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Pairwise comparative analysis of two reliability models with regard to undertaking the failed unit by ordinary or expert repairman with the concept of instruction and replacement time

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Abstract
The present paper deals with pairwise comparative analysis of two reliability models with regard to undertaking the failed unit by ordinary or expert repairman in the concept of instruction and replacement time. In model-1 if at the time of completion of the repair of a failed unit by the expert the second unit is found in failed state, it is also repaired by the expert. In model-2 every failed unit first goes under the repair of ordinary repairman who starts repair after getting instruction from the expert.

Keywords: pairwise comparative analysis, instruction and replacement time, repairman

Introduction

In order to enhance the reliability, concept of redundancy is used in various systems. As a result, two-unit standby systems have widely been studied in the field of reliability. Concept of two types of repairman has been considered in some of these studies including [1-5] wherein one of the repairman had been taken as an ordinary and the other as an expert. The ordinary repairman may not be able to do some complex repairs and then an expert comes. Long stay of the expert with the system may be costly and hence idea of instruction time was introduced by Kumar *et al*. [3]

There may also be situations when the ordinary repairman even after getting the instruction may damage the failed unit during his try for repair. This leads to the unit in more degraded stage and sometimes to a stage where we are left with no other option but to replace it by a new one.

The purpose of the present study is:

i) To introduce redundancy
ii) To introduce a new type of repair policy which is defined as: "when the ordinary repairman makes the unit damaged and leads it to more degraded stage due to mishandling, it is undertaken by the expert at much earlier stage than the stage at which its repair has been started by the ordinary repairman"
iii) To make the replacement when the failed unit is made no more repairable by the ordinary repairman
iv) To reduce the stay of the expert.

The present paper, therefore, investigates two-unit cold standby system introducing the aforesaid repair policy together with instruction and replacement. In model-1 if at the time of completion of the repair of a failed unit by the expert the second unit is found in failed state, it is also repaired by the expert and in model-2 the additional assumptions taken for the model is that every failed unit first goes under the repair of ordinary repairman who starts repair after getting instructions from expert. Failure times are assumed to follow exponential distributions whereas other time distributions are arbitrary. Other assumptions are as usual.

Both the systems have been analysed by making use of Semi-Markov Processes and regenerative point technique in Reference 6 and Reference 7. Various measures of system effectiveness including profit incurred have been evaluated.

Various cut–off points for various rates / costs / probabilities, prior or beyond which the system is profitable, have been obtained. However, no model is best in every situation. A model may be better in some situations but worse in some other situations. So it is highly significant to make the comparative study of the models taking two at a time to know under which situation one is better than the other so far as the economical aspect concerned.

Comparative analysis of model discussed in reference – 6 and reference – 7

Pairwise comparative analysis of the models through graphs is carried out for the same particular cases as taken in the previous papers for concerned models. The assumed values for various rates/costs/probabilities have been mentioned along with graphs. Let P_{61} be the profit of the model discussed in the Reference 6 and P_{62} be the profit of the model discussed in Reference 7. Let us now compare the models (taking two at a time) through graphs on the basis of profit aspect.

Two models of two-unit cold standby systems with the concept of replacement and instruction rate discussed in reference 6 and reference 7 have been compared by plotting the two graphs.

(A) Behaviour of the difference between profits P_{62} and P_{61} with respect to cost (C_2) for different values of cost (C_8) is shown as in Fig. 1. Following observations can be made:

(i) The difference increases with increase in values of cost (C_2) and becomes higher for higher values of C_8.

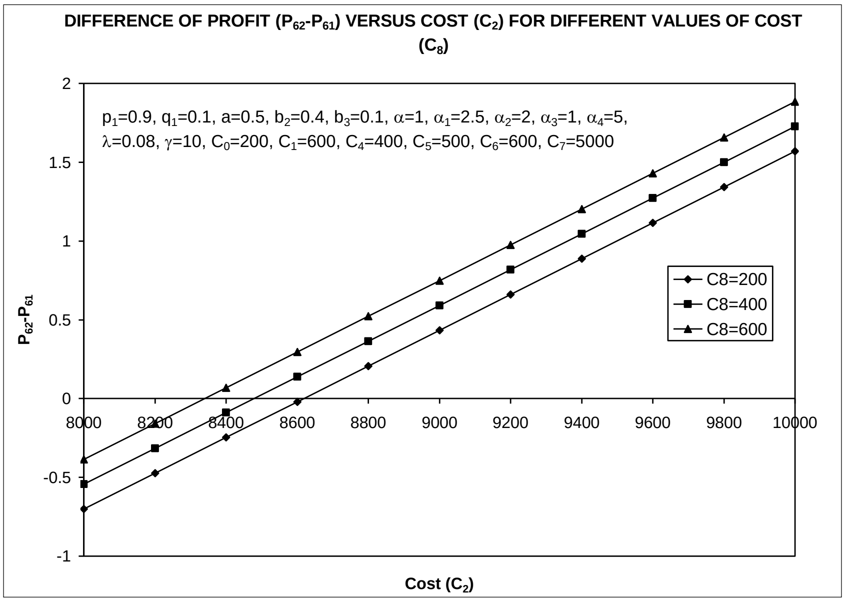

Fig 1: Difference of profit versus cost for different values of cost

(ii) For C_8 = 200, ($P_{62} - P_{61}$) > or = or < 0 according as C_2 > or = or < 8608.84. So Model 2 is better or worse than Model 1 if C_2 > or < 8608.84. Both the models are equally good if C_2 = 8608.84.

