ASSET MANAGEMENT - REPLACE OR REFURBISH ASSETS

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ABSTRACT

This document constitutes the final version of the full paper of the abstract with the same title, previously submitted to CIRED 2011. It assesses the major lines of the thematic under subject and has been prepared in accordance with the instructions and basic guidelines of the official site in order to eventually be presented to the Conference and included in the Conference CD ROM.

INDEX

The present document is structured in five main chapters: Guidelines, Objective, MAD – The Model, Conclusions and Constraints and Risk Matrix, each of which will be presented with figures / graphs that would illustrate and facilitate the reading.

GUIDELINES

Within the asset management it is crucial to monitor the continuous performance of the assets and search for potential cost increase of maintenance and the risk exposure, in order to assess the best intervention in economic terms:

Replace with new equivalent - removing the asset run down and replacing it with one that is technically equivalent
Adapt - making slight improvements in the asset in service so as to restore the previous technically expected conditions
Rehabilitate - making significant improvements in the asset in service so as to restore the previous technical conditions.
Repair - reinsert the asset in service after restitution of its normal functions in the sequence of serious damaged or flaw occurrence

Scheme

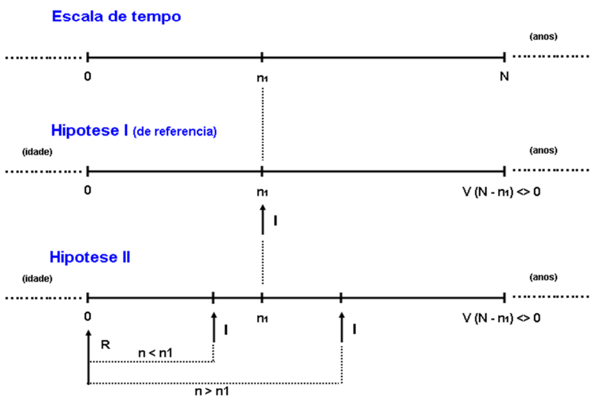

Fig. 1

As a result of analysis, in the context of the more general and comprehensive management of an asset, it may arise that the estimated remaining lifetime after the intervention is less, equal or more than the remaining lifetime of reference (n comparing with n1) resulting in three levels of evaluation: n < n1; n = n1; n > n1.

In the scheme, hypothesis I corresponds to no intervention, i.e., to the natural evolution of the asset. It is the reference to the study being done at moment 0, and the assets of a certain age. It is expected to be replaced after n1 years thereafter, which corresponds to the horizon of life remaining reference (n=n1).
In hypothesis II, the decision is made between rehabilitating or replacing with a new one, depending on the specificities of the problem (n < n1 or n > n1).

OBJECTIVE

Select the best option, choosing among several, the one that is the most advantageous economically, under the conditions of risk and technical performance.

MAD – THE MODEL

To achieve the referred objective we developed the MAD model of expeditious exclusive use in EDP Distribution.
The model, MAD, compares iteratively the benefits of each option, naming:

br – refurbished old asset benefits
bs – new asset benefits
be – not-refurbished old asset benefits (as is)

and relates them by defining two ratios:

k1 = br / be
k2 = bs / be

Both ratios tend to rise as be decreases. As a result of this behavior, k1 and k2 will soon or later cross decisive parameters, which indicates: when to take action and what kind of action.
Given the critical importance of be in the model, it was adopted the ratio be / iI as a benchmark against which we compare the benefits of a rehabilitated active (br) and of the substitute (bs), leading to the two ratios mentioned, k1 and k2.
MAD uses five other main variables:

R – old asset refurbishing cost
I – new asset buying cost
n – old asset expected extended life time after refurbishing
n1 – old asset expected remaining life time
i – annual rate of interest

The first two are related considering the ratio R/I.
Results are considered in the plane - two dimensional surface - (n ; R/I) where R/I = f(n)
Over the curve R/I are the solutions where it is better to buy a new asset; under are those where refurbishing the old one is the best choice.

Structure calculation

- calculating the discounted cash flow of the various alternatives
- establishment of the economic condition of equivalence
- verification of relations between variables and parameters
- choice of variables: R / I (ratio of the updated cost of rehabilitation of the existing asset and the new equivalent asset cost) and n (old asset expected extended life time after refurbishing).

