DYSON REPLENISHMENT PROCESS (part II)

Department of Industrial Systems Engineering and Management
IE3100R/IE3100M Systems Design Project | Group 16

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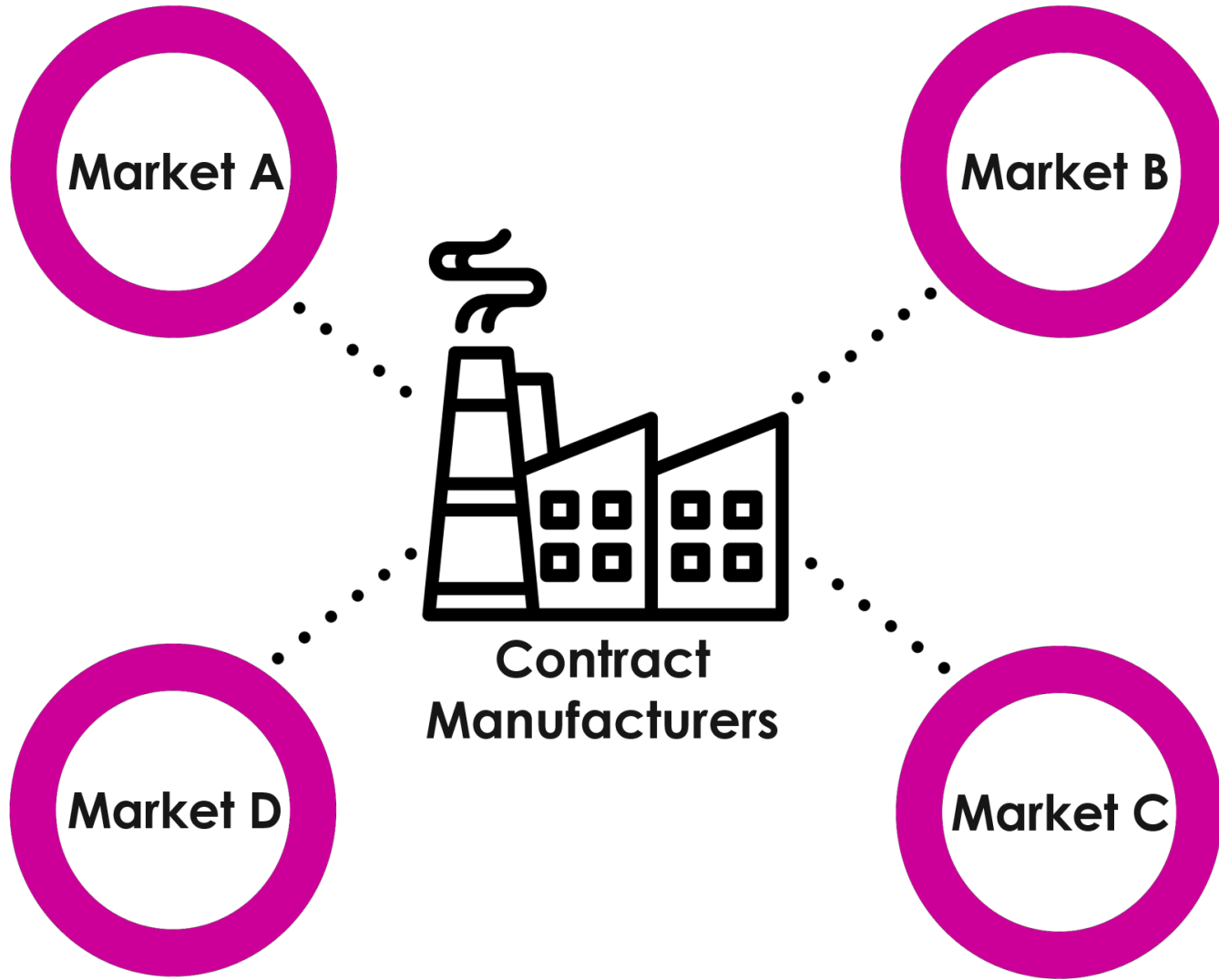
PROJECT OVERVIEW: To set a systematic decision making tool to help supply planners identify worthwhile supply division within markets when considering replenishments in Dyson's Spares & Accessories (S&A)

1. BACKGROUND

- Dyson's supply chain network consists of Contract Manufacturers (CMs), distribution hubs and markets.

