SONY

Production Management

WH-1000XM5

Berta Leach, *Huiyun* Zhu, *Ivan* Ushakov, *Yong-Qi* Gao
Group 12

Mentor: Xavier Groux, Amin Kaboli
18 December 2024

Alex

Brief Background on Sony

Electronics Products & Solutions

Music

Game & Network Services

Financial Services

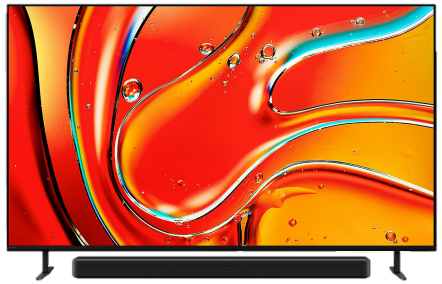
Image & Sensing solutions

Pictures

Most known products

Sony PlayStation

Bravia TV



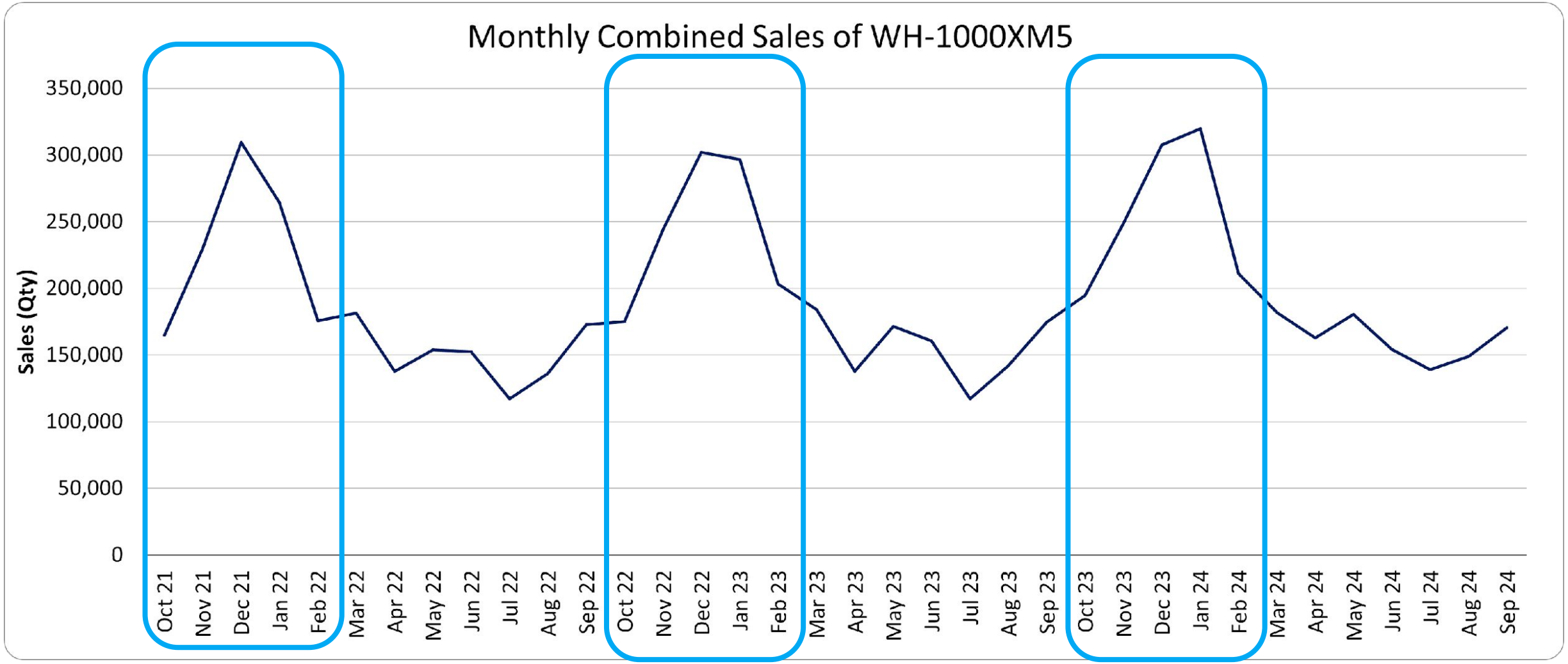
Noise canceling headphones

WH-1000XM5 (black + silver)

