RISK ANALYSIS DEVELOPED MODEL

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Abstract

Through Risk analysis developed model deciding whether control measures suitable for implementation.
However, the analysis determines whether the benefits of a data control options cost more than the implementation.

Key words: *CBA-Cost Benefit Analysis, Cost-Benefit Ratio CIDP-Implied Cost of Averting a Fatality, CRRU- Unitary Cost for Risk Reduction*

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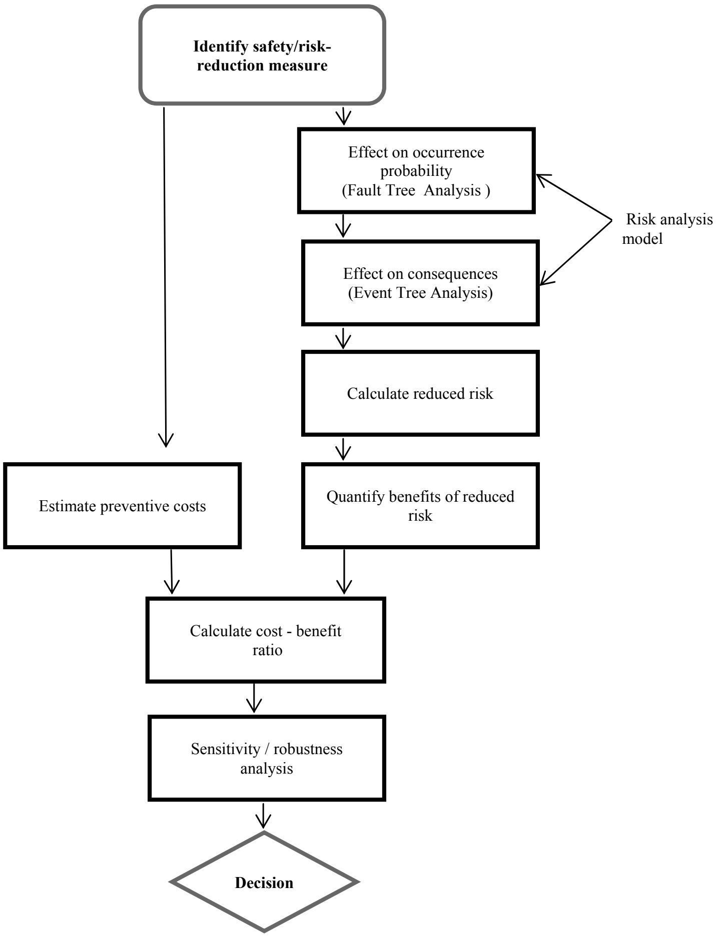
Objective of Cost Benefit Analysis - CBA - in the context of risk in shipping, is to identify safety (risk reduction) efficient cost. If known costs and benefits of safety measures suggested cost-benefit analysis is easy to achieve. Provocation of Management, in terms of risk assessment shipping, refers to how to determine the costs and benefits of risk analysis model developed.

Costs of safety measures are mainly associated with costs of implementation, operation (including inspections, audits and maintenance) and safety management measures. Estimate the benefits of safety measures is generally more complicated and difficult. The benefits of safety measures related to the value of prevention an/or reduce unwanted consequences dangers that come true. The safety measures, the likelihood of events and their consequences can be studied using the model developed by risk analysis, by estimating their effect on fault tree analysis (AAG) and event tree analysis (AAE).If these benefits can be quantified in monetary terms, we can calculate the cost-benefit and these relationships, the various safety measures taken, can be used to decide if advantageous implementation of such measures and in such a situation, what measures should be implemented. Usually there is great uncertainty about both the fault tree analysis and the analysis and event tree analysis should be performed to test the robustness of the original recommendation.

Diagram(scheme)of Cost Benefits Analysis



Source**:** Kristiansen,S,2009,Maritime Transportation-Safety Management and Risk Analysis, Elsevier Butterworth-Heinemann

A problem with assessing the benefits of prevention and / or reduce the consequences following the introduction of safety measures is extremely high number of types of consequences that can occur and that the effects of certain security measures may vary strongly. Some degree of safety can affect many types of damages corresponding to several types of accidents.