(iii) For C_8 = 400, ($P_{62} - P_{61}$) > or = or < 0 according as C_2 > or = or < 8478.91. So, Model 2 is better or worse than Model 1 if C_2 > or < 8478.91. Both the models are equally good if C_2 = 8478.91.

(iv) For C_8 = 600, ($P_{62} - P_{61}$) > or = or < 0 according as C_2 > or = or < 8340.12. So, Model 2 is better or worse than Model 1 if C_2 > or < 8340.12. Both the models are equally good if C_2 = 8340.12.

(B) Fig. 2 shows the behaviour of difference ($P_{62} - P_{61}$) with respect to probability (p_1) for different values of probability (b_2). Following conclusions are drawn:

i) The difference increases with increase in the values of probability (p_1). However, it is lower for higher values of probability (b_2).

ii) For b_2 = 0.3, ($P_{62} - P_{61}$) > 0 irrespective of the values of probability (p_1). Therefore, in this case and also for b_2 < 0.3, Model 2 of reference 7 is better than Model 1 of reference 6 irrespective of the values of p_1.

iii) For b_2 = 0.5, ($P_{62} - P_{61}$) > or = or < 0 according as p_1 > or = or < 0.037. So, Model 2 of reference 6 is better or worse than Model 1 of reference 6 if p_1 > or < 0.037. Both the models are equally good if p_1 = 0.037.

iv) For b_2 = 0.7, ($P_{62} - P_{61}$) is > or = or < 0 according as p_1 > or = or < 0.098. So, Model 2 of Reference 6 is better or worse than Model 1 of reference 6 if p_1 > or < 0.098. Both the models are equally good if p_1 = 0.098.

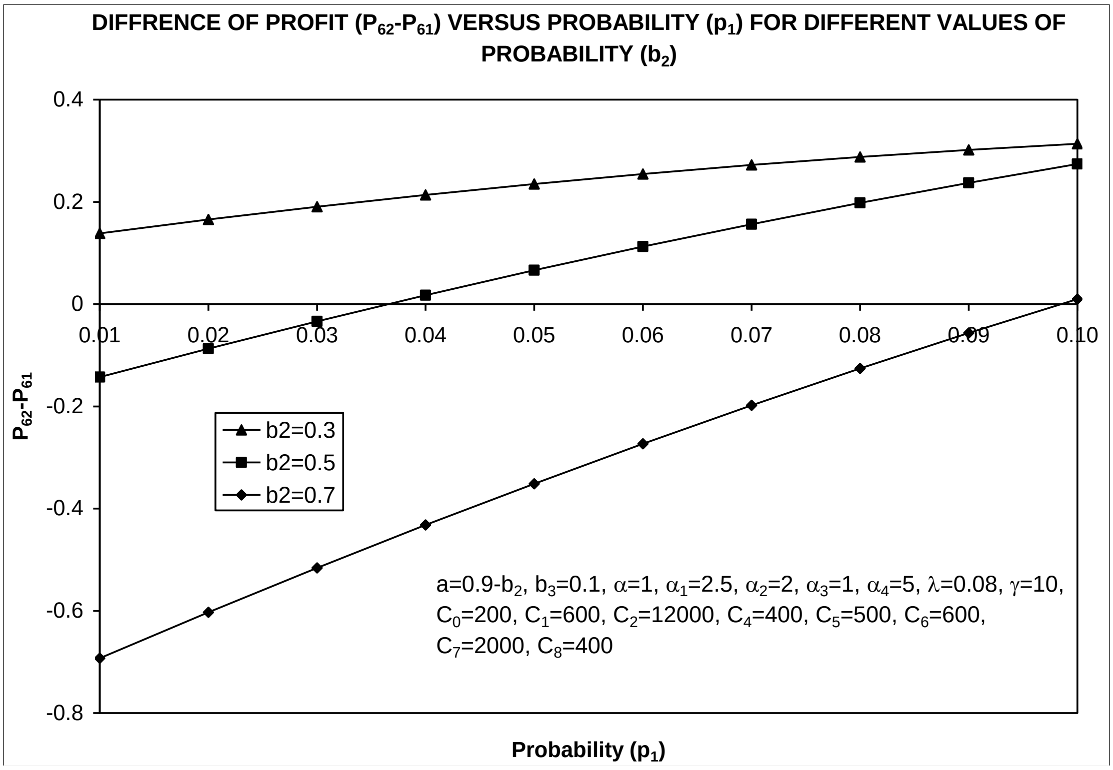

Fig 2: Difference of profit versus probability for different values of probability

The comparative analysis done above can guide various companies for taking decision as to which one of the two systems can be chosen under prevailing situations.

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