W2300	Order 40466400202	EAFF00736	8	3/23/21 12:43 AM	3/23/21 12:00 AM	83 MZ-1	C_W2300_4_1-6	C_W2300_4_1-6_W23001	1	22	1	3/23/21 12:00 AM			
17	Order 40466824720_HVKU2175886	W2300	Order 40466824720	HVKU21758	2	3/23/21 12:54 AM	3/23/21 12:00 AM	86 MZ-0	C_W2300_3_1-6	C_W2300_3_1-6_W23001	1	5	1	3/23/21 12:00 AM			
18	Order 40471128968_PGZF476412	W2300	Order 40471128968	PGZF47641	1	3/23/21 12:26 AM	3/23/21 12:00 AM	2 MZ-5	C_W2300_1_7-12	C_W2300_1_7-12_W230010	1	1	1	3/23/21 12:00 AM			
19	Order 4047119401_RLUJ142375	W2300	Order 4047119401	RLUJ14237	2	3/23/21 12:58 AM	3/23/21 12:00 AM	5 RS-0	C_W2300_2_7-12	C_W2300_2_7-12_W230010	1	4	1	3/23/21 12:00 AM			
20	Order 40471140300_STVL371196	W2300	Order 40471140300	STVL37119	3	3/23/21 12:22 AM	3/23/21 12:00 AM	6 BL-0	C_W2300_16_7-12	C_W2300_16_7-12_W230010	1	5	1	3/23/21 12:00 AM			
21	Order 40471121781_OASH610128	W2300	Order 40471121781	OASH61012	1	3/23/21 12:26 AM	3/23/21 12:00 AM	8 MZ-7	C_W2300_15_7-12	C_W2300_15_7-12_W230010	1	7	1	3/23/21 12:00 AM			
22	Order 40471148594_QDSO6122516	W2300	Order 40471148594	QDSO61225	2	3/23/21 12:13 AM	3/23/21 12:00 AM	16 RS-0	C_W2300_2_7-12	C_W2300_2_7-12_W230010	1	11	1	3/23/21 12:00 AM			
23	Order 40471098036_DMH1340417	W2300	Order 40471098036	DMH13404	4	3/23/21 12:00 AM	3/23/21 12:00 AM	17 MZ-5	C_W2300_1_7-12	C_W2300_1_7-12_W230010	1	15	1	3/23/21 12:00 AM			
24	Order 40471126187_KCDY9758517	W2300	Order 40471126187	KCDY97585	1	3/23/21 1:14 AM	3/23/21 12:00 AM	17 RS-0	C_W2300_2_7-12	C_W2300_2_7-12_W230010	1	1	1	3/23/21 12:00 AM			
25	Order 40471135510_QLVK227618	W2300	Order 40471135510	QLVK22761	1	3/23/21 12:05 AM	3/23/21 12:00 AM	18 MZ-5	C_W2300_1_7-12	C_W2300_1_7-12_W230010	1	1	1	3/23/21 12:00 AM			
26	Order 40471140200_CXMK2275461	W2300	Order 40471140200	CXMK22754	6	3/23/21 12:44 AM	3/23/21 12:00 AM	61 MZ-0	C_W2300_3_7-12	C_W2300_3_7-12_W230010	1	0	1	3/23/21 12:00 AM			
27	Order 40471140200_ITSG1445061	W2300	Order 40471140200	ITSG14450	1	3/23/21 12:43 AM	3/23/21 12:00 AM	61 MZ-0	C_W2300_3_7-12	C_W2300_3_7-12_W230010	1	0	1	3/23/21 12:00 AM			
28	Order 40471126187_OFPN0994363	W2300	Order 40471126187	OFPN09943	3	3/23/21 12:52 AM	3/23/21 12:00 AM	63 MZ-0	C_W2300_3_7-12	C_W2300_3_7-12_W230010	1	2	1	3/23/21 12:00 AM			
29	Order 40471125088_THGI6395663	W2300	Order 40471125088	THGI63956	2	3/23/21 12:56 AM	3/23/21 12:00 AM	63 MZ-2	C_W2300_5_7-12	C_W2300_5_7-12_W230010	1	2	1	3/23/21 12:00 AM			