The overall effect of a measure may be difficult to determine and quantify CBA applications.

CBA's on safety issues is based normally on marginal considerations, which means that preventive measures are implemented as soon as the expected benefits of risk reduction is equal to the expected costs (cost ≤ benefits).

Stages

The existing risk R_0 can be calculated using the Eq.:

$R_0 = C*P$

unde P = Expected probability of an event

C = Expected consequence provided in terms of human loss, economic and/or environmental

The risk after implementation of the safety measure R1:

$R_1 = C*P$

The benefits of reduced risk will be:

$\Delta R = R_0 - R_1$

The net present value of this benefit-Vab- can be calculated using the follow equation:

$$V_{ab} = V_b * \left[\frac{(1+i)^n - 1}{i * (1+i)^n}\right]$$

where:

Vb = Value of benefits

i = Rate of interest per year/period (corrected for inflation)given as decimal fraction(e.g. 5% = 0.05)

n = Number of years /periods

The net present value of cost of protective measures Vac :

$V_{ac} = C_t - V_{ea}$

Ct= Total cost of protective measures

V_{ea} = Estimated cost reduction per year result from the relationship:

$$V_{ea} = V_e * \left[\frac{(1+i)^n - 1}{i * (1+i)^n}\right]$$

Ve= Present value of annual cost savings due to the introduction of safety measures

The cost-benefit ratio will be:

$$\frac{C}{B} = \frac{V_{ac}}{V_{ab}}$$

If cost-benefit ratio is more than 1.0, (which means that the present value cost of introducing measures exceeds the present value of profits made), as proposed is not considered effective in terms of cost, and should not be implemented.

All risk control measures result in different levels of risk reduction, different benefits and adverse effects and different costs of implementation of maritime transport managers should take into account. Without some method of comparison of these risk control measures, using a similar basis, it is very difficult to select the best measures in terms of cost efficiency, to be implemented, namely the measures necessary to obtain the most great benefits compared to costs.

While the majority of costs and benefits can be quantified in terms of monetary values, we must try to evaluate measures using a similar basis.

Possible adaptation measures at normal scale is one of the most important features of cost-benefit assessment methodologies. Can be use different approaches and, in this paper, the main principles will be reviewed two popular approaches: Cost Unitary Risk Reduction (CRRU) and the Cost of the Prevention of Death (CIDP) that are used in shipping management.

Unitary Cost Methodology for Risk Reduction (CRRU) was originally developed in the international context of the International Maritime Organisation (IMO), which probably was bound to be a great disparity of ideas on how low should be assessed deaths and injuries. The approach is to evaluate in monetary terms, costs and benefits, except for economic benefits related to the low number of deaths and to determine separately the number of lives lost lifetime equivalent measure, taking into account the equivalence of minor injuries, major injuries and death (example, 100 slight injuries creates 10 major injuries, which lead to death). Net present value (VCN) to implement risk control measure is calculated using the following equation:

VCN(-net present value of implementing a risk control measure)is calculated using the equation:

$$VCN = \sum_{t=0}^{n} [(B_t - C_t) * (1 + r)^{-1}]$$

where:

C_t =The sum of costs in period t

B_t = The sum of benefit in period t (excluding economic benefits of reduced fatalities)

r = The discount rate per period

t = Measure of time horizon for the assessment starting in period(e.g. year 0) and finishing in period n

VCN are then used later to calculate the cost of Unitary Risk Reduction (CRRU), VCN dividing the appropriate benefit equivalent to the low number of deaths estimated. CRRU values for different risk reduction measures can then be compared in terms of cost efficiency, improving safety for people.

All estimates of costs and benefits involves some uncertainty evaluated and considered. Uncertainty could be evaluated, for example, by performing a sensitivity analysis on the parameters involved, to study how these changes affect the total net present value (VCN).

