

Temasek Defence Systems Institute

Optimizing Ammunition Management in Singapore

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Motivation

Ammunition is crucial to Singapore's defense readiness and national security. Challenges faced by Singapore include **low peacetime usage, limited storage capacities, and significant disposal costs of ammunition**, highlighting a need for efficient ammunition stockpile management.

Objectives

To develop an optimization model to guide procurement strategies, determine optimal resource allocation between local production and overseas purchases, and recommend appropriate stockpile quantities to **optimize the overall lifecycle cost of ammunition**.

Analysis

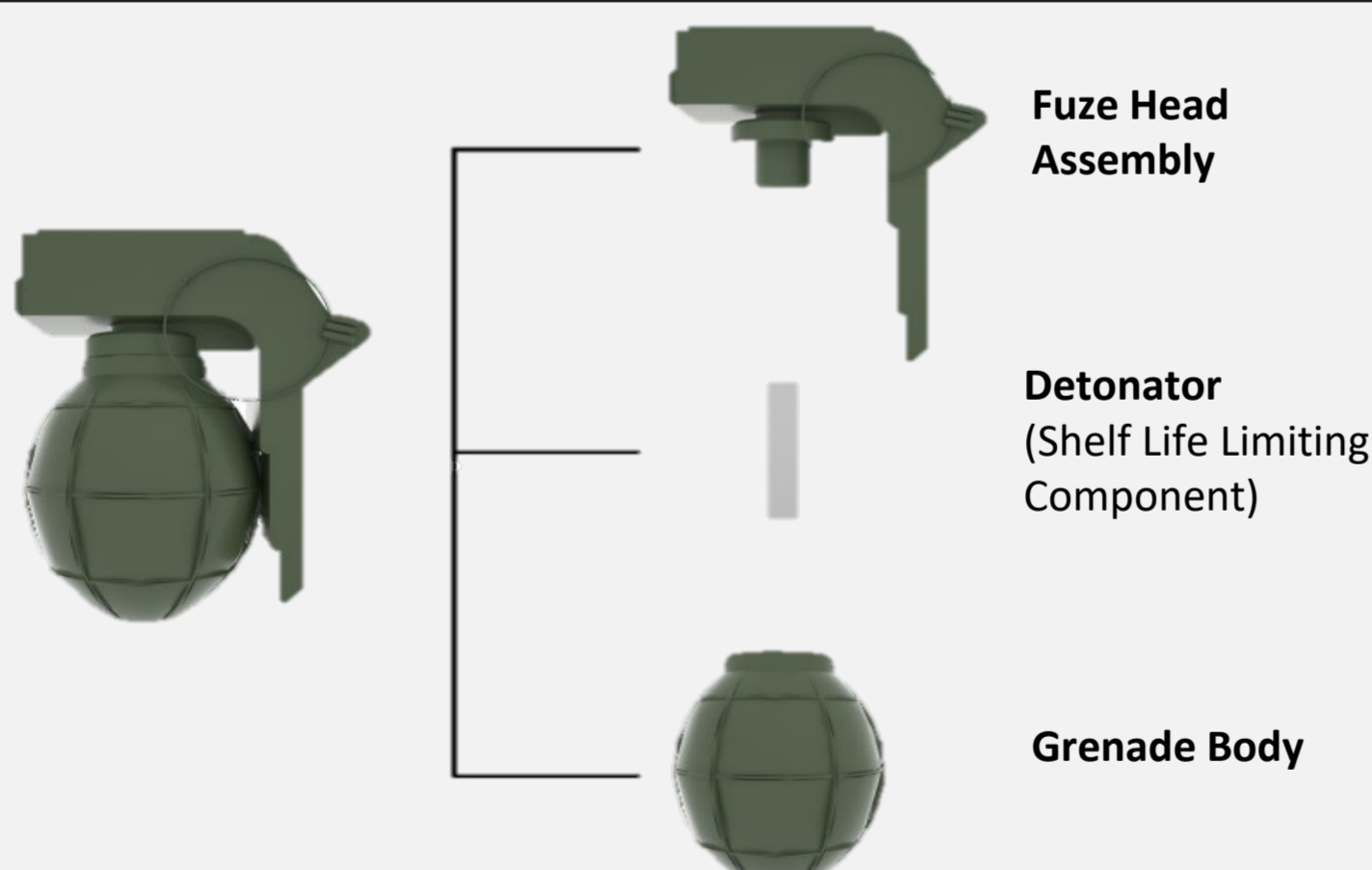
Methodology

Leveraging **integer linear programming**, our study analyzes 30 specific ammunition items. By incorporating modular storage management, our model ensures a **balance between maintaining a robust ammunition stockpile and cost efficiency**.

