

# Inventory optimization – Safety stock / Reorder point model

Global consumer book publisher

Evaluated over 150K SKUs & created an inventory optimization model that took into the account key demand and supply factors, resulting in over \$5M in freed-up working capital

# Global consumer book publisher needs to optimize its inventory

## Picture this...

You’re looking for an enhanced inventory management processes by streamlining existing order cycles to minimize cash tied up in inventory by developing a robust Inventory Optimization Model, that can recommend statistical safety stock levels and reorder points by title, considering essential demand and supply parameters to capitalize on an opportunity.

## You turn to Accordion.

We partner with your team to evaluated SKUs & create an inventory optimization model that takes into the account key demand and supply factors, resulting in over \$5M in freed-up working capital, including:

- 1) Assessing over 150K+ SKUs and established 270+ unique criteria spanning nine inventory characteristics, including sales, book divisions, format, text color, vendor, lead time, unit cost, age, and print type, to methodically identify ~1100 pilot SKUs that accurately represent the entire population
- 2) Creating 6 statistical methods to calculate safety stock and reorder points tailored to various product archetypes, taking into consideration factors such as forecast accuracy, sales volatility, lead time variability, target service levels, inventory classification, and seasonality
- 3) Projecting the theoretically optimized inventory levels and quantifying the potential opportunity by comparing them with historical inventory levels
- 4) Collaborating with the client’s inventory planning and technology teams to facilitate the scaling of inventory optimization across all SKUs

## Your value is enhanced.

- You have unlocked \$5M+ of working capital by reducing the inventory levels of ~1100 pilot SKUs by 25%
- You have streamlined the existing order cycles by having visibility into the optimal safety stock and reorder point by SKU through a dynamic model with intuitive user interface where users can simulate various scenarios
- You also have an actionable roadmap for implementing and scaling the inventory optimization program across the entire SKU population

### KEY RESULT

- \$5M+ in working capital tied in the inventory of ~1100 pilot SKUs

### VALUE LEVERS PULLED

- Inventory optimization
- Safety stock modelling
- Reorder point modelling
- Forecast accuracy analysis
- Seasonality analysis
- Inventory classification by \$ value and demand variability

# Inventory optimization for a leading global book publisher

## Situation

- Client aimed to enhance inventory management processes and streamline existing order cycles to minimize cash tied up in inventory
- Partnered with the client to develop a robust Inventory Optimization Model, which recommended statistical safety stock levels and reorder points by title, considering essential demand and supply parameters and their variabilities to capitalize on the opportunity