CONCLUSIONS

n > n1

Example1

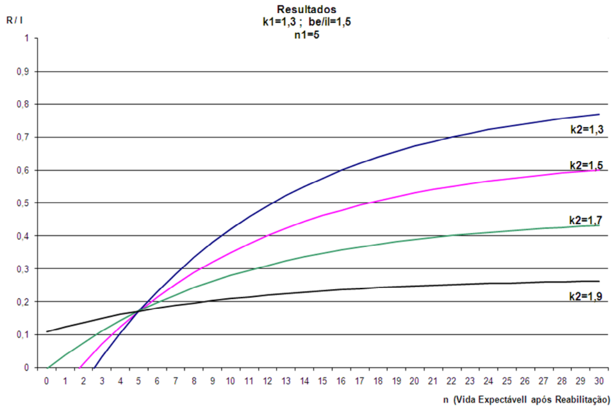

Fig. 2

Example2

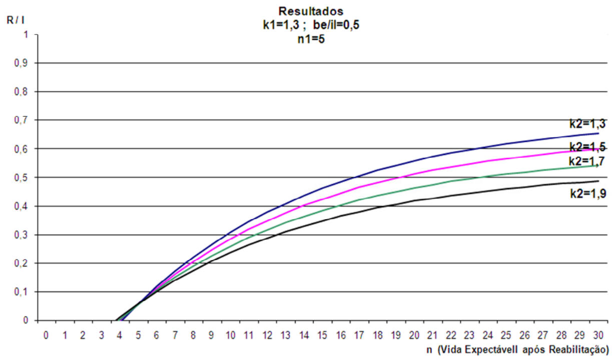

Fig. 3

In the examples presented, which took n1 = 5, n> n1, the curves in the plane (n, R / I) identify, for the parameters presented, be, k1 and k2, the economic equivalence between the options Replace / Rehabilitate.
According to the general principle of the model, the region above the curve contains the options in which the replacement of assets is the most advantageous solution.
The region below the curve contains the options in which the Rehabilitation is economically more favorable.

Example3

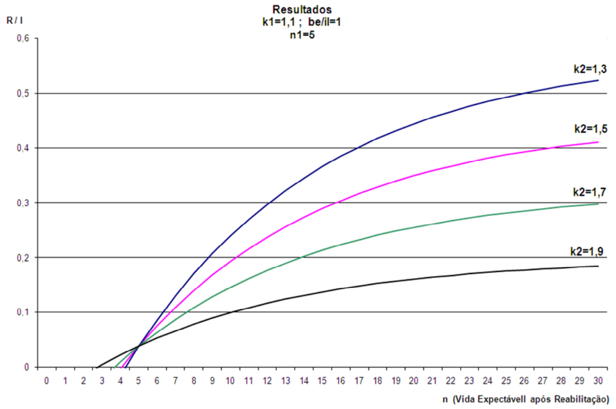

Fig. 4

These three examples demonstrate that:
- for identical conditions to be, the increase of k1 (= br/be), determines the increase of the region that recommends the option of Rehabilitation - example 1 vs 3
- the technical condition of the asset / its criticality (be) is decisive and very sensitive in defining the areas Rehabilitate or Replace - the future solution depends on and is strongly influenced by be, the existing benefit (annualized net present, drawn from the statistical and historical information of the asset in question)
- the better the technical conditions of the asset, the more reasoned must be the decision to replace or rehabilitate, i.e., as be increases (reduces risk), widens the range of variation of k2
- the better the technical condition of the asset the more careful must one be when making his decision.
- on the contrary, in highly degraded assets (be reduced; increased risk), the curves are closer to k2 and the decision error decreases
- in the extreme case of an asset severely degraded or even damaged, all the curves as a function of k2 tend to coincide.