Objective Function for Integer Linear Programming

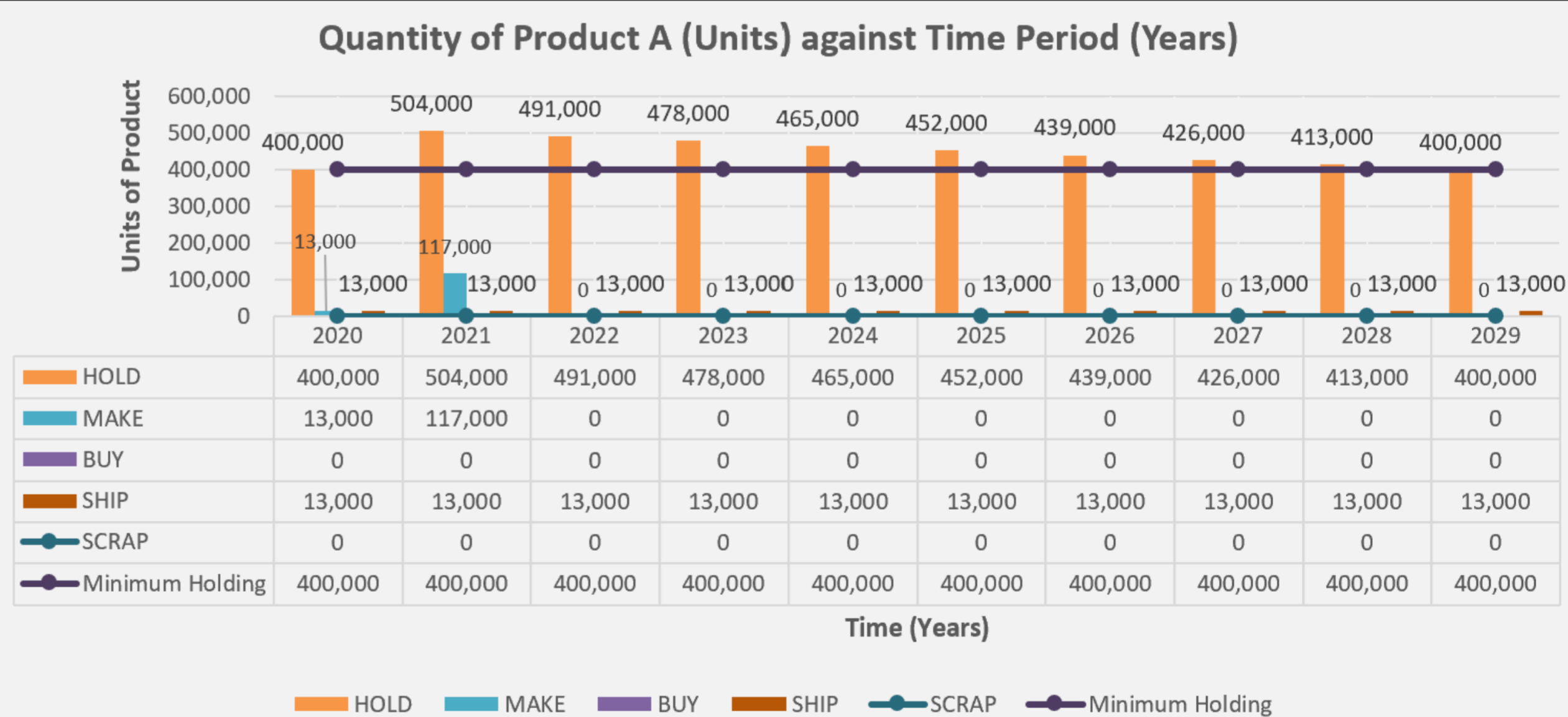
$$\begin{aligned} \min_{MAKE, BUY, ASSY, TRANS, SCRAP, A, R} & \left[\sum_j \sum_t makecost_j \times MAKE_{j,t} + buycost_j \times BUY_{j,t} \right. \\ & + \sum_{\tau} (disposalcost_j \times SCRAP_{j,t,\tau} |_{t=\tau+age}) \\ & + (pen_{j,t} \times A_{j,t} + \overline{pen}_{j,t} \times R_{j,t}) \left. \right] \\ & + \sum_i \sum_t compcost_i \times ASSY_{i,t} \\ & + \sum_d \sum_s \sum_{\sigma} \sum_t trans_{d,s,\sigma,t} \times TRANS_{d,s,\sigma,t} \end{aligned}$$

Modular Storage



By replacing only the shelf life limiting component, it leads to a cost avoidance of 60% of its unit cost in 30 years.

Results



With the following Key Considerations/Constraints:

- Transition cost arising from changing states of production lines
- Segregated storage of explosives
- Aged inventory where unused ammunition must be disposed of at a significant cost
- Elastic variables and penalties to localize unachievable results (due to stretched goals) with the best achievable results

Future Work

- To analyze the maximization of budget allocation for Defence Procurement
- To analyze the effects of bulk-buy for ammunition acquisition