Walkman

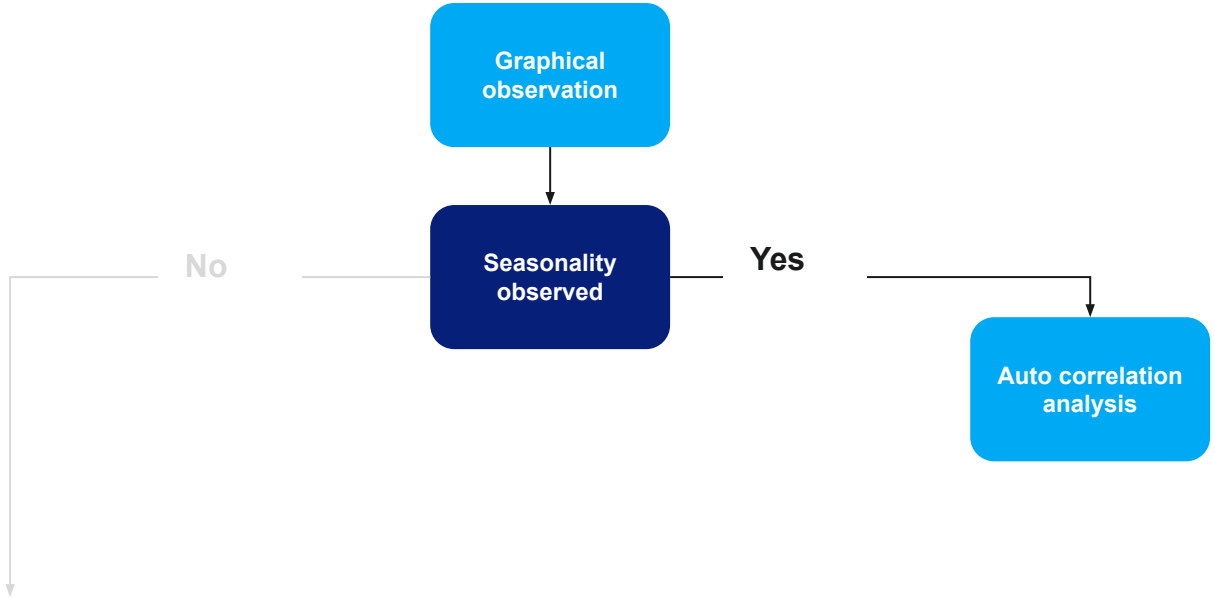
Ivan

Aggregated monthly sales data shows peaking sales in winter months every year



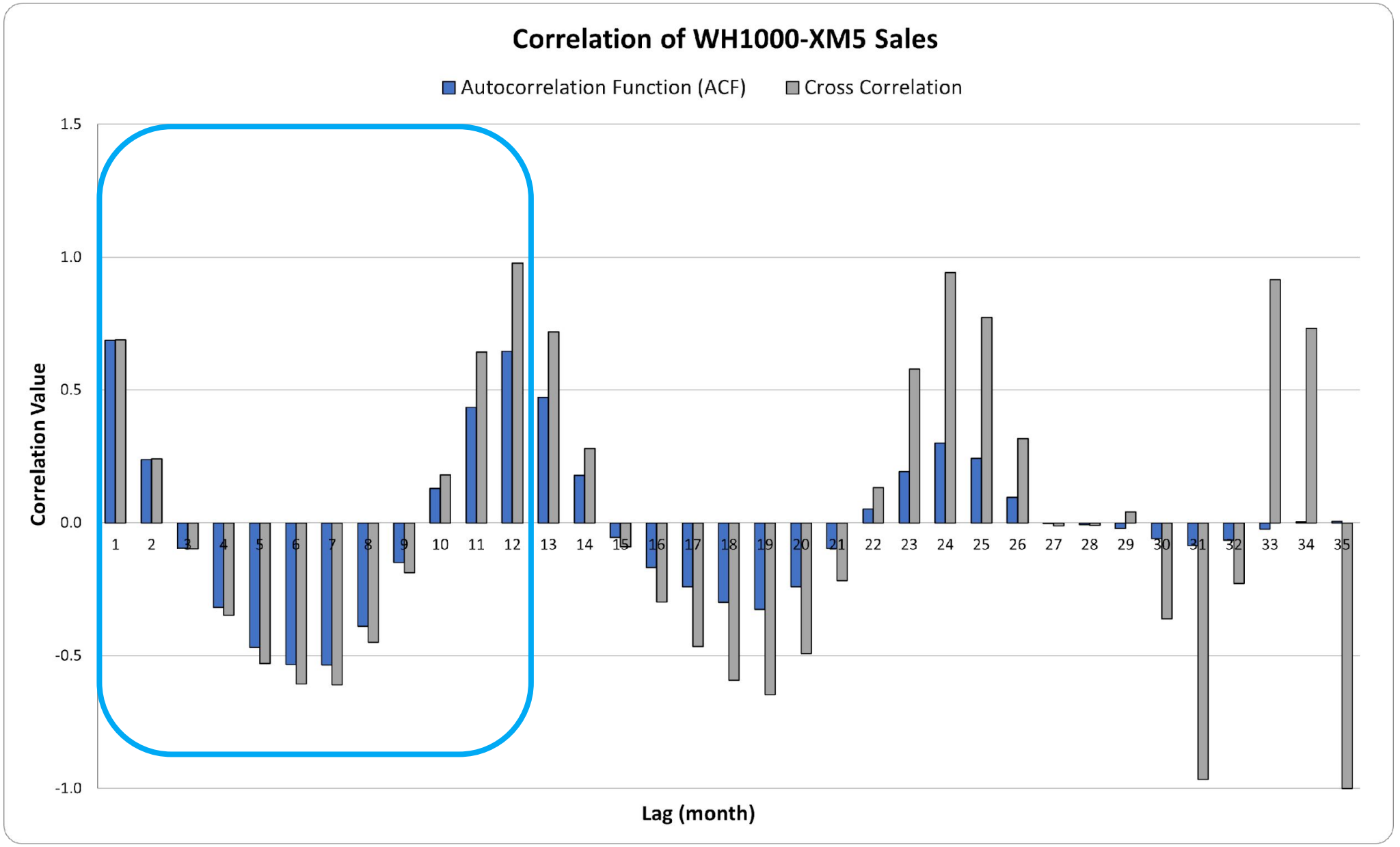
Ivan

Forecast model selection flow chart



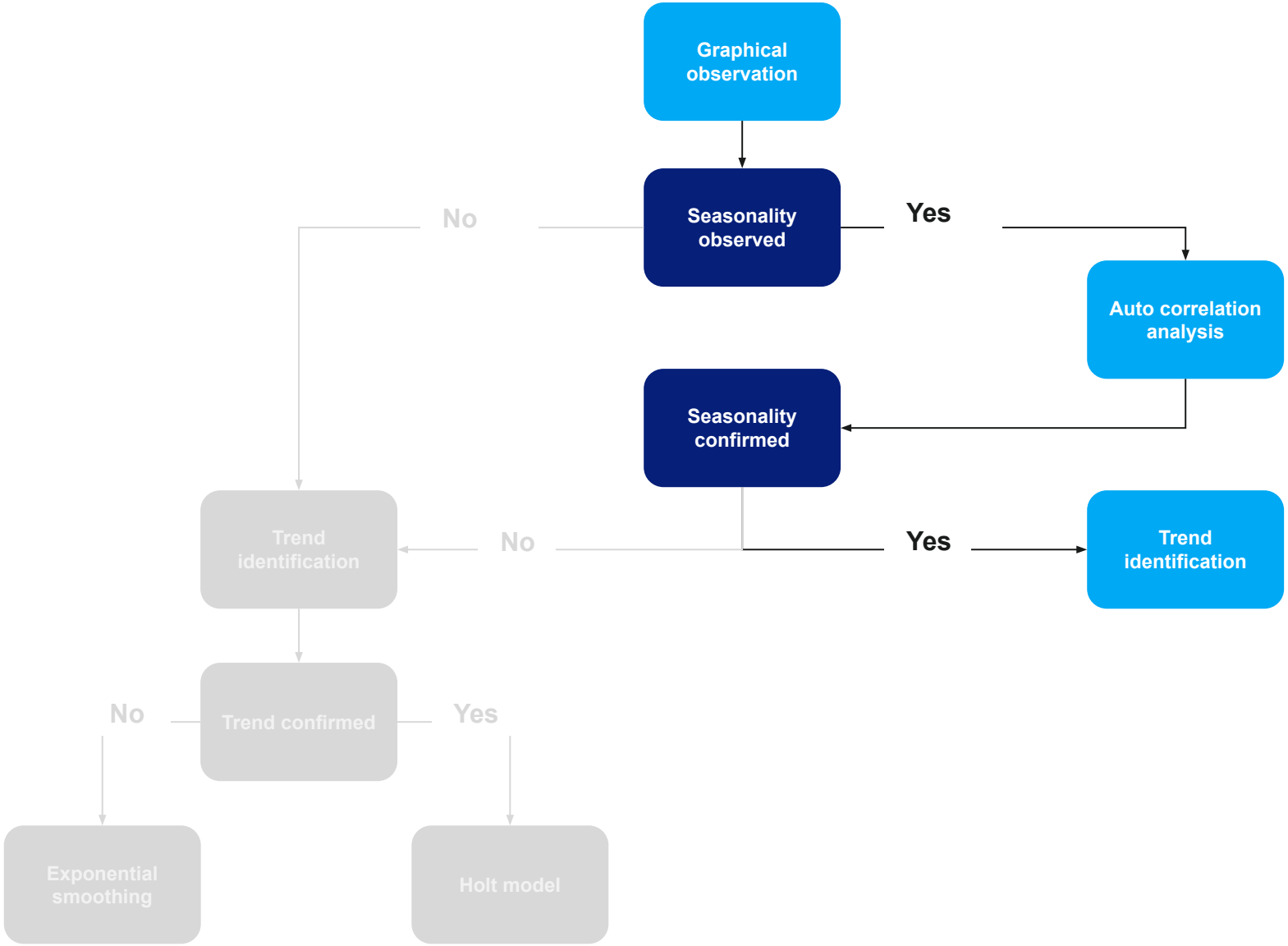
Correlation analysis demonstrates the existence of seasonality with a renewed cycle every 12 months