n < n1

Example1

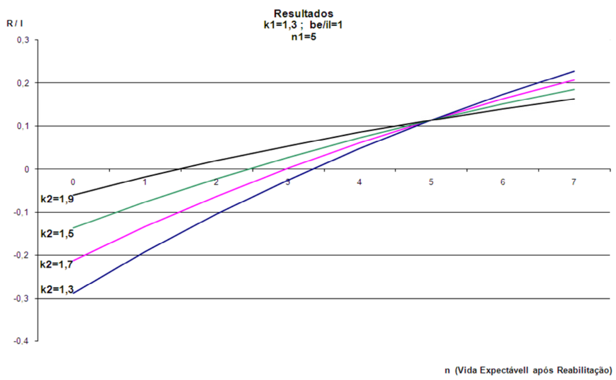

Fig. 5

Example2

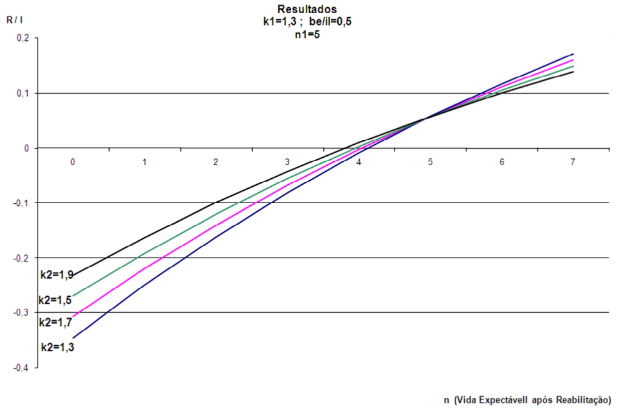

Fig. 6

Example3

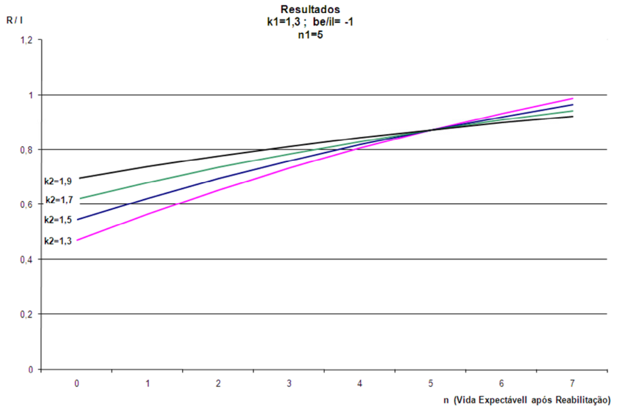

Fig. 7

Example4

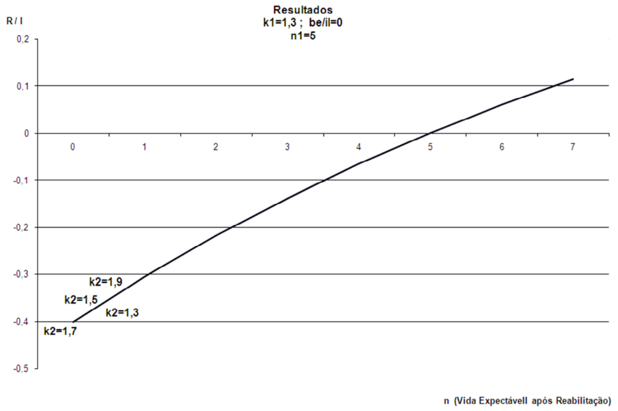

Fig. 8

In this approach the rehabilitation of the asset has an expected duration below the limit of its useful life reference. We are facing a typical problem of maintenance, because there is no extension of useful life (n < n1). The economic management of the maintenance of an asset with a given fixed horizon lifetime reference (n1) always has an absolute maximum - the corresponding node in the graph - that is independent of k1 and k2 and only depends on the reference horizon, n1 .

If the requirements for improvement / rehabilitation of the assets are located above the absolute maximum, then we are in the presence of a non-economic situation from the maintenance point of view. Solutions should be sought within the investment options, i.e., to provide increased service life (rehabilitation/replace).

Maintenance costs are heavily dependent on the lifetime horizon of reference and have less economic justification when the asset is closer to the end of its life cycle.
As better is the performance of the asset (k2 close to 1), the more justified are the repair costs (corrective), under the economical point of view.

As the asset tends to present lower levels of performance (increase of k2), increasingly less justified it is, from an economic standpoint, to incur costs for its repair.

The point of n that corresponds to R / I = 0, represents the year from which a corrective action on the asset is no longer economically justifiable, since the potential costs incurred are no longer recoverable.

Differences in benefits between be, br and bs, implicit in the k1 and k2, generate economic limits to the maintenance, which has in the region n < n1 its scope of action, bounded by the curve and the axis of nn. Outside this area, the solutions are out of the scope of maintenance.

The parameters k1 and k2 are of decisive importance in the analysis of the "Corrective / Preventive".

<u>The Overall model</u>

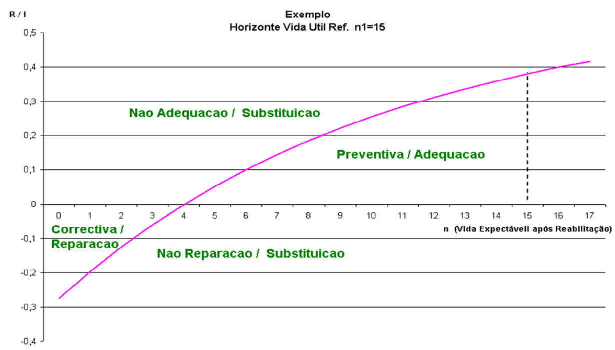

Fig. 9

Every asset has a remaining useful life horizon of reference (n1), a desirable known and evolutionary be and the parameters k1 and k2 (corresponding to rehabilitate or replace options) and can be associated with three areas of economic exploitation (identified in the chart) - adapt (preventive action), repair (corrective action) or replace (not repair or not adapt).
The chart above illustrates the relationship between the

economic values of preventive and corrective maintenance, verifying that as the asset is deteriorating - k2 increases - the economic area of preventive action expands, reducing the area of corrective. The curves R / I = f (n) have the geometric configuration of the previous slide, verifying that the change of life horizon does not affect them, it only changes the scale of values.