Table 2: Zone wise Aisles

	A	B	C	D
1	Area	Min of Aisle	Max of Aisle	Difference
2	BL-0	1	19	18
3	HV-0	101	111	10
4	MZ-0	61	97	36
5	MZ-1	61	97	36
6	MZ-2	61	97	36
7	MZ-3	61	97	36
8	MZ-4	11	32	21
9	MZ-5	1	20	19
10	MZ-7	1	40	39
11	MZ-9	1	1	0
12	RK-0	105	130	25
13	RS-0	1	16	15

Table 3: Zone wise Aisle length & c2c distance

	A	B	C
1	Zone	Aisle Length	C2C
2	BL-0	2085	425
3	HV-0	7553	217
4	MZ-0	9883	251
5	MZ-1	9883	251
6	MZ-2	9883	251
7	MZ-3	9883	251
8	MZ-4	9224	251
9	MZ-5	11243	251
10	MZ-6	4306	447
11	MZ-7	3357	251
12	MZ-9	2580	690
13	RK-0	6940	572
14	RS-0	11243	251
15	SA	3241	559

Simulation Framework

Simulation helps in making critical decisions using what if (Scenario) analysis and optimization with specific constraints

Components of Simulation

Variables/Parameters

This refers to the static/ dynamic variables inside the simulation model

- T_Avg_batch_perwave
- P_Picktime
- P_speed
- PutwallsMap
- I_Wave_Ord
- Picking_Time
- Orders_Picked

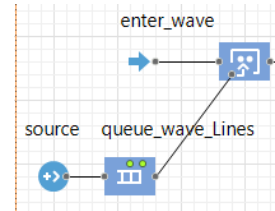
Resources/Constraints

This refers to the Capacity of the resources in a simulation model

- R_batchsorters
- R_staging

Processes

This refers to the operational processes in the form of building blocks



Events

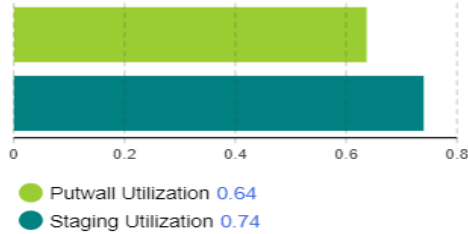
This refers to the Trigger of some specific events of interest

- First_wave_release
- wave_release

Simulation Results: As-is Model

Staging wasn't used at it's maximum capacity. There were instances with idleness and high queuing at the staging which leads to congestion. There lies an opportunity to increase resource utilization to complete the task early