Ivan



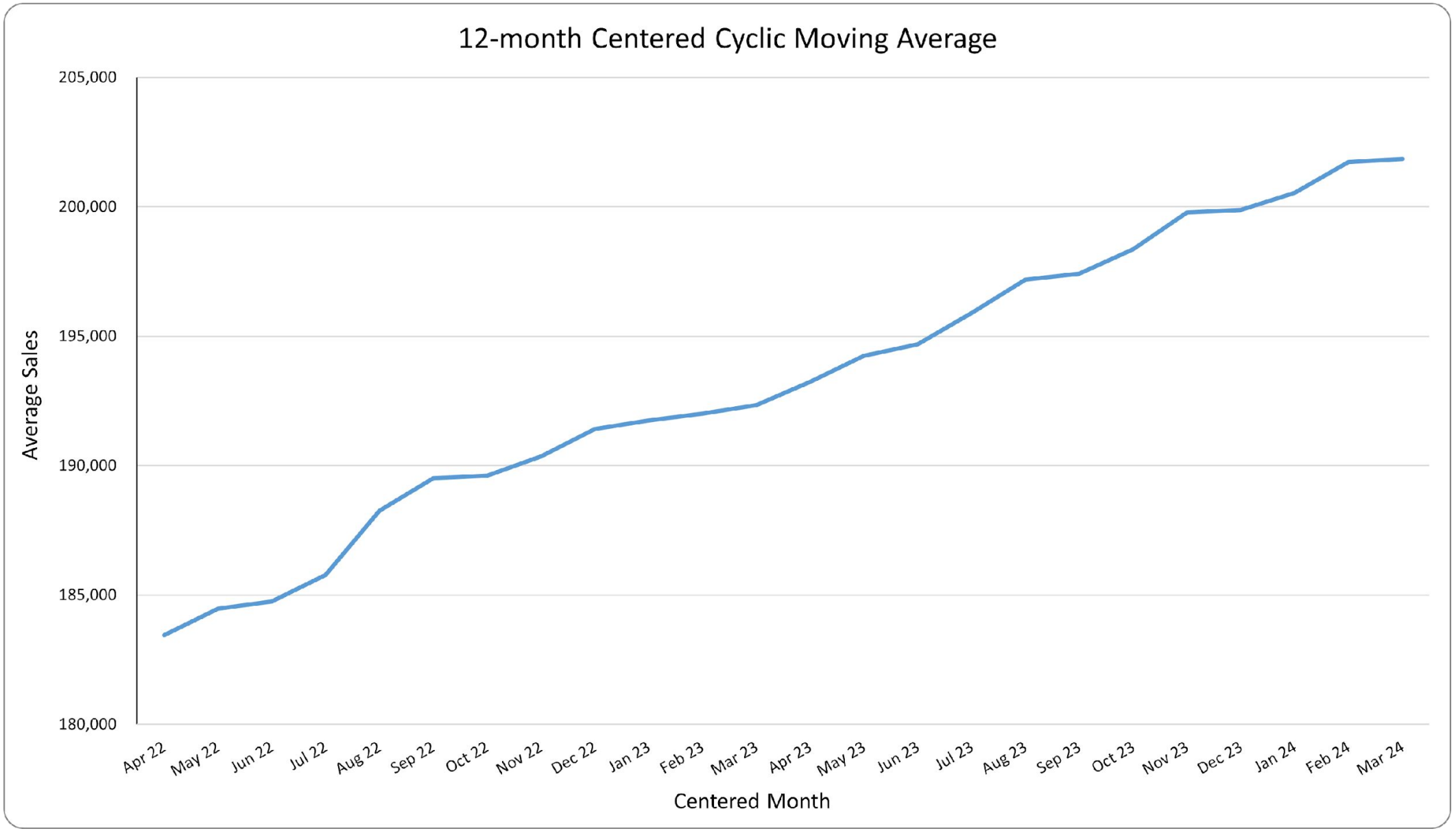
Ivan

Forecast model selection flow chart



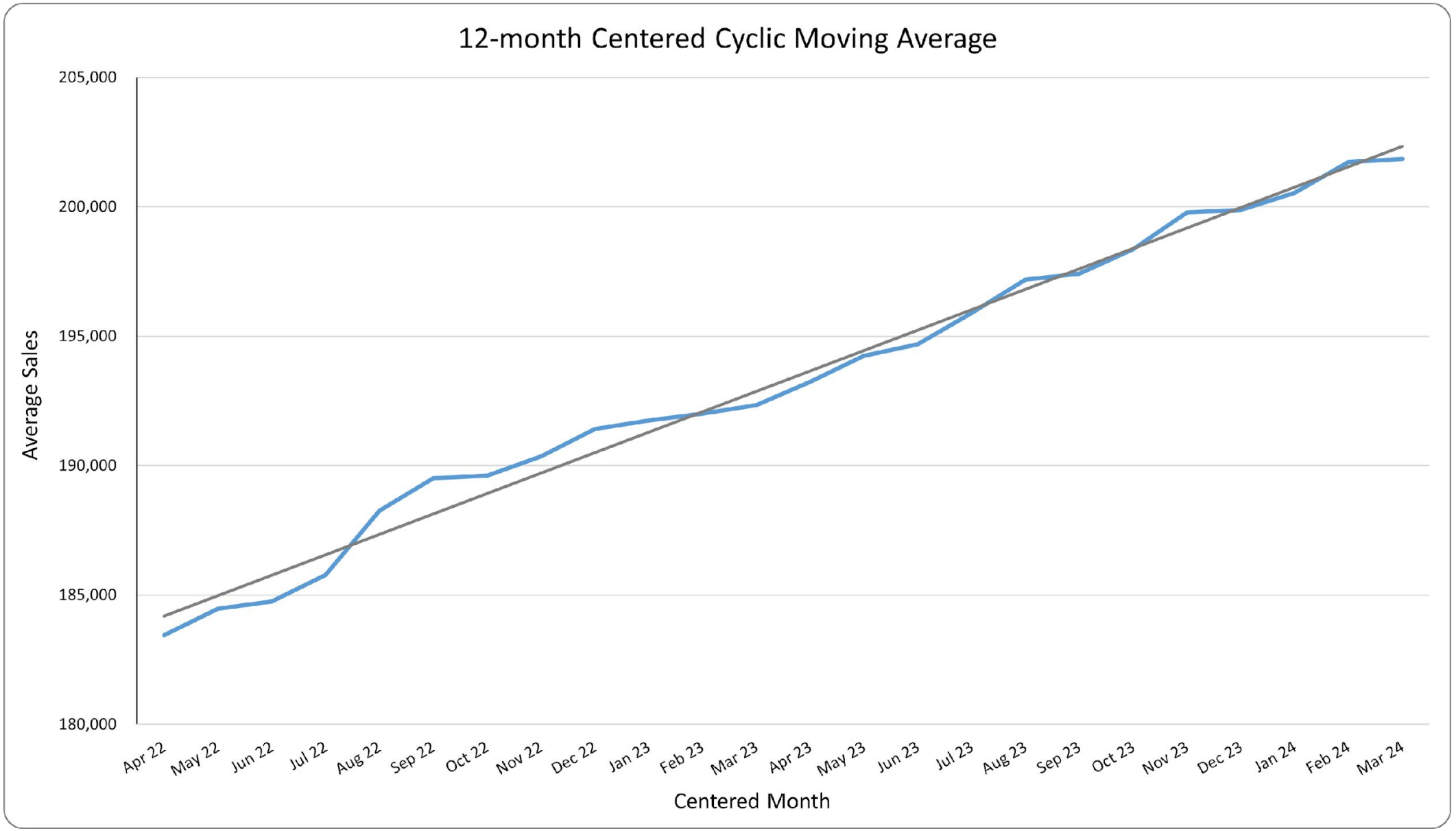
Ivan

Trend analysis by centered cyclic moving average show YOY increase in sales



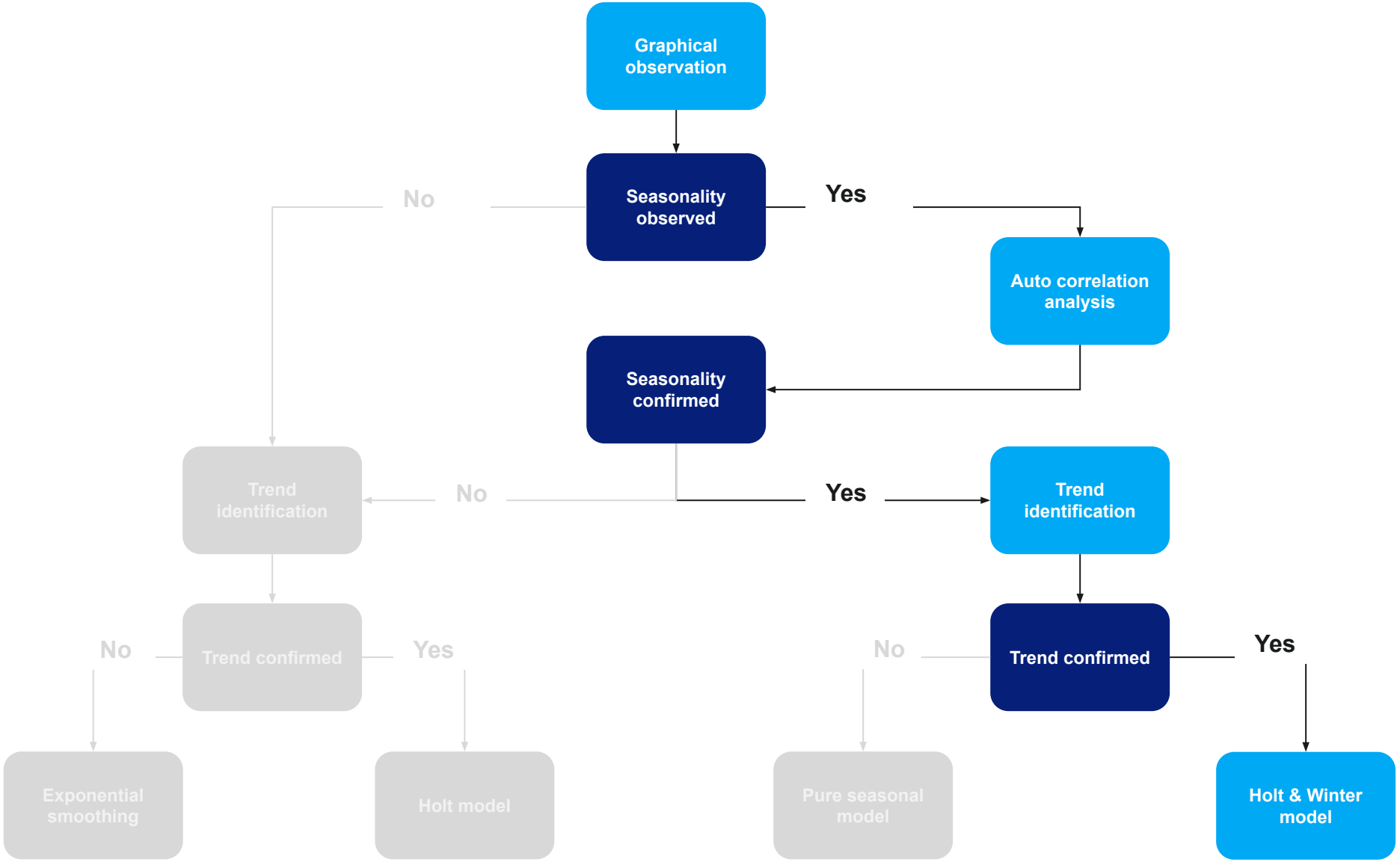
Trend analysis by centered cyclic moving average show YOY increase in sales