- To fulfil the shortages of S&As during the replenishment process, Dyson sets up transfers within markets in addition to the replenishments from the CM's

- Decisions made between transfers are currently ad-hoc and unsystematic, which rely on planners' decisions

2. OBSERVATIONS

Bottlenecks / Opportunities

- During the replenishment process, planners mainly consider direct replenishments from the CMs. Dual sourcing is available in the APO but transfers are only considered when CM's are unable to fulfil.

- Supply planners manually check some markets for excess stock. From there the planner contacts the market to request.

Root Causes Analysis
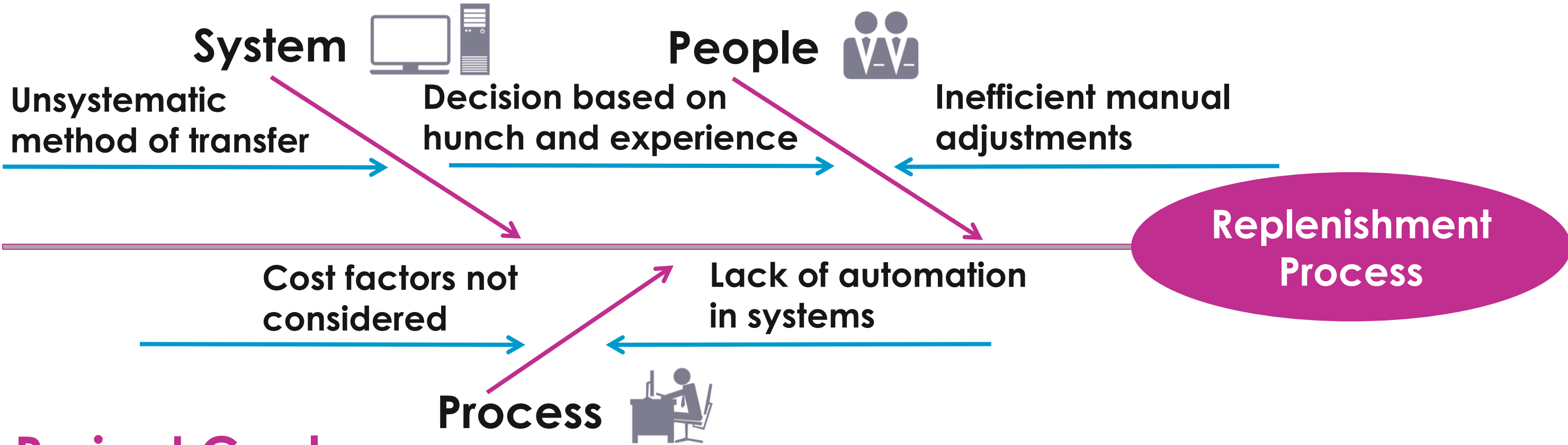
Project Goals:

- To codify the decisions of transfers between markets and reduce shortages by identifying more replenishment opportunities
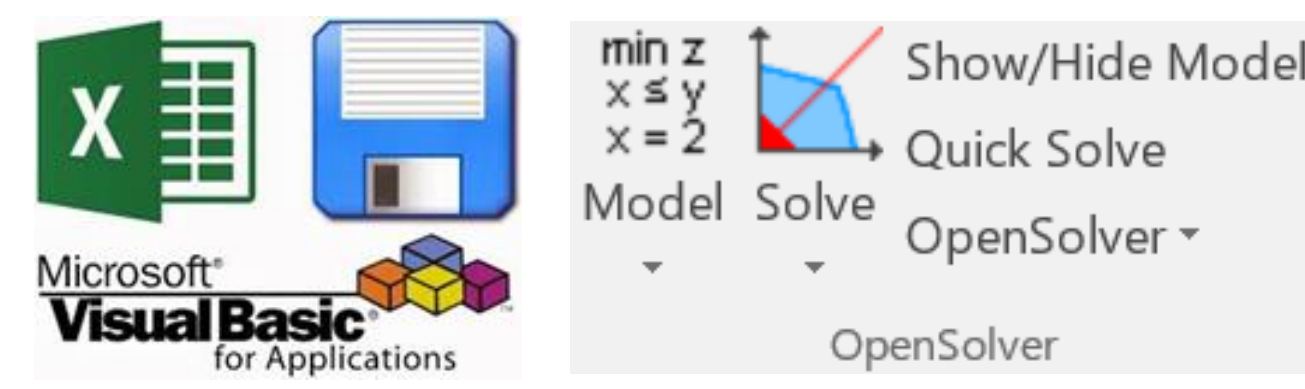
3. METHODOLOGY

