Optimal Decision Procedure to Declare Human Fatigue and Prediction of 3-Mean Repair Times with One Repairman

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ABSTRACT

This paper gives an optimum procedure to decide whether fatigue is present in a repairman and if it is true prediction of the 3-mean repair times of the three failed systems.

Keywords: Mean repair times, optimal decision procedure, human fatigue

NOMENCLATURE

MRT	Mean repair time
A, B, C	Three support systems for which MRTs are needed.
η_1, η_2	Multiplying constant for t_3
α	Type I error
β	Power function
t_1, t_2, t_3	3-MRTs of support systems A, B, C, respectively
Z_b	A random variable which takes values between 1 or 0, depending on whether fatigue of repairman exists or not.
S	$S = \sum_{1}^{M} Z_b$
M	Total number of MRTs for which repair completions are over, i.e., $M = 3$
H_0	Null hypothesis
H_1	Alternate hypothesis

1. INTRODUCTION

Consider a multisystem model $(N + 3)$, where N is the number of systems, in the major system which has three additional systems called support systems. These support systems are denoted by A, B and C. The repair of A, B and C is taken by a single repairman in the order A, B, C. The mean repair completion times for the three support systems A, B and C (3-MRTs) are denoted by symbols t_1, t_2 and t_3. The human fatigue problems enter the 3-MRT process since there is one repairman only. In such cases, it is easy to think and formulate the whole problem as problems in the decision-making[1] and decision procedures.

2. DECISION-MAKING PROBLEM

The decision-making problem is formulated as

H_0	No fatigue exists in the repairman
H_1	Fatigue exists in the repairman, or in other words $t_1 < t_2 < t_3$

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2.1 Decision Procedure

Step 0 Choose α (type I error)

Step 1 If $t_1 < t_2 < t_3$, then $Z_b = 1$, otherwise $Z_b = 0$

Step 2 Compute $S = \sum_{b=1}^{M} Z_b$

Step 3 Put $M = 1, 2, 3$ in summation S successively

Step 4 Determine k, such that $binf(k;1/6,3) = \alpha$

Step 5 Reject H_0 *iff* $S = 2$ and if $S \neq 1$.

2.2 Analysis

Define $$h(t_1) = \int_{t1}^{\infty} d\,t_2 \int_{t2}^{\infty} d\,t_3 \;\exp f(t) \exp f(t) \quad (1)$$

It is to be remembered that Eqn (1) is true regardless of H_0 and H_1.

It can be easily shown that

$$P_0 = Pr\{Z_b = 1; \text{regardless of } H_0, H_1\}$$
$$= E\{h(t_1)\} \quad (2)$$

where E is the expected value.

Now

$$Pr\{S = r; H_0 \text{ is true}\} = binm(r;1/6,3) \quad (3)$$

$$Pr\{S = r; H_1 \text{ is true}\} = binm(r;P_1,3) \quad (4)$$

It can easily be proved that $P_1 < 1/6$ under H_1.

Hence, from Neyman-Pearson lemma, decision procedure [Eqns (1) to (4)] is optimum. The performance of decision rule [Eqn (3)] is evaluated for two illustrations. The power function is:

$$\beta = binf(3;P_1;3) \quad (5)$$

The Eqn (5) can be illustrated for two cases by putting the expression for

$$F(t_1) = F(t_3 - 2\Delta)$$

$$F(t_2) = F(t_3 + \Delta)$$

$$F(t_3) = \exp f(t)$$

The second illustration can be given for

$$F(t_1) = F(\eta_1\, t_3),\ \eta_1 < 1$$

$$F(t_2) = F(\eta_2\, t_3),\ \eta_2 < 1$$

$$F(t_3) = \exp f(t)$$

3. CONCLUSION

Two problems have been analysed. The first problem is a decision procedure to decide whether human fatigue is present in the repairman, when $M = 3$. By setting probabilities P_0, P_1 and P_2 equal to t_1, t_2 and t_3, respectively, one can easily predict t_1, t_2 and t_3 (3-MTRs) after deciding that there is human fatigue in the repairman.

Type I error and M as $\alpha = 0.05$ and $M = 3$, respectively can be chosen. The value of k in the relation $S \leq k$ should be chosen as one among any values for $k = 2$ or $k = 3$.

REFERENCES

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