Ivan



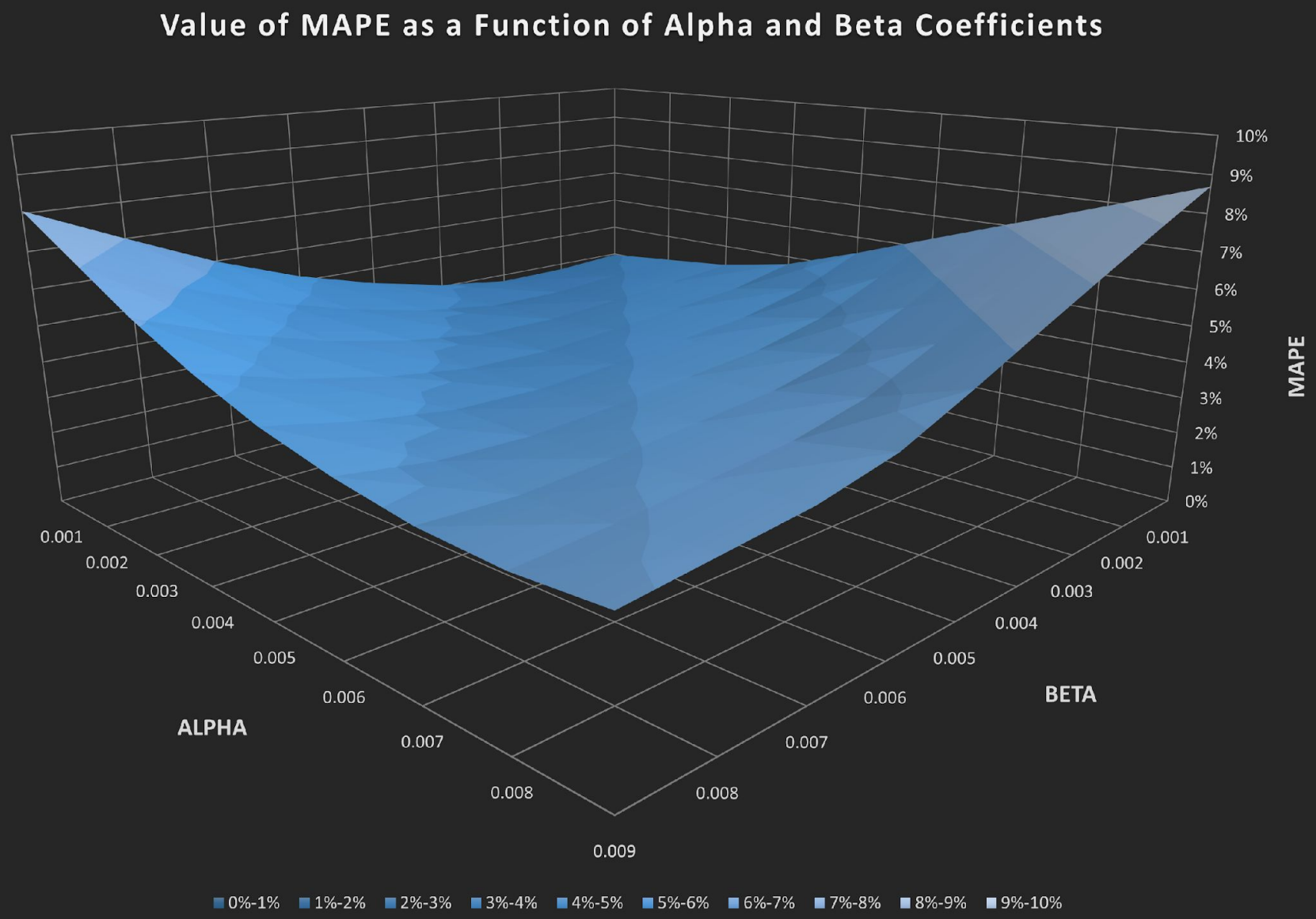
Ivan

Forecast model selection flow chart



Ivan

Optimisation for the Holt-Winter Forecast Model



Key Points

- **Three cycles** defined:
  - Oct 2021 ~ Sep 2022 → Training
  - Oct 2022 ~ Sep 2023 → Training
  - Oct 2023 ~ Sep 2024

- **Holt-Winter Model** in [a;m] configuration was selected

$$B_t = \alpha \frac{Y_t}{S_{t-c}} + (1-\alpha)(B_{t-1} + T_{t-1})$$

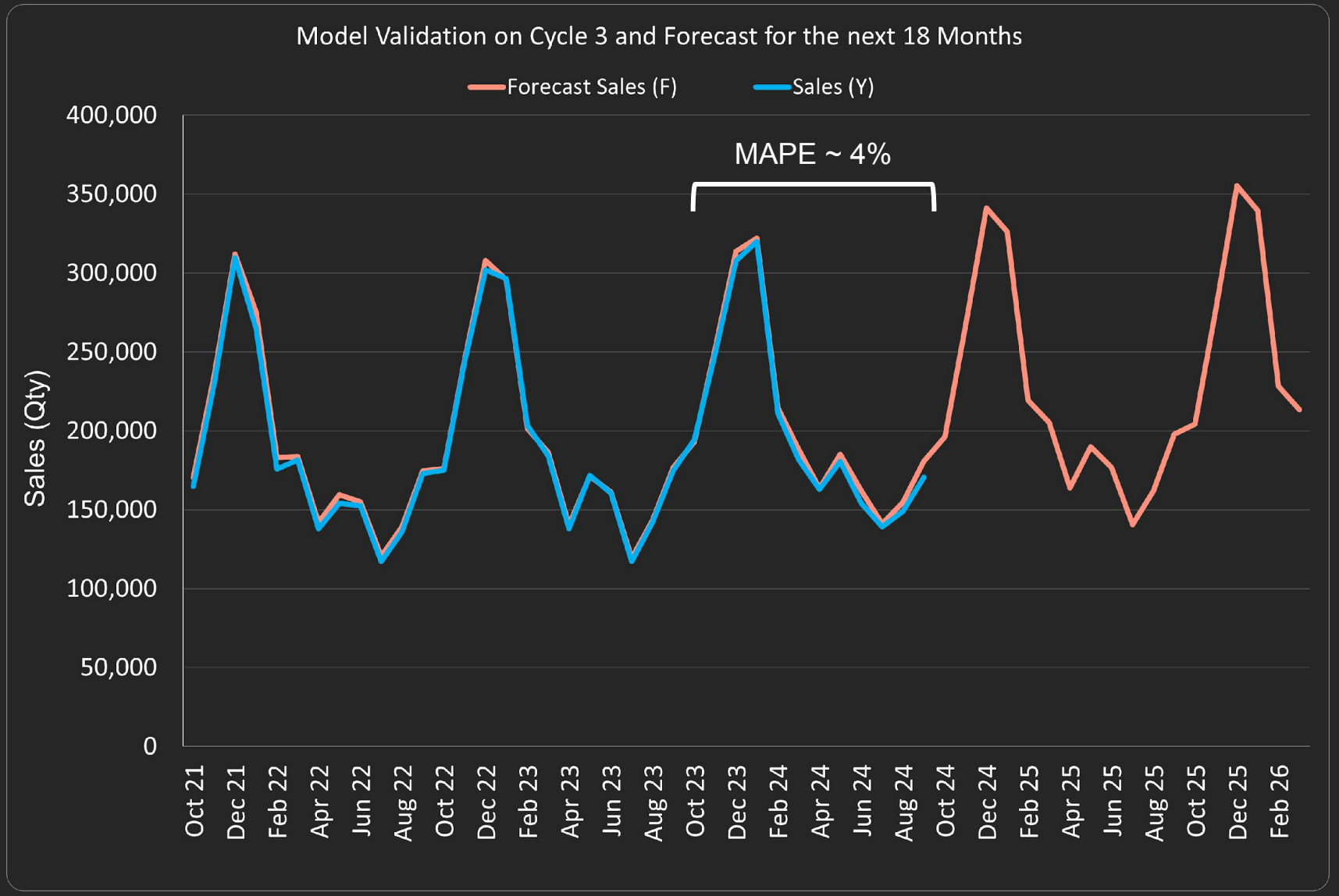
$$T_t = \beta(B_t - B_{t-1}) + (1-\beta)T_{t-1}$$

$$S_t = \gamma \frac{Y_t}{B_t} + (1-\gamma)S_{t-c}\,, c = 12$$

$$F_{t+h} = (B_t + hT_t) * S_{t+h-c}\,, h \in \mathrm{Z}$$

- **Optimised values** of average 3.78% MAPE was set at:
  - Alpha = 0.001
  - Beta = 0.003
  - Gamma = 0.8

Optimised Holt-Winter Forecast Model shows great match to cycle 3 sales data



Key Points

- **Three cycles** defined:
  - Oct 2021 ~ Sep 2022 → Training
  - Oct 2022 ~ Sep 2023 → Training
  - Oct 2023 ~ Sep 2024 → Validation

