ON WARRANTY POLICIES OF TWO WHEELER
VEHICLES IN INDIA

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It is observed that in India for all types of two wheeler vehicles, warranty offered is Free Replacement Warranty (FRW) policy. Present paper deals primarily with the cost analysis of warranty being given on different types of two wheeler vehicles, in India.
Under the existing cost set up, a new warranty model, which involves an initial FR period, followed by the Pro Rata period, has been developed and suggested for the vehicles understudy. This warranty policy is valid for longer time, compared to the existing one and at the same time there is no extra cost burdon to the manufacturer. Therefore, this policy will be more appealing to the buyers and manufacturers as well.

INTRODUCTION

A warranty is a contractual obligation incurred by a manufacturer in connection with sale of an item. The warranty specifies that the manufacturer agrees to remedy certain products for a specified period after sale. There are mainly two types of warranties discussed in the literature. These are Free Replacement Warranty (FRW) policy and Pro Rata warranty (PRW) policy. Under FRW policy, failed items are replaced / repaired free of charge, if the product fails before the warranty expires. Whereas in PRW policy, replacement / repair cost depends on the age of the product at the time of failure, and consumer is charged an amount proportional to the useful life of the item. Thus, PRW favors the consumer at the expense of the manufacturer. PRW is more appealing to the manufacturer but unattractive to the consumer. Therefore, a policy which involves an initial FR period followed by the PR period, is more appealing and which is more fair and attractive to the manufacture and consumer as well.

Existing Warranty policy

It is observed that in India, for almost all types of two wheeler vehicles warranty offered is FRW policy, which runs for a specified period of time or for a specified run of the vehicle, whichever event occurs earlier, from the date of sale.

Data Collection

Data regarding first failure reported within warranty period was collected from the authorised dealers of the two wheeler vehicles. The two wheelers were classified in to three categories namely moped, scooter and motorcycle. Two brands were chosen from each category for a detailed study.

When a vehicle does fail during the warranty, the owner of the vehicle will almost seek to get it repaired by the authorised dealer, due to specialisation in the repair operation and to avail free service. In this way, the dealer can accumulate a record of failures, in warranty claim register, such as, how many kilometers the vehicle has run before its failure and age of the vehicle (in days) at the time of failure.

The data collected in the study of Bajaj (`1988) regarding the total number of 'days' and its progressive 'kms' run before its first failure is used here for the study.

Fitting of distribution

Weibull (1951) showed that the Weibull distribution is useful in describing the wearout or fatigue failure. The data collected in this study relates to failure time of vehicles and vehicles often fails due to wear and tear of the components. A two parameter Weibull distribution found best fit to this data, Bajaj (1988), with p.d.f. given by -

$$f(t) = \frac{\beta}{\alpha^{\beta}} t^{\beta-1}. \ \exp\left(-(t/\alpha)^{\beta}\right).$$

$$t, \alpha, \beta, > o \ .$$

whe*re*, α is Scale Parameter, β is Shape Parameter.

Scale and shape parameters of this distribution are estimated using Menon's method (1963).

COST ANALYSIS OF WARRANTY POLICY

A new warranty policy, which involves an initial FR period, followed by the Pro Rata period, has been suggested for the two wheeler vehicles under study.

Notations used

t	-	Failure time of the vehicle within warranty period.
c	-	Unit cost of repair, assumed to have fixed value.
b	-	Cost proportion factor = c / w-s , used in proposed policy.
s*	-	Length of existing FRW Policy.

s   -   FR period in the Proposed policy, if the item fails before s,
              manufacturer is charged full cost of repair c, if it fails at time t,
              $s \le t \le w$, the consumer is charged a fraction.
w   -   Length of proposed policy ($s \le s^* \le w$)
M(t)   -   Manufacturer's expected cost within warranty period.
W(t)   -   Consumer's expected cost within warranty period.

$$c\text{-}b\,(t\text{-}s) = c(w\text{-}t)\,/(w\text{-}c)$$
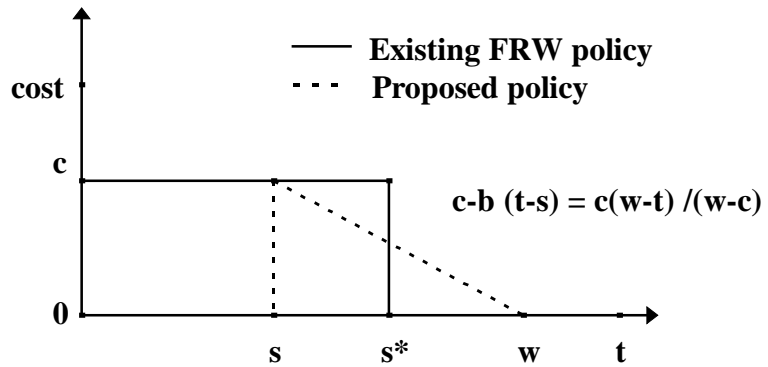
Warranty Cost Model

Under this section, the two policies are compared by estimating expected costs to both the manufacturer and consumer assuming Weibull failure distribution.