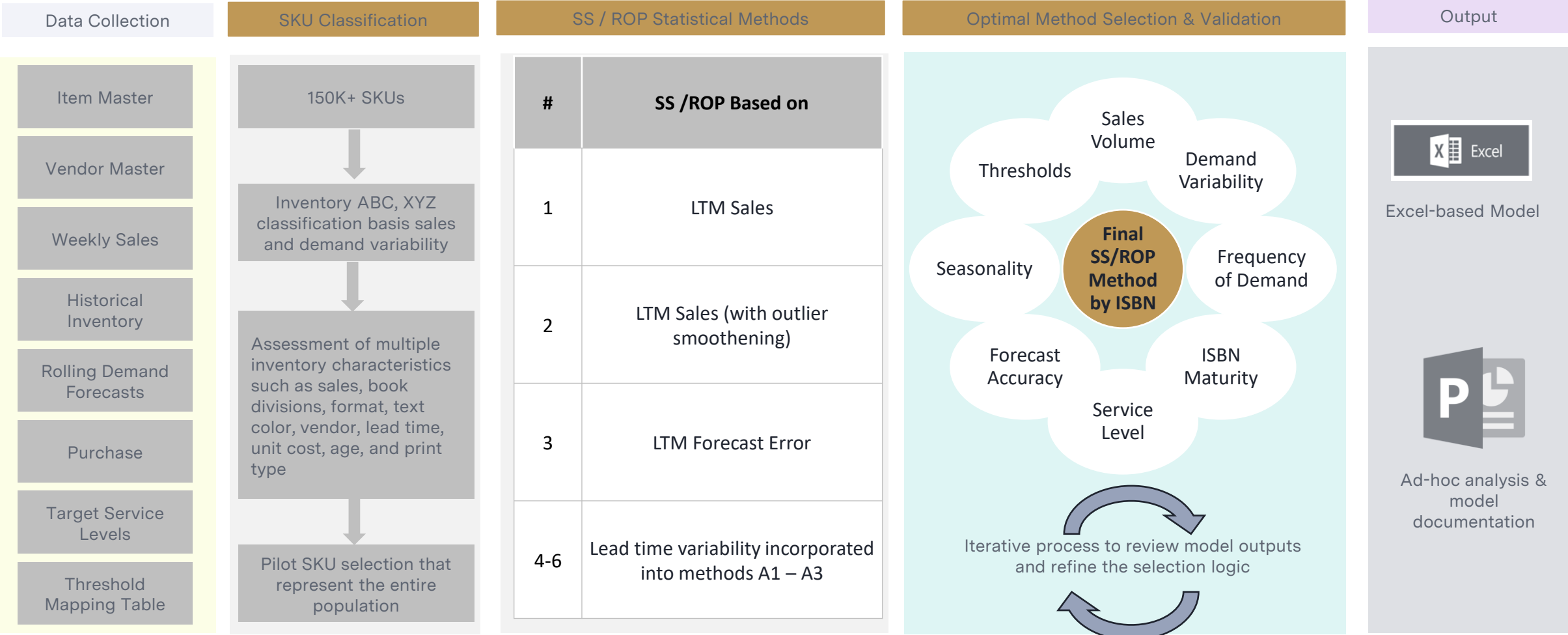
## Accordion Value Add

- Assessed over 150K+ SKUs and established 270+ unique criteria spanning nine inventory characteristics, including sales, book divisions, format, text color, vendor, lead time, unit cost, age, and print type, to methodically identify ~1100 pilot SKUs that accurately represent the entire population
- Created 6 statistical methods to calculate safety stock and reorder points tailored to various product archetypes, taking into consideration factors such as forecast accuracy, sales volatility, lead time variability, target service levels, inventory classification, and seasonality
- Projected the theoretically optimized inventory levels and quantified the potential opportunity by comparing them with historical inventory levels
- Collaborated with the client's inventory planning and technology teams to facilitate the scaling of inventory optimization across all SKUs