- Create a linear optimization model that seeks to minimize overall cost by recommending the best routes of transfers
- Extraction of data from stock projection reports using Excel VBA

Optimization Model

Objective Function:

$$\text{Min } Z = \sum_{t=1}^{n}\sum_{j=2}^{m} h_j i_{jt} + \sum_{t=1}^{n}\sum_{j=2}^{m} c_j b_{jt} + \sum_{t=1}^{n}\sum_{j=2}^{m} g_{jt} y_{jt} + \sum_{t=1}^{n}\sum_{j=1}^{m}\sum_{k=2}^{m} a_{jk} x_{jkt}$$

Constraints	Remarks
$i_{jt} = i_{jt-1} - b_{jt-1} + p_{jt} - d_{jt} + b_{jt} - \sum_{k=1}^{m} x_{jkt} + \sum_{k=1}^{m} x_{kj(t-Tkj)}$	Inventory at location j at time t is the previous inventory - the previous backorder + current planned receipt time t - demand at location j at time t + current backorder - total transfers from location j to location k which was sent at time t + total transfer from location k to location j which was sent at time (t- lead time)
$\sum_{k=1}^{m} x_{jkt} \le i_{jt} + p_{jt} + \sum_{k=1}^{m} x_{kj(t-T/jk)}$	Total sent away at time t from location j must be less or equal to inventory of location j at time t-1 + sum total received at time t from location k (k=1,2,3,..., m) + planned receipt of location j at time t
$b_{jt} \le b_{jt-1} + d_{jt}$	Backorder of location j at time t must be ≤ to the sum of backorder of location j at time t-1 and demand at location j at time t
$y_{jt} \ge 0$	The amount below safety stock must not be negative
$y_{jt} \ge SS_{jt} - i_{jt}$	The volume below safety stock at a location and time must be ≥ the (safety stock – inventory)
$i_{jt} \ge 0$	Inventory must not be negative
$d_{jt} \ge 0$	Demand must not be negative

