## Contribution to Rational Determination of Warranty Parameters for a New Product

Zdenek Vintr

&

## Michal Vintr

Faculty of Military Technology University of Defence Brno, Czech Republic



Faculty of Mechanical Engineering Brno University of Technology Brno, Czech Republic



## **Subject of Presentation**

- A model of the two-dimensional warranty cost exploiting the results of a research of customer's behavior.
- Demonstration of practical usage of the proposed model for determination of warranty parameters for a passenger car at limited level of warranty costs.

## **Outline of Presentation**

- 1. Background of the solution
- 2. Two-dimensional warranty
- 3. Research of the customer's behavior
- 4. A model of warranty cost
- 5. An example of practical usage of the procedure
- 6. Conclusions

## **Background of the solution**

#### Problem:

for a two-dimensional warranty, level of warranty costs is not influenced only by parameters of the warranty and properties of the product, but also by behavior of customers, especially how intensively they use this product.

#### Task:

to describe real customer's behavior with usage appropriate statistics tools on the base of results of a research of behavior of the customers.

#### Aim:

to create a warranty cost model enabling the warranty parameters determination at limited level of warranty costs.

## **Two-dimensional warranty (1)**

#### **Two-dimensional non-renewing free-replacement warranty:**

the seller will repair or provide a replacement for failed product free of charge up to a calendar time  $t_0$  or up to a usage (operating time)  $u_0$ , whichever occurs first, from the time of the initial purchase.



## **Two-dimensional warranty (2)**

A time instant, when warranty will expire, is predetermined by the usage rate:





## **Research of the customer's behavior (1)**

#### The gathered data:

- a product purchase date,
- an actual range of realized operating time.

#### **Data processing:**

- enumeration of usage rate for ever inquired customer,
- statistical processing of data on usage rate,
- substitution of statistical data with a suitable continues probability distribution (determination of probability density function and distribution function).

### **Research of the customer's behavior (2)**

Probability that a warranty of a product will be terminated by exceeding a guaranteed calendar time:

$$Pr(0 \le X < x_0) = \int_{0}^{x_0} f(x) dx$$

Probability that a warranty of a product will be terminated by exceeding a guaranteed operating time:

$$Pr(X > x_0) = \int_{x_0}^{\infty} f(x) dx$$

robability density function - f(x)



## A model of warranty cost (1)

Mean warranty cost

 $\overline{C} = \overline{c} \, \overline{u}_W$ 

 $\overline{C}$  - unit warranty cost  $\overline{u}_W$  - mean operating time realized during the warranty

#### Mean operating time realized during the warranty



The warrantyisterminated by exceedinga guaranteedoperatingtime (duringwas realizedoperatingtime  $u_0$ ).

## A model of warranty cost (2)

#### Mean warranty cost (for one product)

as a function of basic parameters of warranty:

$$\overline{C} = \overline{c} \left( t_0 \int_0^{x_0} x f(x) dx + u_0 \int_{x_0}^{\infty} f(x) dx \right)$$

- $t_0$  guaranteed calendar time of the use
- $u_0$  guaranteed operating time
- $\overline{c}$  unit warranty cost

### A model of warranty cost (3)



Field of acceptable values of warranty parameters

Guaranteed operating time -  $u_0$ 

Guaranteed calendar time of use -  $t_0$ 

# An example of practical usage of the procedure (1)

More than 600 customers – owners of lower medium class personal car manufactured in the Czech Republic – were involved in research.



# An example of practical usage of the procedure (2)

Statistical results of the research was substituted by log-normal distribution with parameters  $\mu = 10.1037$  and  $\sigma^2 = 0.241$ .



## An example of practical usage of the procedure (3)



13

Guaranteed calendar time of use -  $t_0$  [years]

## Conclusions

- The model is applicable for an initial estimate of two-dimensional warranty cost.
- The model enables to determine warranty parameters for limited level of warranty costs.
- The model represents useful tool for support of decision making what an extent of warranty will be provided.