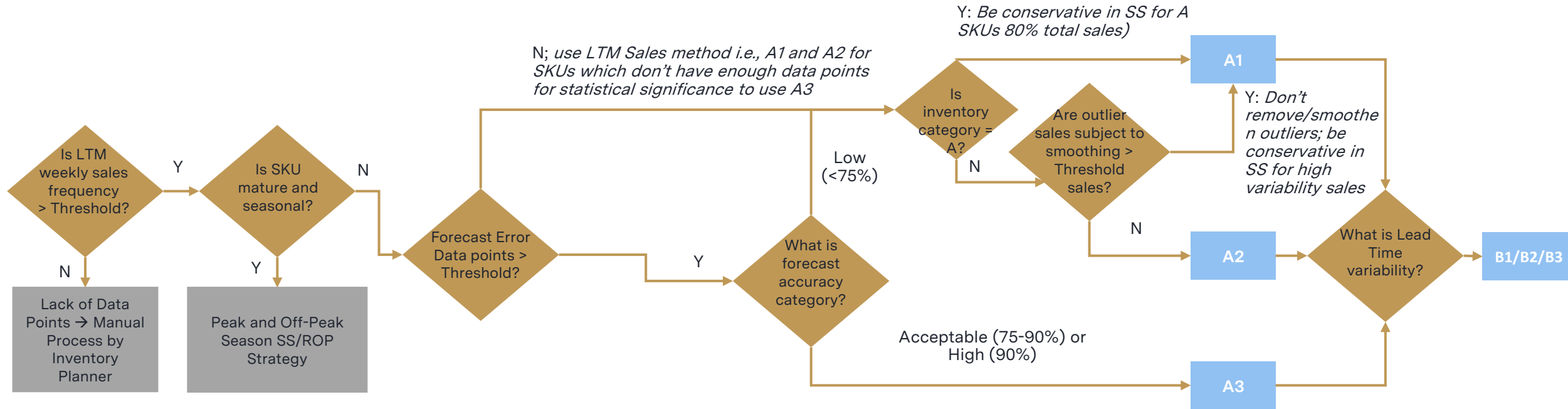
## Impact

- Unlocked \$5M+ of working capital by reducing the inventory levels of ~1100 pilot SKUs by 25%
- Enabled the supply chain team in streamlining the existing order cycles by providing visibility into the optimal safety stock and reorder point by SKU through a dynamic model with intuitive user interface where users can simulate various scenarios