- **Holt-Winter Model** in [a;m] configuration was selected

$$B_t = \alpha \frac{Y_t}{S_{t-c}} + (1-\alpha)(B_{t-1} + T_{t-1})$$

$$T_t = \beta(B_t - B_{t-1}) + (1-\beta)T_{t-1}$$

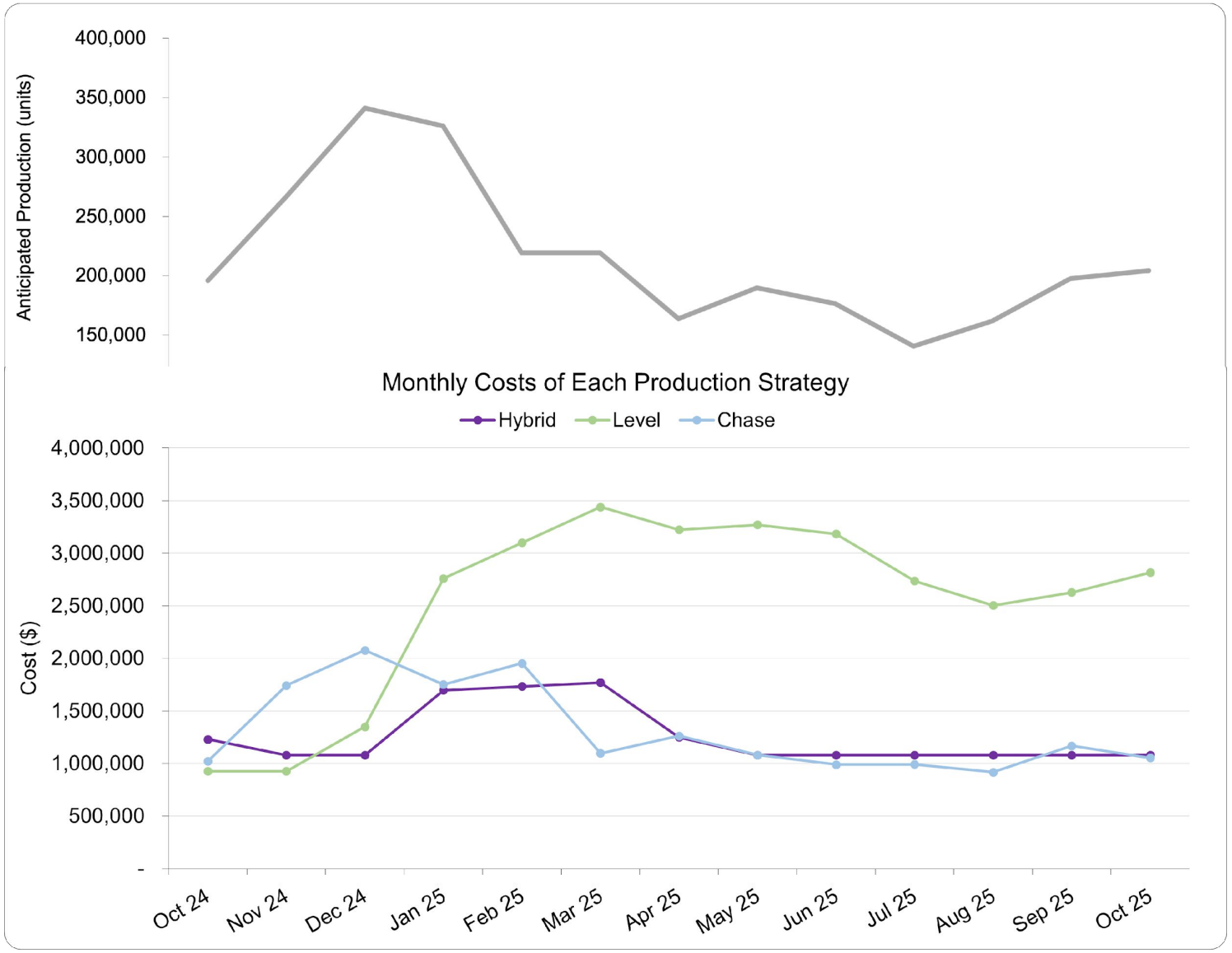
$$S_t = \gamma \frac{Y_t}{B_t} + (1-\gamma)S_{t-c}\,, c = 12$$

$$F_{t+h} = (B_t + hT_t) * S_{t+h-c}\,, h \in \mathrm{Z}$$

- **Optimised values** of average 3.78% MAPE was set at:
  - Alpha = 0.001
  - Beta = 0.003
  - Gamma = 0.8

Hybrid Aggregated Plan (AP) is the most optimal production strategy based on our assumptions

Alex



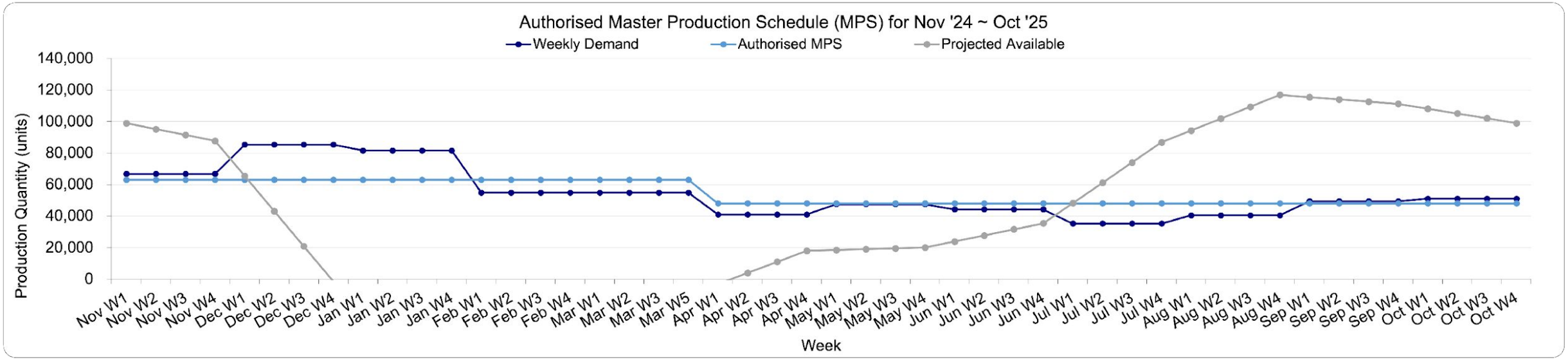
Assumptions

- Beginning inventory is average of cycle 3 (previous cycle).
- Labour standard estimated 100 units/worker 2150 employees.
- Hourly rate in Southeast Asia is $3/hr, with 160 hr/month Labor costs $5/unit.
- Overtime/ Subcontracting costs = 180% of labor costs.
- Inventory costs = $5/unit (upper end).
- Backorders = $10/unit.
- Hiring costs = $500/employee.
- Firing costs = $800/employee.
- **Level AP** = hire 300 by Oct ‘24
- **Chase AP** = hire and fire based on demand
- **Hybrid AP** = subcontract 400 from Nov ’24 until Apr ‘25, and fire an extra 100.

V1

Alex

Master Production Schedule (MPS) cannot account for all customer orders



Assumptions

- Initial inventory is average of previous cycle
- The security inventory is 20% of initial inventory
- MPS = (Allocated Demand) – (Available Units)
- Available to Promise = (Beginning Inventory) + (MPS) – (Next Customer Order)

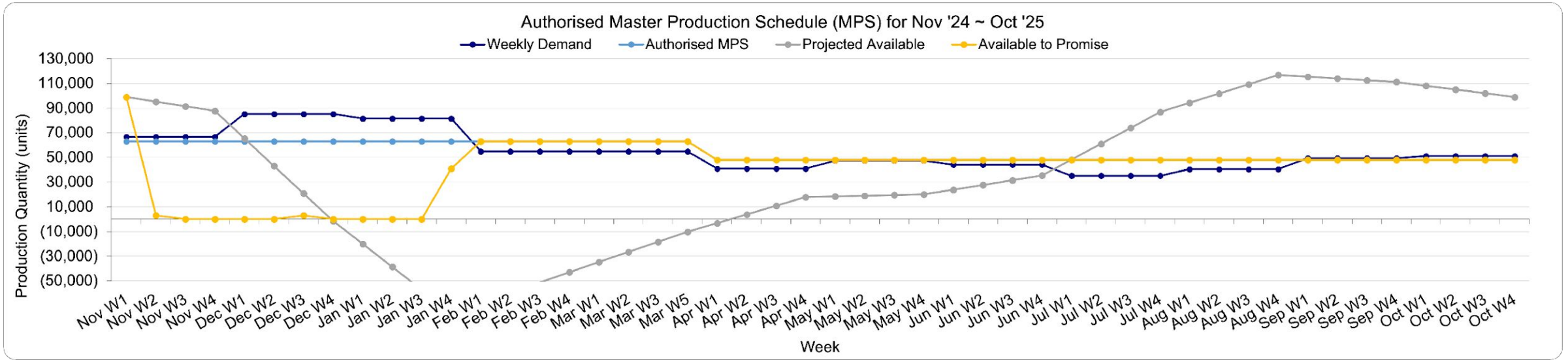
Customer Orders

- ✅ Nov 2024 Week 2 = 230,000 □ 4 weeks of Nov
- ✅ Dec 2024 Week 1 = 312,000 □ 4 weeks of Dec
- ✅ Jan 2025 Week 2 = 274,000 □ 4 weeks of Jan
- ❌ Mar 2025 Week 1 = 401,000 □ 8 weeks of Feb and Mar

