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Optimal maintenance policy for a system subject to damage in a discrete time process

Yu-Hung Chien[a], Shey-Huei Sheu[b, c], Zhe George Zhang[d, e]

[a] Department of Applied Statistics, National Taichung University of Science and Technology, No. 129, Section 3, San-min Road, North District, Taichung 40401, Taiwan

[b] Department of Statistics and Informatics, Providence University, No. 200, Chung Chi Road, Taichung 43301, Taiwan

[c] Department of Industrial Management, National Taiwan University of Science and Technology, No. 43, Section 4, Keelung Road, Taipei 107, Taiwan

[d] Department of Decision Sciences, Western Washington University, 516 High Street, Bellingham, WA 98225, USA

[e] Beedie School of Business, Simon Fraser University, Burnaby, BC, Canada V5A 1S6

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Abstract

Consider a system operating over n discrete time periods (n=1, 2, …). Each operation period causes a random amount of damage to the system which accumulates over time periods. The system fails when the cumulative damage exceeds a failure level ζ and a corrective maintenance (CM) action is immediately taken. To prevent such a failure, a preventive maintenance (PM) may be performed. In an operation period without a CM or PM, a regular maintenance (RM) is conducted at the end of that period to maintain the operation of the system. We propose a maintenance policy which prescribes a PM when the accumulated damage exceeds a pre-specified level δ ($<\zeta$), or when the number of operation periods reaches N, whichever comes first. With the long-term average cost rate as an optimality criterion, we optimize the maintenance policy parameters δ and N and discuss some useful properties about them. It has been shown that a δ-based PM outperforms a N-based PM in terms of cost minimization. Numerical examples are presented to demonstrate the optimization of this class of maintenance policies.

Keywords

Maintenance; Cumulative damage; Expected cost rate; Operation period; Renewal reward theory

Figures and tables from this article:

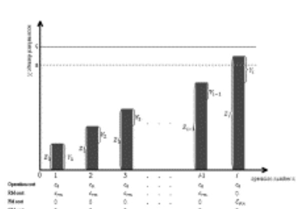

Fig. 1. PM due to damage level δ at i th (i=1, 2, …, N) operation.

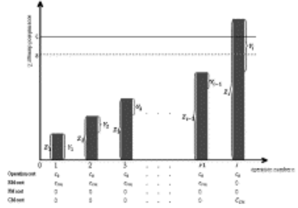

Fig. 2. CM due to damage level ζ at i th (i=1, 2, …, N) operation.

Figure options

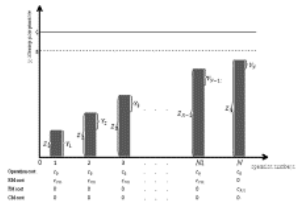

Fig. 3. PM due to the completion of N th operation without exceeding damage level δ.

Figure options

Table 1-1. N and $CR(\delta,N)$ for a given δ=20 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

View Within Article

Table 1-2. N and $CR(\delta,N)$ for a given δ=18 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 1-3. N and $CR(\delta,N)$ for a given δ=16 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 1-4. N and $CR(\delta,N)$ for a given δ=14 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 2-1. δ and $CR(\delta,N)$ for a given $N=\infty$ and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 2-2. δ and $CR(\delta,N)$ for a given N=15 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 2-3. δ and $CR(\delta,N)$ for a given N=10 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

View Within Article

Table 2-4. δ and $CR(\delta,N)$ for a given N=8 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 2-5. δ and $CR(\delta, N)$ for a given N=5 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Corresponding author. Tel.: +886 4 22196080; fax: +886 4 22196331.