- Outlined an actionable roadmap for implementing and scaling the inventory optimization program across the entire SKU population

# Approach

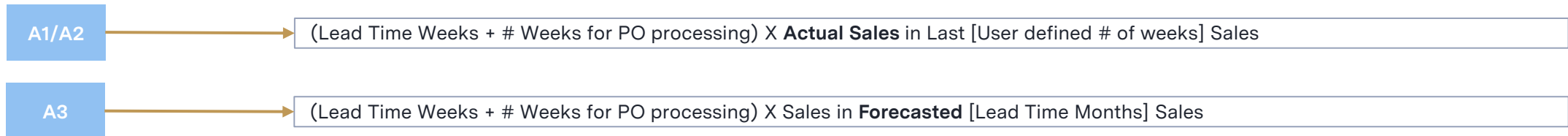


# SS & ROP recommendation methodology



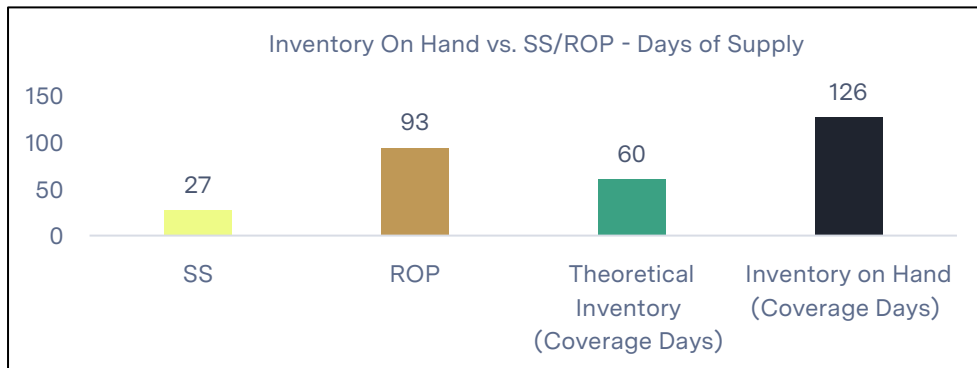
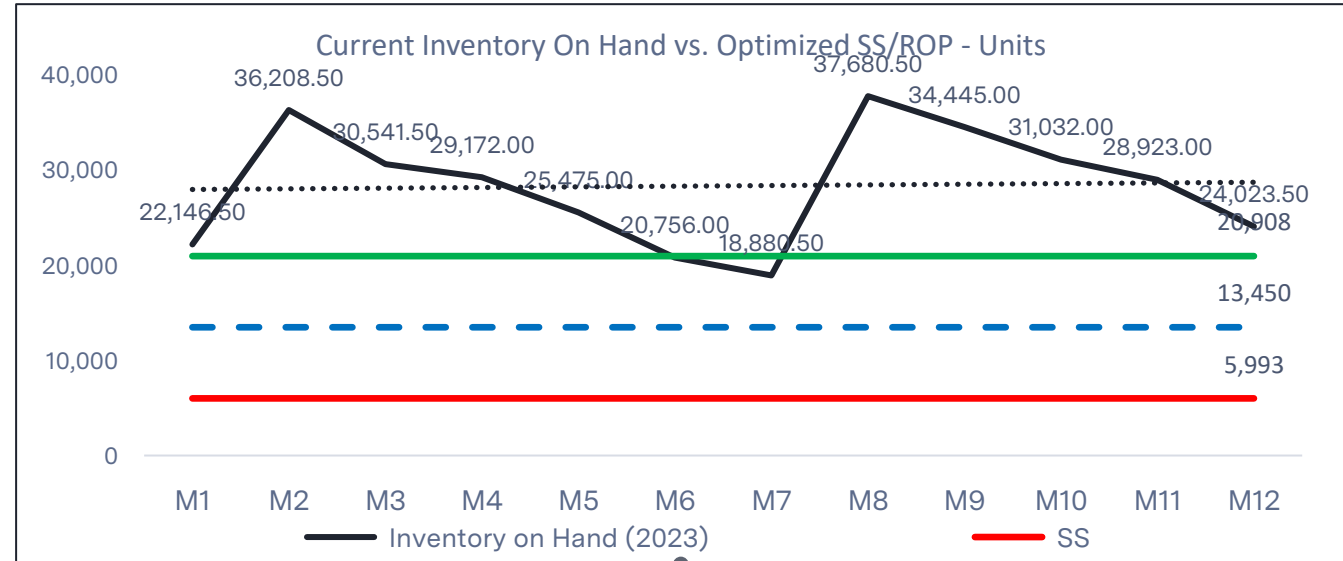
## Lead Time Demand Assumption

