Cooling Fan Replacement Policy Evaluation Report

# Introduction

This report presents a discrete-event Monte Carlo simulation to evaluate two cooling-fan replacement policies in a data center. We compare the Current Policy, which replaces a single failed fan, against the Proposed Policy, which replaces all three fans upon any failure. Key performance indicators include total cost and total elapsed time to service a fixed number of failures, facilitating a recommendation based on cost-effectiveness per operational hour.

# Policy Definitions

Under the Current Policy, each time a fan fails, exactly one fan is replaced. Under the Proposed Policy, all three fans are replaced whenever any one fan fails. Let n denote the number of fans replaced (n=1 for Current, n=3 for Proposed).

A black background with a black square

AI-generated content may be incorrect.

# Methodology

The simulation proceeds as a discrete-event model over N failures (default N=45) within each Monte Carlo run.

# Mathematical Expressions

## Policy Definitions

A black background with a black square

AI-generated content may be incorrect.

## Sampling Fan Lifetimes

A black background with a black square

AI-generated content may be incorrect.

## Sampling Probabilities



## Failure Time



## Technician Delay

D \in \{20, 30, 45\} \quad \text{(minutes)}

## Delay Probabilities

\{0.60, 0.30, 0.10\}

## Replacement Cost

C\_{\text{rep}} = n \times c\_{\text{fan}}, \quad c\_{\text{fan}} = \$32.00

## Downtime Cost

C\_{\text{down}} = (D + T\_{\text{rep}}) \times c\_{\text{down}}, \quad c\_{\text{down}} = \$10.00/\text{min}

## Labor Cost

C\_{\text{labor}} = \frac{T\_{\text{rep}}}{60} \times c\_{\text{labor}}, \quad c\_{\text{labor}} = \$30.00/\text{hr}

## Event Cost

C\_{\text{event}} = C\_{\text{rep}} + C\_{\text{down}} + C\_{\text{labor}}

## Time per Event

T\_{\text{event}} = \Delta t\_{\text{oper}} + \frac{D + T\_{\text{rep}}}{60} \quad (\text{hours})

## Total Time

T\_{\text{total}} = \sum\_{j=1}^{N} T\_{\text{event}}^{(j)}

## Total Cost

C\_{\text{total}} = \sum\_{j=1}^{N} C\_{\text{event}}^{(j)}

## Effectiveness

\text{Effectiveness} = \frac{E[C\_{\text{total}}]}{E[T\_{\text{total}}]}

## Policy Comparison

\frac{E[C\_{\text{total}}^{\text{Proposed}}]}{E[T\_{\text{total}}^{\text{Proposed}}]} < \frac{E[C\_{\text{total}}^{\text{Current}}]}{E[T\_{\text{total}}^{\text{Current}}]}