V2

Alex

Master Production Schedule (MPS) cannot account for all customer orders



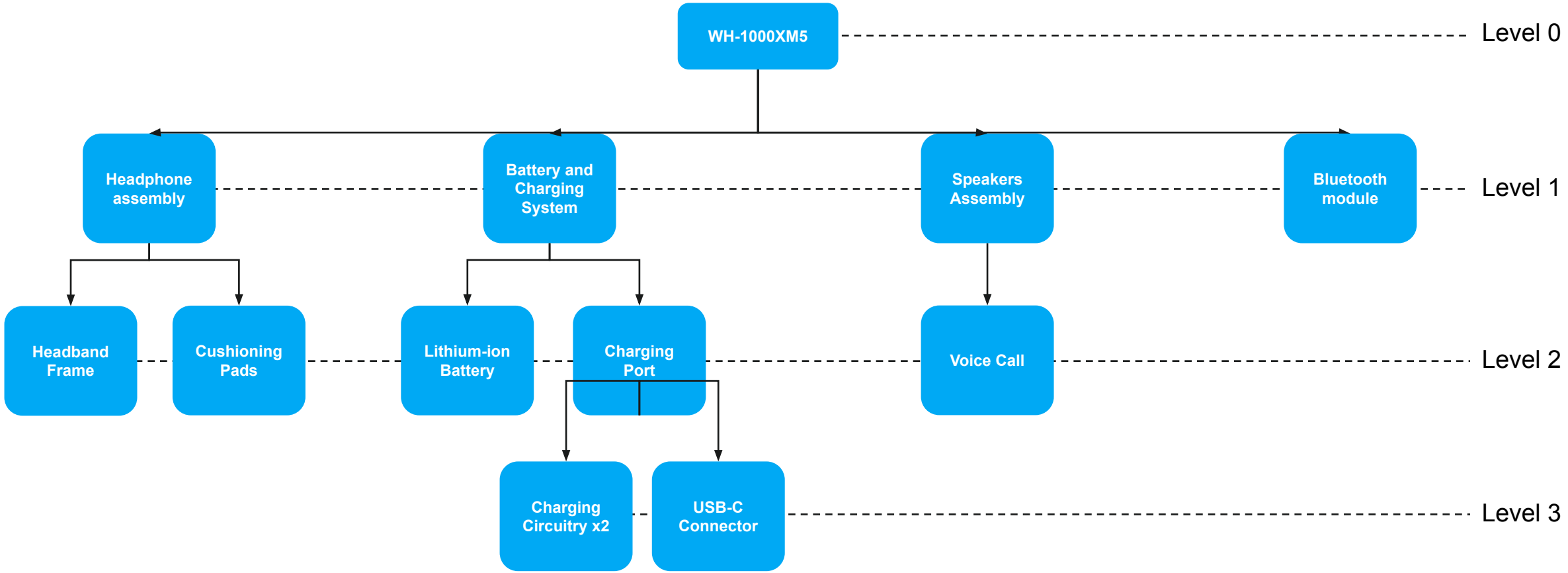
Assumptions

- Initial inventory is average of previous cycle
- The security inventory is 20% of initial inventory
- MPS = (Allocated Demand) – (Available Units)
- Available to Promise = (Beginning Inventory) + (MPS) – (Next Customer Order)

Customer Orders

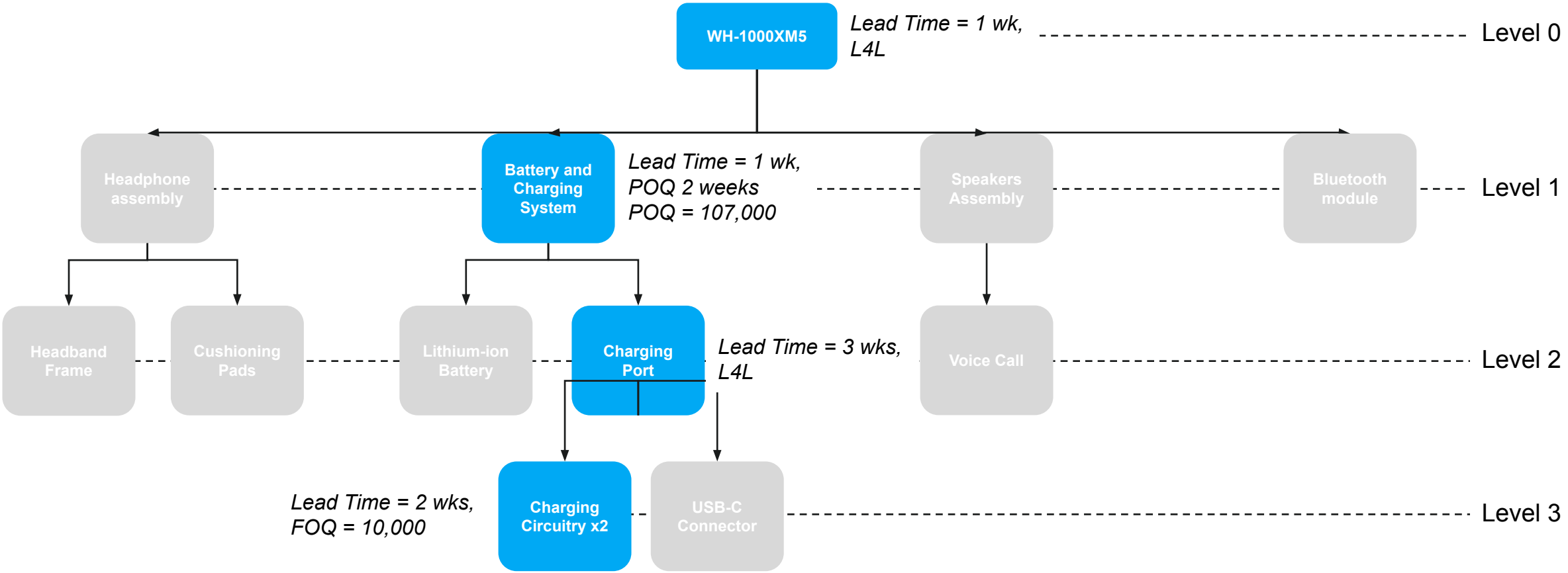
- ✅ Nov 2024 Week 2 = 230,000 □ 4 weeks of Nov
- ✅ Dec 2024 Week 1 = 312,000 □ 4 weeks of Dec
- ✅ Jan 2025 Week 2 = 274,000 □ 4 weeks of Jan
- ❌ Mar 2025 Week 1 = 401,000 □ 8 weeks of Feb and Mar

Bill of Materials (BoM)



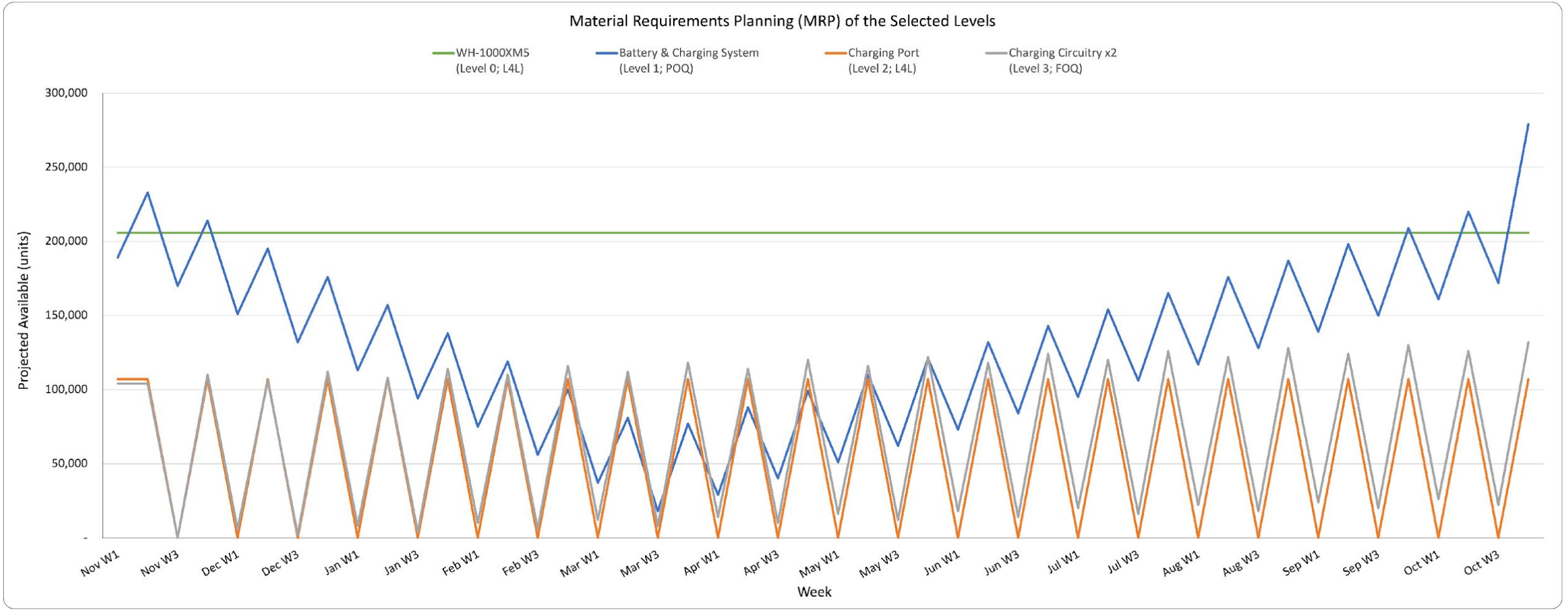
Known information for selected components in BoM used for downstream analysis