Assumed user defined # Weeks for order processing



# Optimized safety stock & reorder point vs current inventory on hand

ISBN Details	
ISBN	XXXXXXXXXXXX
Title	Title T
Author	Author A
Division TTTT	Division X
Format	
Text Colors	4C
Release Date	X/XX/20XX
Backlist Type	C. Mature (25+)
FG Vendor	Vendor V
Lead time (Days)	120
Unit Cost	\$2.50
Inventory Classification	AM
FG Vendor Region	Europe
Forecast accuracy	52.44%
Periodic	N



Recommended Safety Stock and Re-Order Points are optimized leading to 50% reduction in the average inventory levels of SKU

# Opportunity to unlock working capital through inventory optimization

ABC Class	Key Stats	Demand Variability							
		L		M		H		Total	
A	# of ISBNs	159	34.5%	154	33.4%	65	14.1%	378	82.0%
	COGS (2023, \$)	\$ 10,479,876	47.1%	\$ 9,084,933	40.8%	\$ 2,400,673	10.8%	\$ 21,965,482	98.7%
	Inventory on Hand (2023, \$)	\$ 3,591,676	43.4%	\$ 3,515,739	42.4%	\$ 915,321	11.0%	\$ 8,022,736	96.9%
	Coverage (Days)	57		64		64		60	
	Theoretical Target Inventory (\$)	\$ 2,110,805	36.0%	\$ 2,636,503	45.0%	\$ 1,022,211	17.4%	\$ 5,769,519	98.5%
	Excess (\$)	\$ 1,680,664	46.8%	\$ 1,432,398	39.9%	\$ 300,583	8.4%	\$ 3,413,646	95.0%
	Shortage (\$)	\$ (199,794)	17.1%	\$ (553,161)	47.3%	\$ (407,474)	34.9%	\$ (1,160,429)	99.3%
	Net opportunity (\$)	\$ 1,480,871	61.1%	\$ 879,236	36.3%	\$ (106,890)	-4.4%	\$ 2,253,217	92.9%
B	# of ISBNs	18	3.9%	30	6.5%	14	3.0%	62	13.4%
	COGS (2023, \$)	\$ 100,003	0.4%	\$ 115,800	0.5%	\$ 50,836	0.2%	\$ 266,638	1.2%
	Inventory on Hand (2023, \$)	\$ 80,007	1.0%	\$ 105,766	1.3%	\$ 38,688	0.5%	\$ 224,461	2.7%
	Coverage (Days)	130		157		126		141	
	Theoretical Target Inventory (\$)	\$ 22,047	0.4%	\$ 34,675	0.6%	\$ 25,825	0.4%	\$ 82,547	1.4%
	Excess (\$)	\$ 57,990	1.6%	\$ 72,688	2.0%	\$ 19,070	0.5%	\$ 149,748	4.2%
	Shortage (\$)	\$ (30)	0.0%	\$ (1,597)	0.1%	\$ (6,208)	0.5%	\$ (7,835)	0.7%
	Net opportunity (\$)	\$ 57,960	2.4%	\$ 71,091	2.9%	\$ 12,862	0.5%	\$ 141,913	5.9%
C	# of ISBNs	2	0.4%	14	3.0%	5	1.1%	21	4.6%
	COGS (2023, \$)	\$ 504	0.0%	\$ 12,933	0.1%	\$ 4,183	0.0%	\$ 17,620	0.1%
	Inventory on Hand (2023, \$)	\$ 1,607	0.0%	\$ 26,786	0.3%	\$ 7,865	0.1%	\$ 36,258	0.4%
	Coverage (Days)	620		321		417		369	
	Theoretical Target Inventory (\$)	\$ 80	0.0%	\$ 4,158	0.1%	\$ 1,876	0.0%	\$ 6,114	0.1%
	Excess (\$)	\$ 1,527	0.0%	\$ 22,691	0.6%	\$ 6,183	0.2%	\$ 30,401	0.8%
	Shortage (\$)	\$ -	0.0%	\$ (62)	0.0%	\$ (195)	0.0%	\$ (257)	0.0%
	Net opportunity (\$)	\$ 1,527	0.1%	\$ 22,629	0.9%	\$ 5,988	0.2%	\$ 30,144	1.2%
Total	# of ISBNs	179	38.8%	198	43.0%	84	18.2%	461	100.0%
	COGS (2023, \$)	\$ 10,580,382	47.6%	\$ 9,213,666	41.4%	\$ 2,455,692	11.0%	\$ 22,249,740	100.0%
	Inventory on Hand (2023, \$)	\$ 3,673,290	44.3%	\$ 3,648,291	44.0%	\$ 961,873	11.6%	\$ 8,283,455	100.0%
	Coverage (Days)	57		65		66		61	
	Theoretical Target Inventory (\$)	\$ 2,132,933	36.4%	\$ 2,675,335	45.7%	\$ 1,049,913	17.9%	\$ 5,858,181	100.0%
	Excess (\$)	\$ 1,740,181	48.4%	\$ 1,527,777	42.5%	\$ 325,837	9.1%	\$ 3,593,795	100.0%
	Shortage (\$)	\$ (199,824)	17.1%	\$ (554,820)	47.5%	\$ (413,876)	35.4%	\$ (1,168,521)	100.0%
	Net opportunity (\$)	\$ 1,540,357	63.5%	\$ 972,956	40.1%	\$ (88,040)	-3.6%	\$ 2,425,274	100.0%

High sales volume and low / medium demand variability SKUs – tend to present quick-win opportunities for inventory optimization

Inventory segmentation reveals a strong pareto of low and medium demand variability ISBNs – prime candidates for inventory optimization and inventory planning automation

- 82% of pilot SKUs
- 89% of COGS
- 87% Inventory on Hand
- ~100% of theoretical cash opportunity

Theoretical opportunity breakout indicates opportunities to address both excess and shortages  
Greater share of opportunity is potentially in addressing excess inventory

