Temasek Defence Systems Institute

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Improvement of Armored Fleet Availability During Upgrades

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Introduction

Modern forces must modernize legacy armored fleets without creating readiness gaps. This thesis uses a fishbone diagnosis and a discrete-event simulation spanning training, maintenance, and upgrade flows to compare strategies, quantify impacts on operational availability, dwell time, and maintenance burden, and guide a modernization schedule that sustains readiness.

Problem Statement

How can we upgrade armored vehicle while maintaining operational availability, given manpower, spare parts and throughput constraints?

Research Questions

1. How can upgrade strategies be improved to meet or exceed required armored fleet availability throughout modernization efforts?
2. What are the trades off between different upgrade strategies?
3. What decision support insights can be generated to guide future planning and scheduling of system upgrades?

Methodology

The model is developed in ExtendSim to simulate training, maintenance, and upgrade activities of armored vehicles, assessing how different upgrade strategies affect fleet availability in the following steps.

1. Data Collection and Failure Function Determination

- Historical failure hours were collected.
- Kolmogorov-Smirnov (K-S) test was applied to identify the best failure distribution.

2. Modeling in ExtendSim

Fig 1. Simulation Flowchart Overview

Fig 3. Parallel Upgrade Flowchart

Fig 2. Baseline Model Flowchart

Fig 4. Upgrade During Maint Flowchart

- Sequential Upgrade (Baseline) – Upgrades done one subsystem at a time; represents standard practice in most upgrade programs.
- Parallel Upgrade – Multiple subsystem upgrade together; chosen to assess the impact of faster upgrade cycles.
- Upgrade During Maintenance – Upgrades performed when a failure occurs; selected to measure efficiency when upgrades aligns with routine repairs.

3. Measurable Outcomes

- Operational Availability (Ao): The total time the fleet remain operational compared to the total time observed.
- Component Utilization: Tracks how subsystem are used and replaced overtime to assess utilization and bottlenecks.

Key Results

- Baseline (Sequential): Operational Availability (Ao) at 66.5%, served as reference point to measure other strategies.
- Parallel: Ao at 69.01%. Lower upgrade duration but require higher manpower and logistic effort.
- Upgrade during Maint: Ao at 70.5%. Balance between readiness and resource demand. Allowed upgraded components to enter service early, raising reliability.

Conclusion

Upgrading strategy directly affects fleet operational availability and modernization speed. Integrating upgrades into maintenance cycles offers the best balance between readiness, reliability, and resource use while maintaining continuous fleet operation.

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