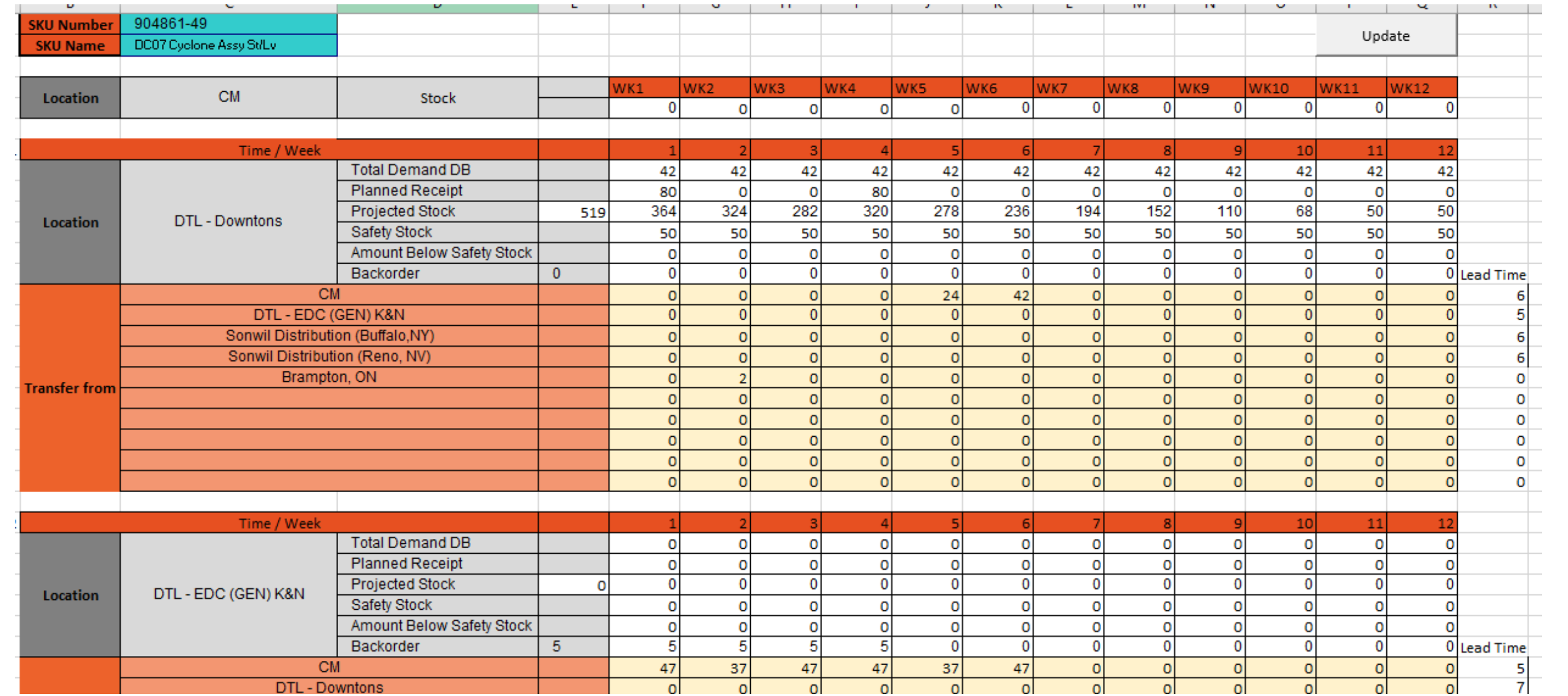| Variables	Definition
N	Length of the planning horizon
M	Number of nodes which has the SKU, whereby location 1 is the CM and location 2,3,4,... would be the markets/hubs
d_{jt}	Demand at location j in period t
h_j	Holding cost per unit per period at location j
i_{jt}	Inventory at location j at the end of period t
T_{jk}	Lead time from location j to location k
a_{jk}	The unit transport cost from location j to location k where j = 2, ..., m, k = 1, ..., m and j ≠ k
b_{jt}	The amount of backorder at location j
p_{jt}	Planned receipt at location j at time t
c_j	The cost of backorder at location j where
SS_{jt}	The safety stock at location j where j at time t
g_{jt}	The penalty below safety stock at location j
x_{jkt}	The quantity of goods transferred from location j to location k at time t where j = 2, ..., m, k = 1, ..., m, t = 1, ..., n and j≠k
y_{jt}	The volume below safety stock at location j at time t

4. SOLUTIONS

Tool for Transfer Suggestions

SKU Number	Reccomended Transfers				
	From	To	Sent at (week)	Received at (week)	Quantity
903431-12	DTL - Downtons	Sonwil Distribution (Buffalo,NY)	1	2	23
903431-12	DTL - Downtons	Sonwil Distribution (Buffalo,NY)	4	5	15
903431-12	CM	Sonwil Distribution (Reno, NV)	1	6	59
903431-12	DTL - Downtons	Sonwil Distribution (Buffalo,NY)	8	9	20
904861-49	DTL - Downtons	Sonwil Distribution (Buffalo,NY)	1	2	193
904861-49	Sonwil Distribution (Reno, NV)	Sonwil Distribution (Buffalo,NY)	1	3	23
904861-49	Brampton, ON	DTL - Downtons	2	5	2
904861-49	Brampton, ON	DTL - EDC (GEN) K&N	1	5	5
904861-49	CM	DTL - EDC (GEN) K&N	1	6	47
904861-49	CM	Sonwil Distribution (Reno, NV)	1	6	4
904861-49	CM	DTL - EDC (GEN) K&N	2	7	37
904861-49	DTL - EDC (GEN) K&N	Sonwil Distribution (Buffalo,NY)	6	7	47

- A fast and systematic tool that extracts and optimizes the proposed allocation of stock based on the SKU selected.
- After solving, a user interface suggests to the planners the sources and destinations to transfer goods, the time it takes and the quantity.