# Forecast accuracy trends and implementation in model

Forecast Error													
	M1-Y2	M2-Y2	M3-Y2	M4-Y2	M5-Y2	M6-Y2	M7-Y2	M8-Y2	M9-Y2	M10-Y2	M11-Y2	M12-Y2	Forecast Considered
Actual sales monthly	23,302	45,267	54,210	43,246	35,264	37,111	45,343	62,326	29,316	54,042	42,495	23,485	For Accuracy
M1-Y1 fcst	32,788	37,518	40,475	35,590	59,454	40,818	41,245	56,286	32,402	41,082	44,292	20,485	No
M2-Y1 fcst													No
M3-Y1 fcst													No
M4-Y1 fcst													No
M5-Y1 fcst													No
M6-Y1 fcst													No
M7-Y1 fcst													No
M8-Y1 fcst													No
M9-Y1 fcst													No
M10-Y1 fcst													Yes
M11-Y1 fcst													Yes
M12-Y1 fcst													Yes
M1-Y2 fcst	32,788	37,518	40,475	35,590	59,454	40,818	41,245	56,286	32,402	41,082	44,292	20,485	Yes
M2-Y2 fcst													Yes
M3-Y2 fcst													Yes
M4-Y2 fcst													Yes
M5-Y2 fcst													Yes
M6-Y2 fcst													Yes
M7-Y2 fcst													Yes
M8-Y2 fcst													Yes
M9-Y2 fcst													Yes
M10-Y2 fcst													No
M11-Y2 fcst													No
M12-Y2 fcst													No
Gross Sales	23,302	45,267	54,210	43,246	35,264	37,111	45,343	62,326	29,316	54,042	42,495	23,485	495,407
Forecast Error	9,486	-7,749	-13,735	-7,656	24,190	3,707	-4,098	-6,040	3,086	-12,960	1,797	-3,000	-12,972
Abs Error	9,486	7,749	13,735	7,656	24,190	3,707	4,098	6,040	3,086	12,960	1,797	3,000	97,504
MAPE	40.71%	17.12%	25.34%	17.70%	68.60%	9.99%	9.04%	9.69%	10.53%	23.98%	4.23%	12.77%	20.81%
Over	9,486	0	0	0	24,190	3,707	0	0	3,086	0	1,797	0	42,266
Under	0	-7,749	-13,735	-7,656	0	0	-4,098	-6,040	0	-12,960	0	-3,000	-55,238
Bias %	40.71%	-17.12%	-25.34%	-17.70%	68.60%	9.99%	-9.04%	-9.69%	10.53%	-23.98%	4.23%	-12.77%	1.53%

Title	ABCDEF
ISBN	123456
Release Date	3/26/20xx
Standard Vendor Lead Time	41 days
Forecast Accuracy	79.19%

Parameter	Formulae
Lag Period	Round up Lead time + 1 M
Forecast Error	Forecast – Actual
Absolute Error	Absolute Value of Forecast Error
MAPE*	Absolute Error / Gross Sales
Forecast Accuracy	1 – MAPE
Over	Positive Forecast Errors
Under	Negative Forecast Errors
Bias %	Forecast Error / Gross Sales

\* MAPE is capped at 100%

While calculating forecast error of a particular SKU in Month 5 - Year2 (SKU has lag period of 3 months), the monthly forecast done in M2-Y2 for the month of M5-Y2 is leveraged along with the actual monthly sales of M2-Y2

The standard deviation of the Abs Error ( $\sigma$ ) of the past 12 months is used to calculation of the Safety Stock by Forecast Error methodology