1) Manufacturer's expected cost under FRW is given by

$$M_1\,(t) = c.P\,(\,0 \le t \le s^*) = c\int_0^{s^*} f(t)dt \quad \text{-- -}$$ (1)

2) Consumer's expected cost under FRW is given by

$$W_1\,(t) = c.P(s^* \le t \le w) = c\int_{s^*}^{w} f(t)dt . \text{-- - -}$$ (2)

3) Manufacturer's expected cost under proposed policy is given by -

$$M_2(t) = c.\int_0^{w} f(t)\,dt. - \frac{c}{w-s}\int_s^{w}(t-s)\,f(t)\,\mathrm{dt} \quad \text{-- -}$$ (3)

4) Consumer's expected cost under proposed policy is given by -

$$W_2(t) = \frac{c}{w-s}\int_s^{w}(t-s)\,f(t)\,\mathrm{dt}. \text{-- -}$$ (4)

Now equating costs of manufacturer and consumer i.e. equation (1) with (3) and (2) with (4) , one gets identical relations, as follows. Implying thereby that the expected costs of consumer and manufacturer under both policies are same i.e.,

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$$\int_{s*}^{w} f(t)dt = \int_{s}^{w} \frac{(t-s)}{(w-s)} f(t)dt. \quad --- \tag{5}$$

After simplifying equation (5) for Weibull distribution, one gets,

$$(wF(w) - sF(s) - (w-s)F(s*))\frac{\alpha^{\beta}}{\beta} = \int_{s*}^{w} t^{\beta} \exp(-t/\alpha)^{\beta} \, dt \quad --- \tag{6}$$

Where $F(t) = 1 - \exp\left(-(t/\alpha)^{\beta}\right)$

This relation is used to obtain optimum values of w for different set of values (s,s*).

COMPARISON BETWEEN EXISTING POLICY AND PROPOSED POLICY

Mamer (1982) has suggested comparing total cost through time t , from the consumer's and profit from the manufacturer's point of view. So we compare the costs for both the policies through variance value.

Variance of the expected cost

Under FRW policy manufacturer's expected cost is $c \int_{0}^{s*} f(t) \, dt$ and hence variance of the cost is given by -

$$V(\cos t) = c^2 PQ \quad --- \tag{7}$$

Where $P = \int_{0}^{s*} f(t) \, dt = F(s*)$ and $Q = 1 - P$

Under the proposed policy, variance of this expected cost is given by (because expected costs are kept fixed)

$$V(\cos t) = c^2 \int_{0}^{s} f(t) \, dt + c^2 \int_{s}^{w} \frac{(w-t)^2}{(w-s)^2} f(t) \, dt - c^2 P^2 \, --- \tag{8}$$

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Difference between these two variances i.e. (7) - (8) yields.

$$PQ - \int_0^s f(t)\,dt - \frac{1}{(w-s)^2}\int_s^w (w-t)^2 f(t)\,dt - P^2 F(s^*) - F(s) -$$

$$\frac{w^2}{(w-s)^2}[F(w) - F(s)] + \frac{2w}{(w-s)^2}\int_s^w t\, f(t)\,dt - \frac{1}{(w-s)^2}\int_s^w t^2 f(t)\,dt. \; \text{- - -} \qquad (9)$$

For Weibull density function (9) becomes.

$$F(s^*) = \left[1 - \frac{w^2}{(w-s)^2}\right]F(s) + \frac{w^2}{(w-s)^2}\cdot F(w) -$$

$$\frac{2w\beta}{\alpha^\beta(w-s)^2}\int_s^w t^\beta e^{-(t/\alpha)^\beta}\,dt. + \frac{\beta}{\alpha^\beta(w-s)^2}\int_s^w t^{\beta+1}\cdot e^{-(t/\alpha)^\beta}\,dt. \; \text{- - -} \qquad (10)$$

It is noted that for all the vehicles under study value of variance under proposed policy is less than that in FRW policy. Smaller value of variance indicates that proposed policy could be treated as better than existing policy.

CONCLUSION

The advantage of the proposed policy is basically in terms of quality assurance for longer duration. In this policy, consumer gets free replacement for a shorter period and pays a proportionate cost for the remaining period. He also has incentive to use the vehicle carefully or in other words, if the vehicle does not fail within the later period of policy, he will not be required to pay any cost.

However, in FRW policy the cost of anticipated failures within the warranty period is added in the cost of the vehicle. Hence there is no incentive given to the owner of the vehicle for using the vehicle carefully. On the other hand, he is tempted to use the vehicle carelessly as he knows that any loss, that may arise during warranty period will be born by the manufacturer. This will increase the warranty cost and hence loss to the manufacturer.

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