Interactive Dashboard

- Supply planners may update their recommended transfers and the effects on the markets will be dynamically reflected
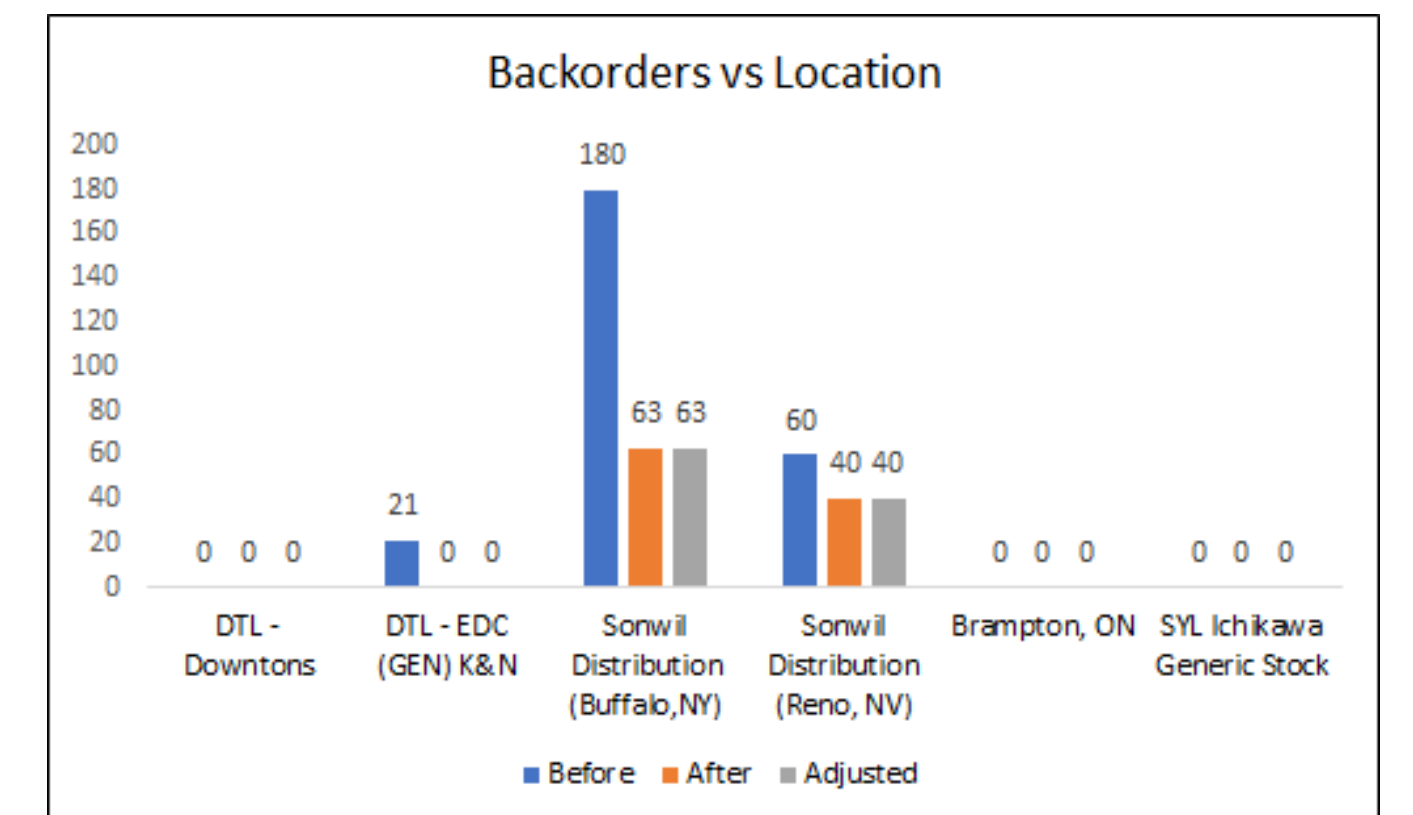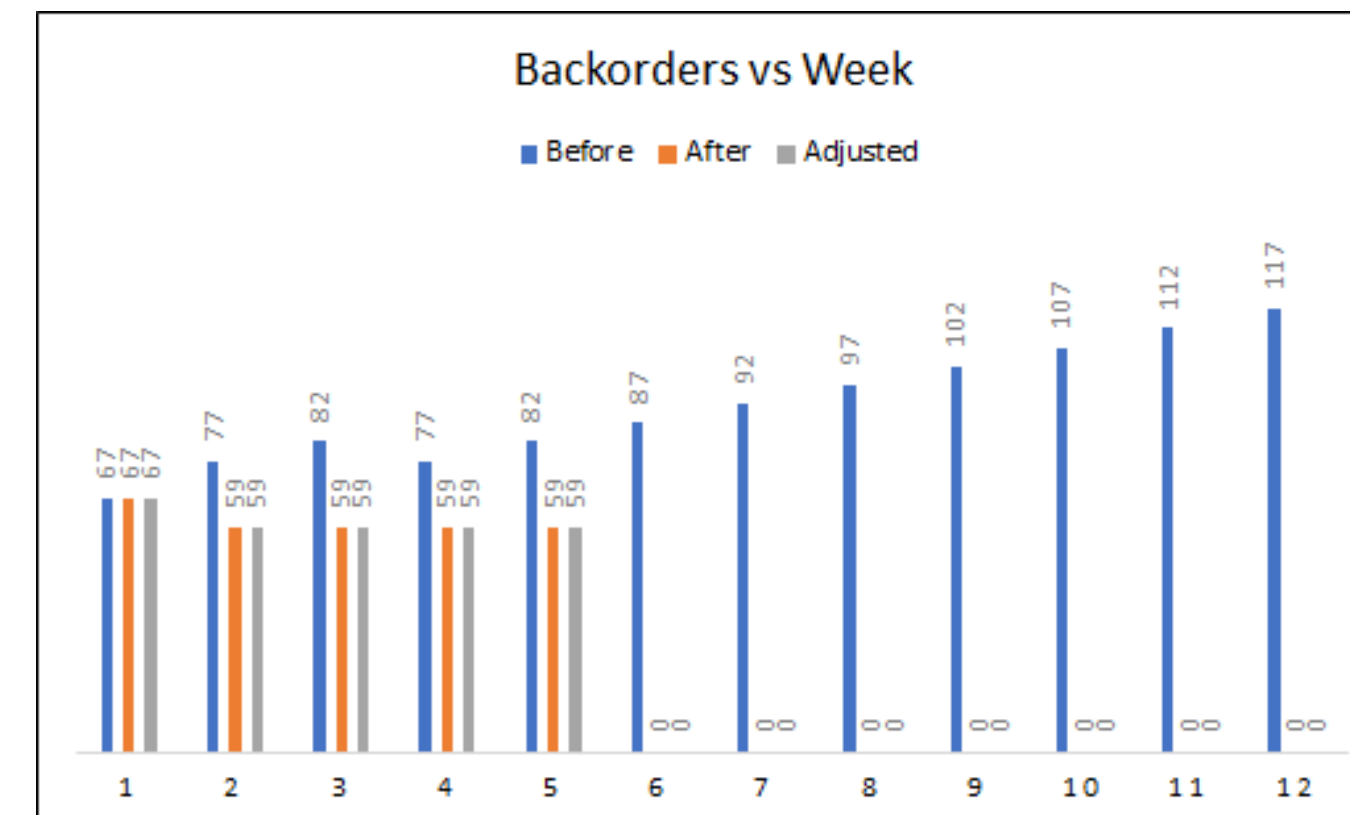
- This dash board will also provide an overall comparison on the
  - Total level of backorders before and after changes
  - Level of weekly backorders for each SKU
  - Level of total backorder in each location

5. EVALUATION

Value Added

Before	**After**
- Manual and unsystematic decisions in transfers between markets	- Accountable and systematic decision in transfers between markets
- Lack of visibility in market opportunities of replenishment	- Greater visibility of opportunities in markets.
	5 markets → Up to 18 markets
	- Decrease in backorders

Future Directions

- Obtaining the exact transport cost after transport lanes are being set up
- Providing management level insights to establishing new transport routes
- Integration of tool into the SAP-APO