# Sales outlier smoothing to reduce overstocking possibility

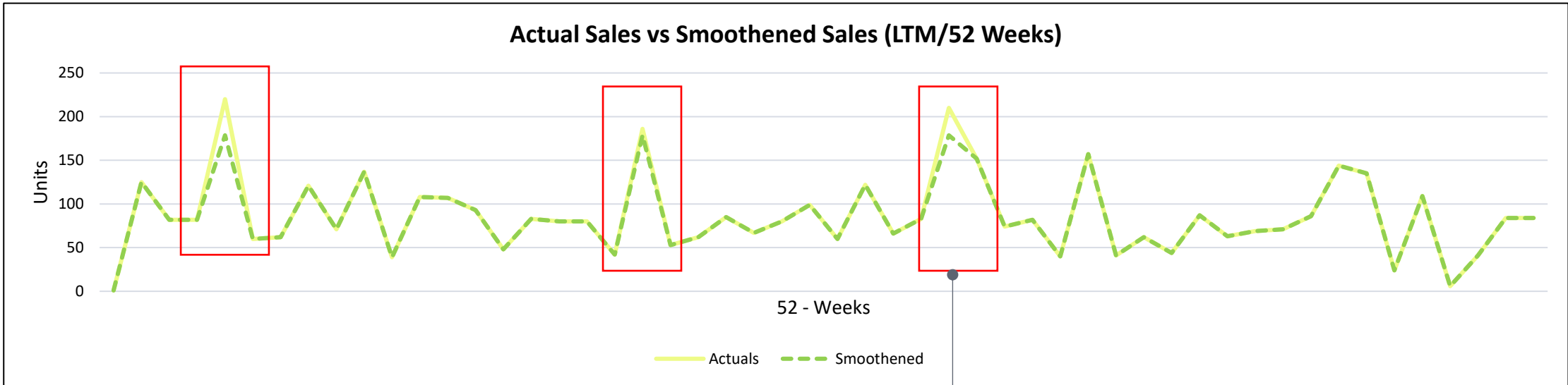
ISBN Details	
ISBN	xxxxxxxxxxxxxxxxxx
Division TTTT	Division X
Format	
Text Colors	4C
Backlist Type	C. Mature (25+)
FG Vendor	Vendor Y
Lead time (Days)	50
Unit Cost	\$1.50
Inventory Classification	AM
FG Vendor Region	Country Z
Forecast accuracy	72.72%

Outlier Threshold Calculation	
1st Quartile	61
3rd Quartile	1,08
Inter-Quartile Range (IQR)	47
Outlier Threshold	179

Smoothing Impact	
Frequency of demand	52
# of outlier smoothed	3
% of outlier smoothed	6%
% of sales smoothed	14%

Safety Stock Calculation	
Based on Actual Sales	
LTM weekly avg sales (actual)	86
LTM weekly volatility (actual)	45
Safety Stock (Actual)	445
Re-Order Point	2,422
Based on Smoothened Sales	
LTM weekly avg sales (smoothened)	84
LTM weekly volatility (smoothened)	41
Safety Stock (Smoothened)	406
Re-Order Point	2,383

