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A system dynamics approach to maintenance capacity optimization under split acquisition: A military case study

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ABSTRACT

This study examines maintenance capacity adjustment strategies under split acquisition, a common practice in defense procurement driven by budgetary and production constraints. Using the Republic of Korea Air Force (ROKAF) F-35A as a case, the study investigates how time gaps between acquisition phases, combined with bathtub-shaped failure patterns, generate non-linear shocks in maintenance workload that threaten operational availability. A System Dynamics (SD) model is developed to simulate a 40:20 split acquisition scenario and to compare three capacity adjustment strategies: Level (fixed), Chase (reactive), and Lead (proactive). The strategies are evaluated under review intervals of 3, 5, and 10 years to reflect realistic defense planning environments. The simulation results show that the reactive Chase strategy consistently fails to achieve the availability target of 75 % due to workforce training delays. In contrast, the proactive Lead strategy successfully defends availability by anticipating future workload changes. A 3-year review interval achieves the highest cost-effectiveness, while a 5-year interval, aligned with the Mid-term Defense Plan cycle, is identified as a realistic threshold for sustaining availability. However, under a 10-year review interval, even proactive strategies lose effectiveness. The findings highlight the importance of proactive, forecast-based decision-making and suggest that synchronizing maintenance review cycles with acquisition schedules within a 5-year horizon is essential for robust maintenance policy design.

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