Berta

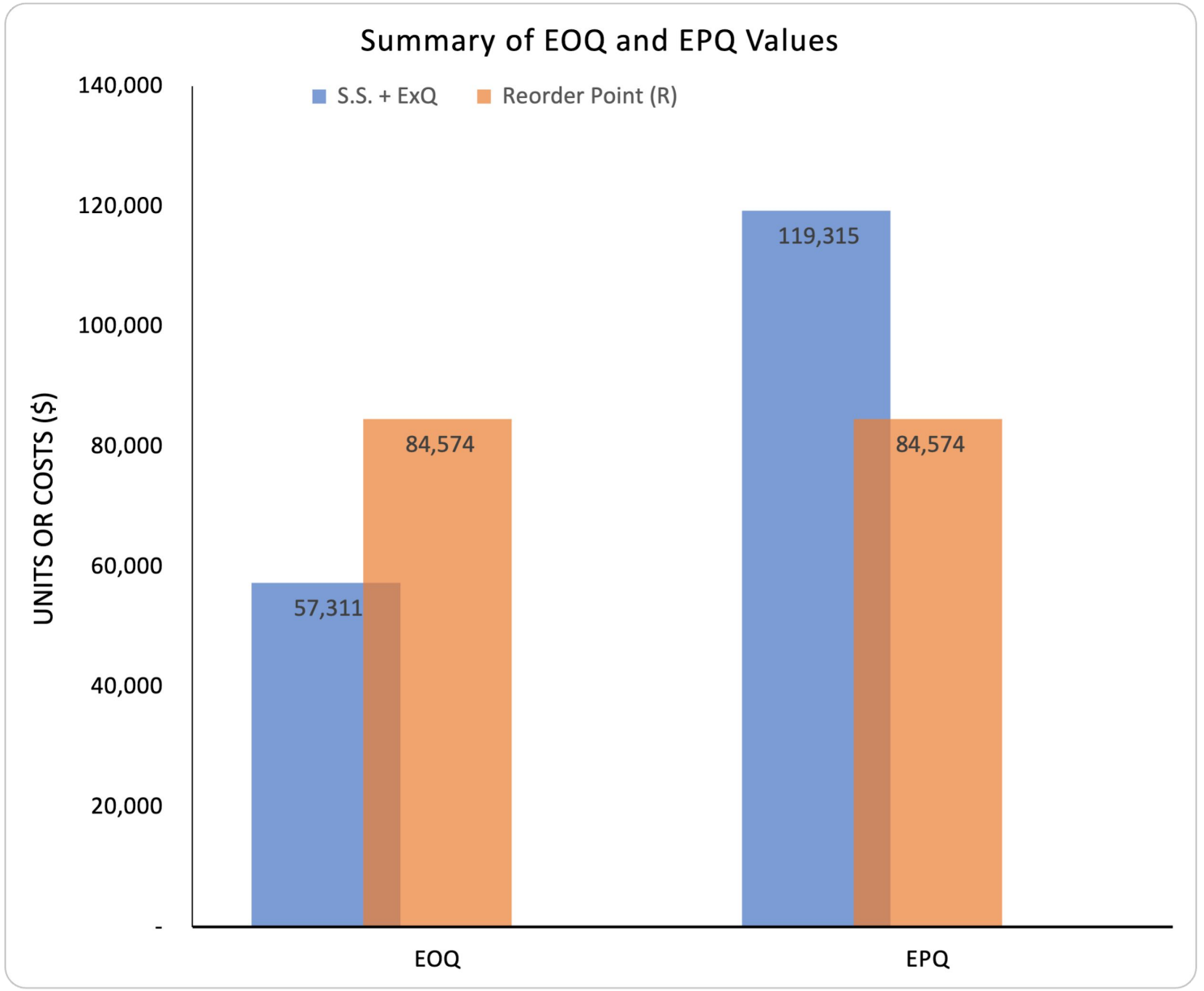


Material Requirements Planning (MRP) shows steady production of final product

Berta



Economic Production Quantity (EPQ) Model represents Sony production better than Economic Order Quantity (EOQ)



Procedure

- Hybrid AP
- Annual production from AP
- Annual demand and lead time from MRP
- 300 operational days/year
- 4~5 hrs/employee/order
- EOQ

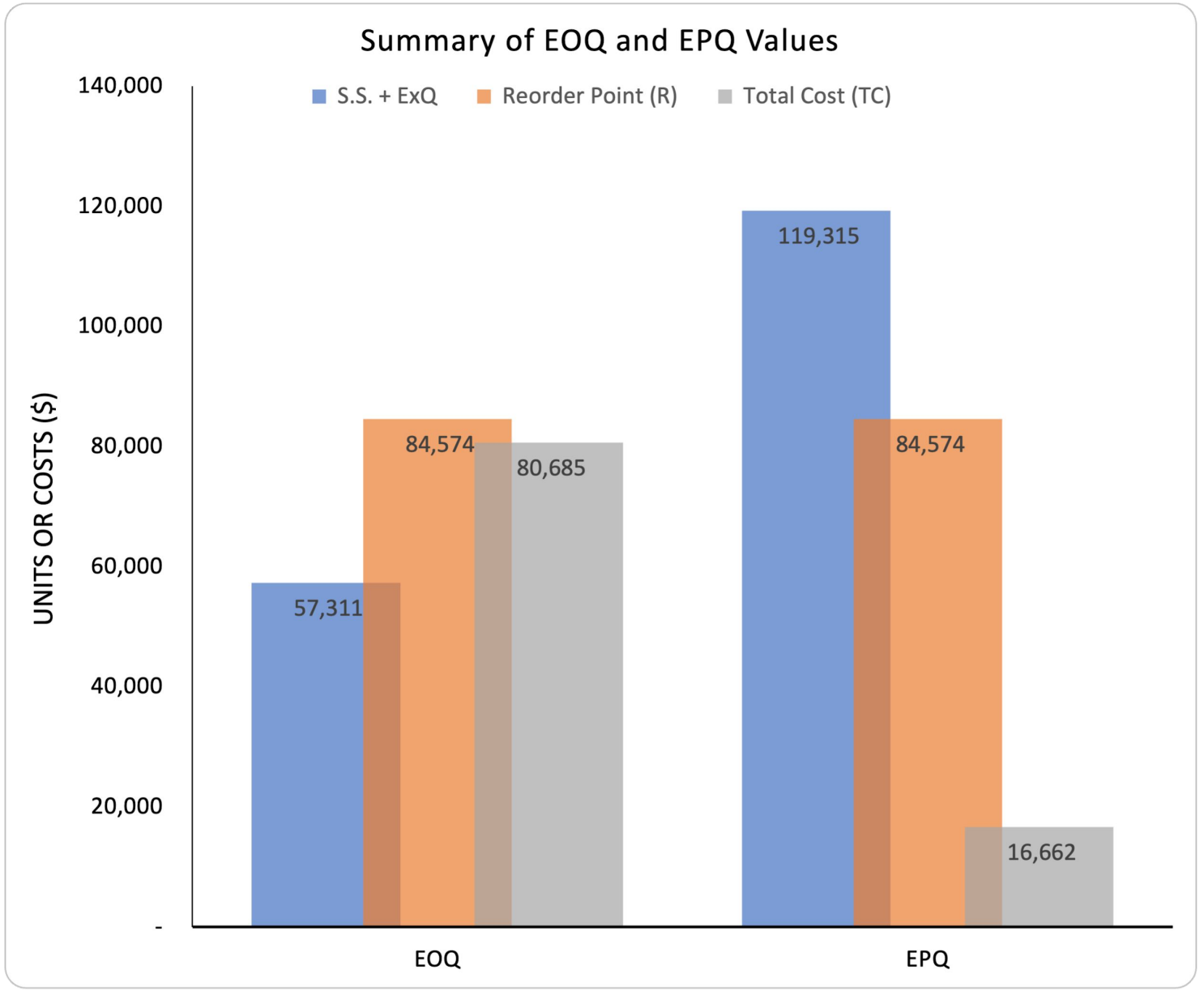
$$Q = \sqrt{\frac{2DS}{H}}, TC = \frac{D}{Q}S + \frac{Q}{2}H$$

- EPQ

$$Q = \sqrt{\frac{2DS}{H\left(1 - \frac{d}{p}\right)}}, TC = \frac{D}{Q}S + \frac{Q\left(1 - \frac{d}{p}\right)}{2}H$$

- Criteria: $R > SS + ExQ$

Economic Production Quantity (EPQ) Model represents Sony production better than Economic Order Quantity (EOQ)



Procedure

- Hybrid AP
- Annual production from AP
- Annual demand and lead time from MRP
- 300 operational days/year
- 4~5 hrs/employee/order
- EOQ