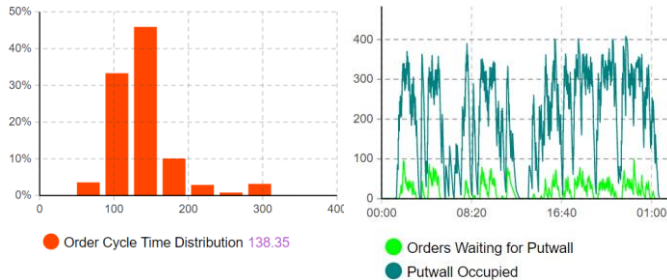
Utilization



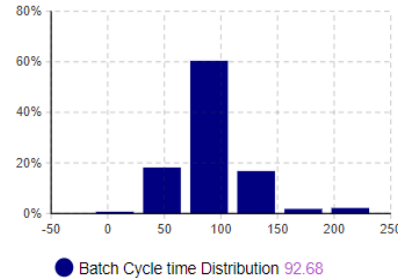
Staging Statistics



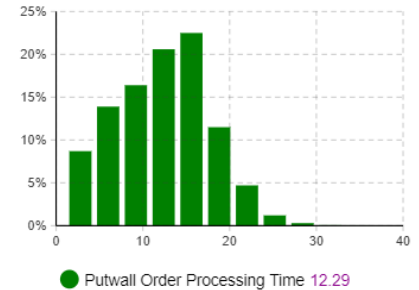
Order profile and Putwall health



Batch Cycle Time



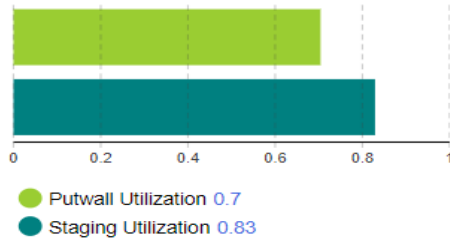
Putwall Processing Time



Simulation Results: Dynamic Waving Model

Increased resource utilization with decreased cycle time. The queue at the staging is attributed to the size of the wave. Putwall order processing time remains almost same