This analysis assumes that the study requires a complete explicitness of the history of assets (cost and performance) and therefore allows the evaluation of risk and establishes a future plan for performance improvement, according to the requirements of economic efficiency and quality of service.

Constraints

Embarrassment: the information available was not, as of now, sufficiently worked on, in order to provide the necessary inputs to the model.
However, there is an ongoing action aimed at collecting and processing the historic information of the assets, based on a defined and approved Risk Matrix.

RISK MATRIX

e.g.

Risk Matrix - 2010
Enterprise Risk Management

	Impacts						Frequency				
	Business Values	Sustainability		Reputation	Service Quality	Economic	Average Period between Events (years)				
	Indicators	People Safety	Environment	Effect on Media and Population	Internal TIEPI MT (min) (EDP base)	Results (k€)	very high (f ≤ 0,5)	high (1 ≥ f > 0,5)	medium (2 ≥ P > 1)	low (5 ≥ f > 2)	very low (5 ≥ f)
							5	4	3	2	1
Severity Level	5 Very Critical	May cause death or permanent and serious disability in people	May cause significant damage to the environment which arise during a period exceeding 5 years	- International - or national with potential for repercussion in the media	TIEPI MT ≥ 3	R ≥ 4.500	I1	I2	I4	M5	M1
	4 Critical	May require hospitalization	May cause significant damage to the environment which arise during a period up to 5 years	- National - or regional with potential for repercussion in the media	3 > TIEPI MT ≥ 1,33	4.500 > R ≥ 2.000	I3	I5	M6	M2	A10
	3 High	May require medical treatment	May cause minor damage to the environment which arise during more than 5 years	- Regional - or local with potential for repercussion in the media	1,33 > TIEPI MT ≥ 0,5	2.000 > R ≥ 750	I6	M7	M3	A9	A6
	2 Medium	May require First Aid	May cause minor damage to the environment which arise during a period up to 5 years	Local News	0,5 > TIEPI MT ≥ 0,17	750 > R ≥ 250	M8	M4	A8	A5	A3
	1 Low	No impact	Without relevant impact	Without external impact to the Group	0,17 > TIEPI MT	250 > R	A11	A7	A4	A2	A1

Fig. 10

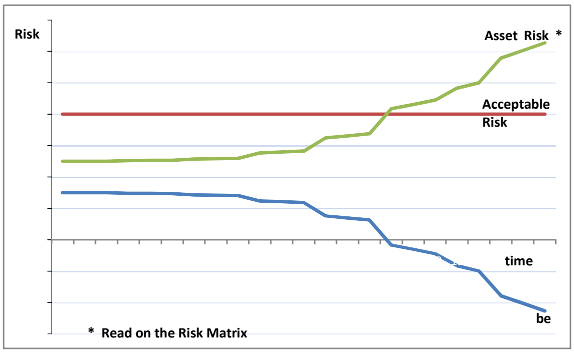

Fig. 11

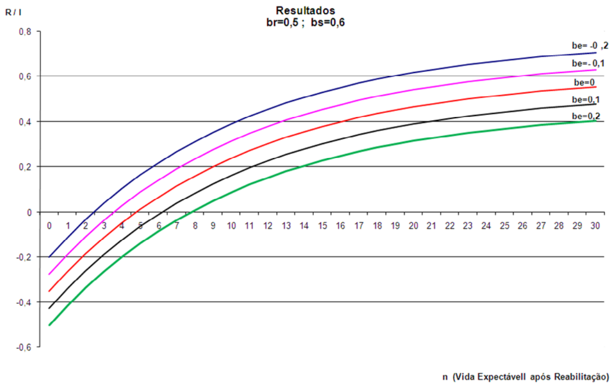

Fig. 12

The tolerable risk corresponds to be = 0.

When be<0, the asset is in increased risk in relation to what is permissible. The solution lies primarily in the replacement with a new one (the curves tend to decline and approaching that of be = 0).

When be>0, the risk of the asset is below the reference (allowed). The solution lies in having greater space for Rehabilitation (the curves tend to rise and get closer to that of be = 0).

As we can see in Fig. 7, when be < 0 the asset is degraded and the curves k2=f(n) indicate that interventions in the asset should have been done some years ago (k2 curves cross n axis in its negative region).

If, by the contrary, as seen in Fig. 5 and 6, be > 0, the asset gives us some time to assess the best intervention, without the pressure of a high level of risk.