$$Q = \sqrt{\frac{2DS}{H}}, TC = \frac{D}{Q}S + \frac{Q}{2}H$$

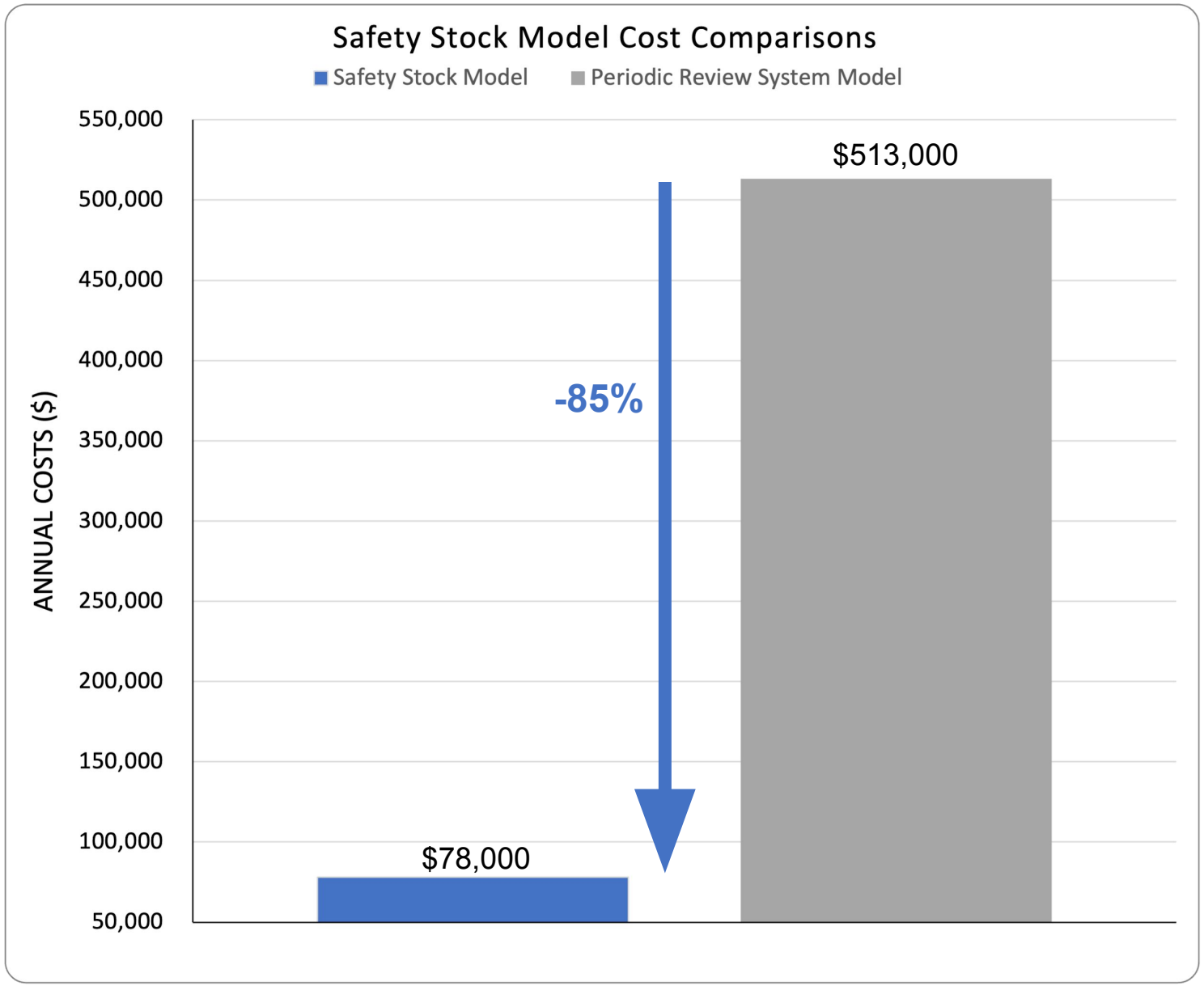
- EPQ

$$Q = \sqrt{\frac{2DS}{H\left(1 - \frac{d}{p}\right)}}, TC = \frac{D}{Q}S + \frac{Q\left(1 - \frac{d}{p}\right)}{2}H$$

- Criteria: $R > SS + ExQ$

Safety Stock Model incur a lower cost than a Periodic Review System Safety Stock Model

Huiyun



Equations

- Safety Stock Model

$$SS = z * \sigma_L$$

- Periodic Review Model

$$TI = d(RP + L) + SS$$
$$SS = z * \sigma_{RP+L}$$

- Annual Holding Costs

$$= Average\ Inventory\ * H$$

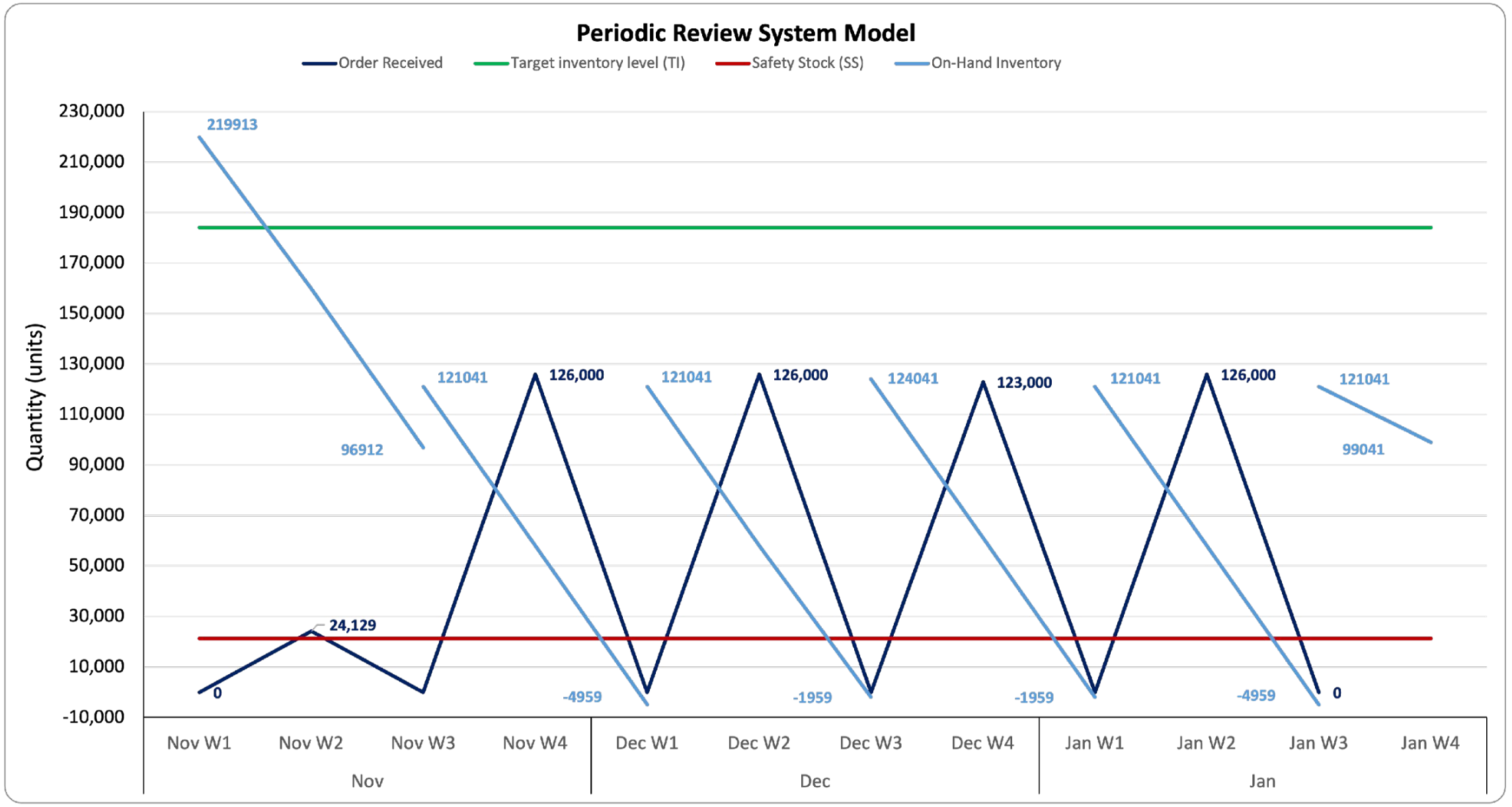
$$\text{Average Inventory} = \frac{\text{Target Inventory (TI)} - \text{Safety Stock (SS)}}{2} + \text{Safety Stock (SS)}$$

$$\text{Annual Holding Cost} = \text{Average Inventory} \times H$$

$$\text{Annual Ordering Cost} = \frac{D}{Q} \times S$$

Annual Total Inventory Cost = Annual Holding Cost + Annual Ordering Cost

Periodic Review System Model with review time of 2 weeks and lead time of 1 week show poor inventory management



Alex

Conclusions

- Sony WH-1000XM headphones **sales have grown** with sales **peaking in winter** months
- Forecasted sales by **Holt-Winter Model** has a **MAPE ~4%** and was used for production planning.
- **Hybrid** AP should be employed to **hire 400** employees that can start by November 2024 to work until April 2025, and we should lay off an additional 100 employees (**fire total of 500**).
- Based on the right lot size policies, we can determine how much of each component we would need to purchase to meet production demand.
- **EPQ** is a better model in terms of feasibility and cost to reflect production strategy of this product.
- **Safety Stock Model** should be adopted instead of a Periodic Review Model for its lower costs.

SONY

Thank You

References

- *Sony Corporation Report 2024*
- Sony Responsible Supply Chain Report 2024.
- Sony Corporation. (2022). *Sony WH-1000XM5 Wireless Noise-Canceling Headphones: Product Overview*. Bose, A. (2022). *How Sony's WH-1000XM5 Outperforms Its Competition*. Tech Review Magazine.
- Marshall, P. (2022). *The Role of AI in Modern Audio Devices: A Case Study on Sony WH-1000XM5*. Audio Engineering Journal, 18(3), 45-59.
- Kotler, P., & Keller, K. (2016). *Marketing Management* (15th ed.). Pearson Education.
- Nielsen, J. (2022). *Wearable Technology and the Future of Consumer Electronics*. Journal of Innovation in Electronics, 22(4), 67-78.
- Survey of chemical substances in headphones and hearing protection aids: https://www2.mst.dk/udgiv/publications/2008/978-87-7052-733-0/html/kap07_eng.htm