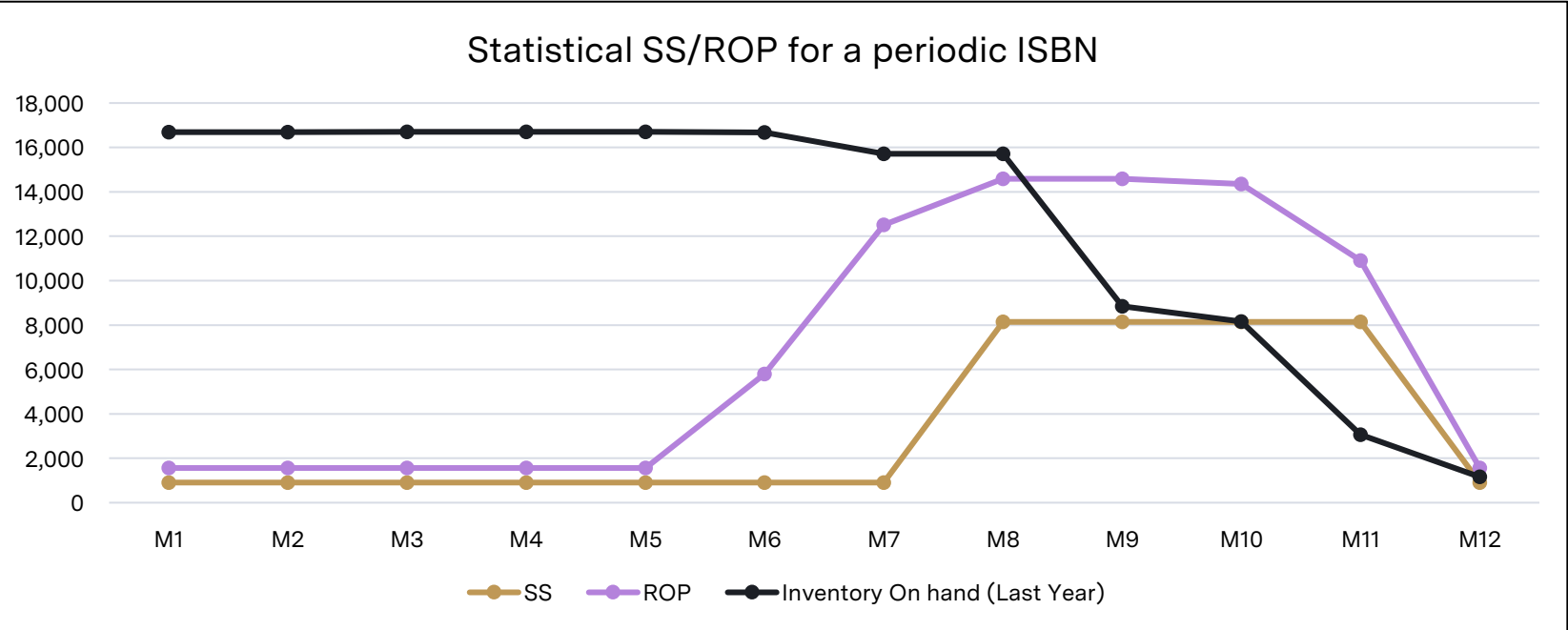
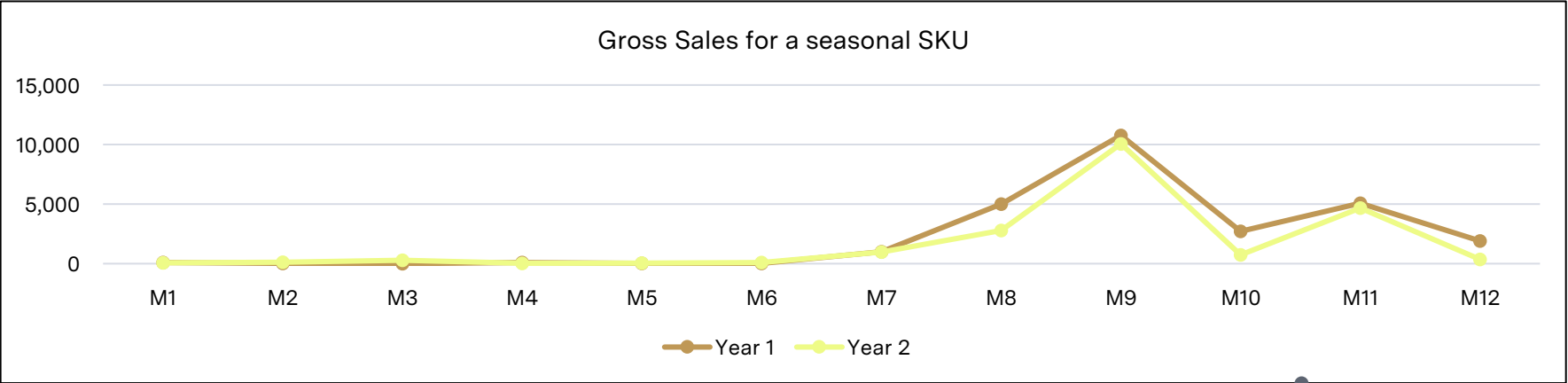
~9% Reduction



Any weekly sales above the threshold value is made equal to the threshold value and then used in the SS/ROP calculations for method A2

# Tailored inventory levels for periodic (seasonal) SKUs

ISBN>>	
Title	
Author	
Periodicity	End of Year
Start Month	8
End Month	11
Vendor Country	Country A
Vendor LT	45 days
LT (Weeks)	7
Inventory Category	AH
Service Level	90%



Periodicity can be identified through historical sales patterns (from M8 to M11 in this case)

The safety stock (SS) is different for peak and off-peak periods

The Reorder Point (ROP) fluctuates throughout the year, increases as we accumulate stock before the peak period and decreases as the peak period ends

During the off-peak period, the Inventory on Hand was unnecessarily high due to the lack of statistical calculations