Statistical Bulletin
Reliability & Variation Research

DETROIT RESEARCH INSTITUTE
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THE FUNDAMENTAL ROLE OF FAILURE COSTS IN SAMPLE SIZE DETERMINATIONS AND THEIR CONFIDENCE LEVELS

THE SAMPLE SIZE REQUIRED DEPENDS ON THE CONFIDENCE LEVEL TO BE ATTAINED

THE CONFIDENCE LEVEL TO BE ATTAINED IS MADE UP OF

(1) THE PRIOR CONFIDENCE

(2) THE SAMPLE CONFIDENCE

THE CRITERION FOR SELECTING THE CONFIDENCE LEVEL TO BE ATTAINED IS BUILT UP BY DECIDING HOW LARGE A RATIO IS DESIRED FOR

$$\left(\frac{\text{LONG RUN EXPECTED DOLLAR GAINS}}{\text{LONG RUN EXPECTED DOLLAR LOSSES}}\right)$$

LONG RUN EXPECTED DOLLAR GAINS

$$= \left(\begin{array}{c}\text{DOLLAR GAIN PER}\\ \text{GOOD EVENT}\end{array}\right) \times \left(\text{CONFIDENCE OF A } \begin{array}{c}\text{GOOD}\\ \text{EVENT}\end{array}\right)$$

LONG RUN EXPECTED DOLLAR LOSSES

$$= \left(\begin{array}{c}\text{DOLLAR LOSS PER}\\ \text{BAD EVENT}\end{array}\right) \times \left(\text{CONFIDENCE OF A } \begin{array}{c}\text{BAD}\\ \text{EVENT}\end{array}\right)$$

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IN THE FIELD OF GAMBLING WE CALL A GAME "FAIR" IF

LONG RUN EXPECTED DOLLAR GAINS PER CONTESTANT

= LONG RUN EXPECTED DOLLAR LOSSES PER CONTESTANT

IN A CONSUMER PRODUCT BUSINESS THE MANUFACTURER SHOULD SEE TO IT THAT THE PRODUCT IS GOOD ENOUGH TO GAIN MORE MONEY THAN IT LOSES.

THIS REQUIRES THAT

$$\frac{\text{LONG RUN EXPECTED DOLLAR GAINS}}{\text{LONG RUN EXPECTED DOLLAR LOSSES}} = K > 1$$

(the selection of factor K is the manufacturers own choice.)

ACCORDING TO THIS , IF C = CONFIDENCE OF A GOOD EVENT , WE HAVE THE RELATION

$$\left[\begin{array}{c}\text{DOLLAR GAIN}\\ \text{PER}\\ \text{GOOD EVENT}\end{array}\right] C = K \left[\begin{array}{c}\text{DOLLAR LOSS}\\ \text{PER}\\ \text{BAD EVENT}\end{array}\right] (1 - C)$$

SO

$$C = \frac{K\ (\text{DOLLAR LOSS PER BAD EVENT})}{(\text{DOLLAR GAIN PER GOOD EVENT}) + K(\text{DOLLAR LOSS PER BAD EVENT})}$$

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NUMERICAL EXAMPLES

A CERTAIN MANUFACTURER'S PRODUCT WILL YIELD A GAIN (PROFIT) OF 10 MILLION DOLLARS WHEN IT PERFORMS AS ADVERTISED.

HOWEVER, SHOULD IT FAIL TO PERFORM AS ADVERTISED THE PREDICTED LOSSES DUE TO LITIGATION AND CUSTOMER DISSATISFACTION IS 100 MILLION DOLLARS.

THIS MANUFACTURER WANTS TO SEE LONG RUN EXPECTED GAINS TO BE TEN TIMES AS LARGE AS LONG RUN EXPECTED LOSSES.

THE PROPER CONFIDENCE LEVEL IS

$$C = \frac{10(\$100,000,000)}{\$10,000,000 + 10(\$100,000,000)} \quad \text{OR}$$

$$\boxed{C = .99099 \quad \text{OR} \quad 99.1\%}$$

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AN ADVERTISED (PROMISED) PERFORMANCE ALWAYS IMPLIES

SOME TYPE OF RELIABILITY HYPOTHESIS

LIKE

R (3000 HOURS) $\geq$ .98

THIS IMPLIES THAT LOSSES OCCUR ONLY IF THE RELIABILITY FALLS BELOW .98 .

SUPPOSE 100,000 PIECES ARE SOLD AT A PROFIT OF 50¢ EACH. IF THE RELIABILITY FALLS BELOW .98, THE LOSS WILL BE $1.25 PER PIECE. IN ORDER TO MAKE LONG TERM EXPECTED GAINS TWICE LONG TERM EXPECTED LOSSES, THE PROPER CONFIDENCE LEVEL MUST BE SET AT

$$C = \frac{2(1.25)}{.50 + 2(1.25)} = \frac{2.5}{3.0} \doteq .83333 = 83.333\%$$

HOW IS THE PROPER K FACTOR DETERMINED ?

ANSWER : BY COMPETITIVE PRICING POLICIES .

IN OTHER WORDS :

TOO HIGH A K WILL REQUIRE SUCH A HIGH PRICE TO BE CHARGED (BECAUSE OF EXTRA TESTING AND RELIABILITY COSTS IN DESIGN) THAT THERE IS A LOSS OF CUSTOMERS TO COMPETITION, AND, HENCE, SMALLER GAINS DUE TO REDUCED SALES .