Methodology for the cost involved to prevent a death (CIPD) is a methodology widely used to study risk control measures at normal scale. The methodology calculates / estimates of risk reduction achieved in terms of cost, using the following equation:

Implied Cost of Averting a Fatality(ICAF)

$$CIDP(ICAF) = \frac{Net\ annual\ cost\ of\ measure}{Reduction\ in\ annual\ fatality\ rates}$$

Annual net cost of the measure was calculated by assigning all costs related to the implementation and operation of measures throughout the life of the latter. Is done by calculating the annuity. Also, the CIPD can be calculated by dividing the net present value related to its lifetime the security measure, the total reduction in deaths in that period. The CIDP can be interpreted as the economic benefits of preventing a death. Decision criteria should be established for this amount in order to assess whether a particular option / risk control measure is effective in terms of cost, or not, and this criterion will mean somehow a price for human life. Studies have shown, for example, that risk control measures with a value of ICPD less than 3 million should be regarded as effective in terms of cost and therefore must be implemented.

Another method, less comprehensive, adaptation to a common scale is exclusive review of the current value net (VCN) of different safeguards. Safety measures (or options to control the risk) with a positive VCN, without adverse effects on the system's under scrutiny, should always be implemented. However, only a few precautions will normally, the current positive economic value, and this method has a significant weakness, non addressing the relative differences in the effect of reducing the risk of various safety measures.

The benefits of prevention of death are difficult to quantify. Some even say that such quantification is impossible, as it involves assigning a value to people's lives. However, such a criterion is economically valuable in the risk analysis and not using it can even be counterproductive in relation to safety, because the benefits of prevention of death can be an important impetus to implement costly mitigation measures.

According to Skjong and Ronold (Skjong, R. and Ronold, K., Social Indicators of Risk Acceptance'' Norvey OMAE 1998)the CIPD(ICAF)value can be calculated white the help of Life Quality as follows

$$I_{CV} = \gamma^{w} * \varepsilon^{1-w}$$

where:

I_{cv} = Life Quality Index

γ = Gross domestic product per person per year

ε = Life expectancy(years)

w = Proportion of life spent in economic activity (in developed countries $w = 1/8$)

ICPD principle as a criterion for risk reduction, implement safety measures so long as the change from the ICV is positive. By partial differentiation of the LCV and that the $\delta Icv > 0$, equation has been established:

$$\frac{\Delta\varepsilon}{\varepsilon} > -\frac{\Delta\gamma}{\gamma} * \frac{w}{1-w}$$

It can be assumed that the prevention of death will save on average

$\Delta\varepsilon = \varepsilon / 2$, which means half the life expectancy. The biggest change in the domestic product, $|\Delta\gamma|_{max}$, was obtained by implementing this expression for $\Delta\varepsilon$, the above equation.

This can be interpreted as optimal acceptable cost per year of life saved. Acceptable cost for the optimal default-CIPDop prevention of death, can be calculated by the equation :

$$CIPD_{op} = |\Delta\gamma|_{max} * \Delta\varepsilon = \frac{\gamma * \varepsilon}{4} * \frac{1-w}{w}$$

where:

$CIPD_{op}$ = Optimum Implied Cost of Averting a Fatality (ICAF) value

$$|\Delta y|_{max} = -\gamma * \frac{(1-w)}{2} * w,$$

$\Delta\varepsilon$= Years saved by averting a fatality= $\frac{\varepsilon}{2}$

γ = Gross domestic product per person per year
ε = Life expectancy(years)
w = Proportion of life spent in economic activity(in developed countries w = 1/8)

Based on this criterion, safety (risk control) proposed / suggested to be implemented, as long as the estimated value of CIDP not exceed CIPDop (ie. criterion).

CIPDop value in 1984 was about 2 million pounds for developed countries. However, the CIPDop fluctuate.

Conclusions

Provocation of Management ,in terms of risk assessment shipping, referred to how to determine the costs and benefits of Risk Analysis Developed Model.

A problem with assessing the benefits of prevention and / or reduce the consequences following the introduction of safety measures is extremely high number of types of consequences that can occur and that the effects of certain security measures may vary strongly.

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