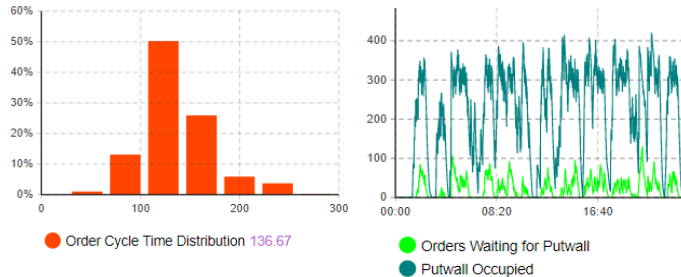
Utilization



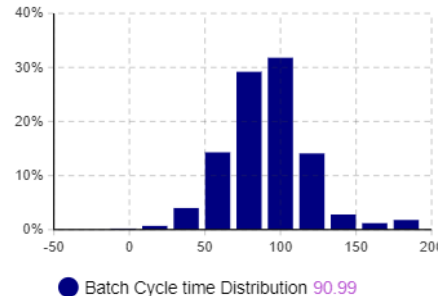
Staging Statistics



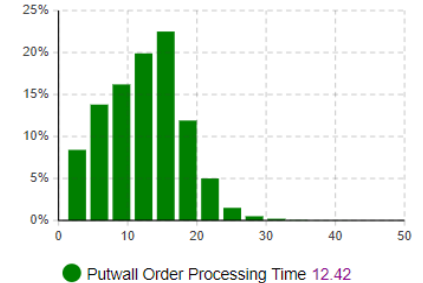
Order profile and Putwall health



Batch Cycle Time

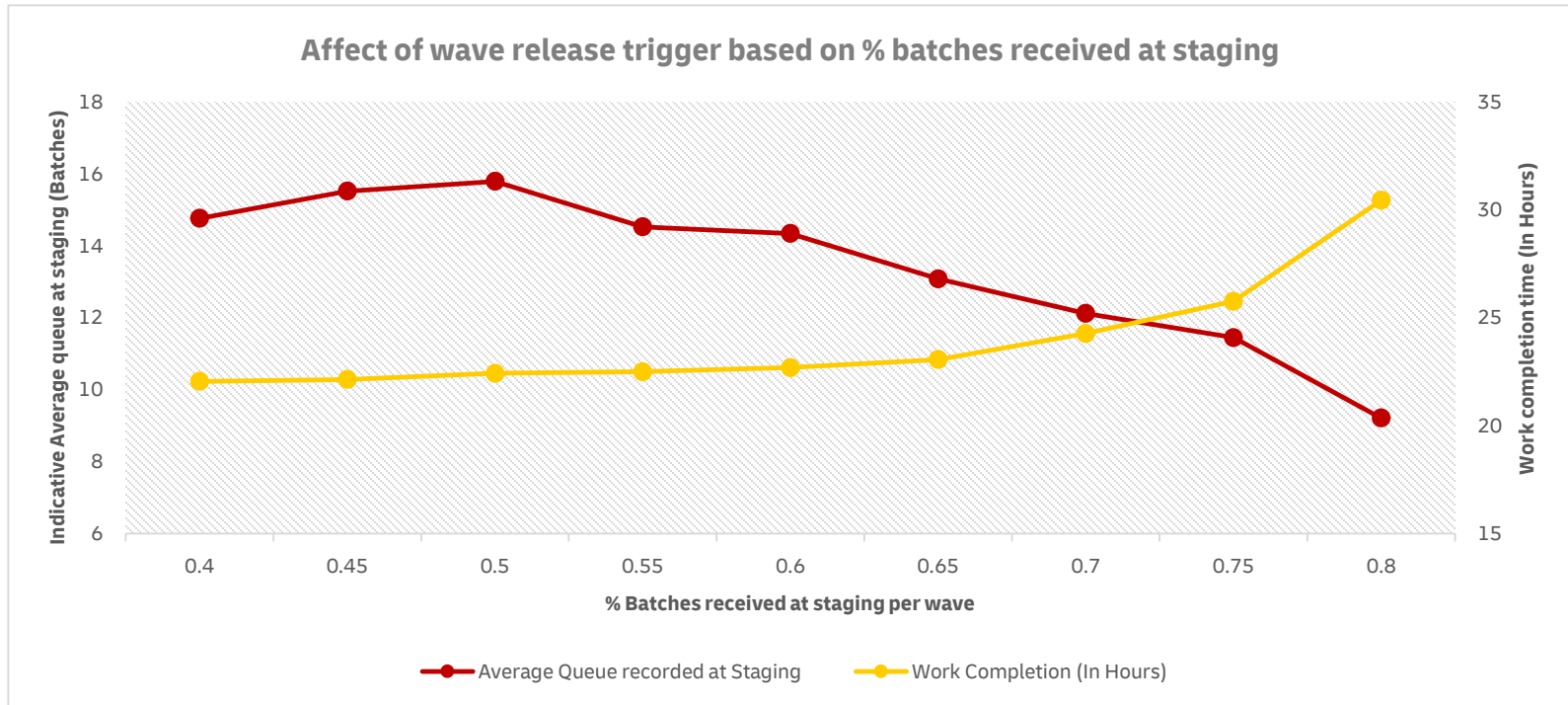


Putwall Processing Time



Sensitivity Analysis

Percentage of Batches in a wave reached at the staging triggers the release of a new wave. As we increase this percentage the average queue at staging decreases but it increases the completion time



Comparative Analysis: As-is Model Vs. Dynamic Waving Model

As-is Model

Average **138.35** Minutes per Order

Average **92.68** Minutes per batch

Total Orders = **24323** per day

Putwall Utilization: **64%**
Staging Utilization: **74%**

Orders processed in **25.76** Hours

Order Cycle time

Batch Cycle time

Throughput (Orders)

Resource Utilization

Overall Completion time

Dynamic Waving Model

↓ Average **136.67** Minutes per Order or saving of **681** human hours

↓ Average **90.99** Minutes per batch or saving of **50** human hours

█ Total Orders = **24323** per day

↑ Putwall Utilization: **70%**
Staging Utilization: **83%**

↓ **23.65** hours, **8.2%** less than As-is or with **66** less associates considering same completion time

Summary



- » Effective management of Staging and Putwall play a key role in Ecommerce warehouses.
- » Modeled large Ecommerce warehouse with ~500K SKUs and 249 Associates for picking, consolidating and packing
- » Anylogic model recommended to release waves after **60-70%** of the batches reach staging
- » Simulated Model shows an improvement in resource Utilization by **8-10%** and reduced the turnaround time by **8.2%** or can complete the same task in same time with **66** less associates
- » Warehouse simulation modeling involves working with frequent changes of flow UoM (Agent) to accommodate business logic and capture key insights



Thank you.