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FROM VALUE TO SUSTAINABILITY INDEX:

VALUE ANALYSIS AS A METHOD TO MANAGE COMPLEXITY FOR SUSTAINABLE DEVELOPMENT

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1. ABSTRACT

The relationship among the functions' utility and the global costs (value index in the meaning of Lawrence D. Miles) is crucial in the moment in which the demand of measuring quality in terms of performances is becoming pressing.

Reference to global costs allows to program any intervention within the available resources for defined service life, in a perspective that respect conditions of sustainable development for future generations.

To give strategies inside a real sustainability of land transformation, the core aim is passing from enunciations to principles, to realistic projects of feasible works and profits for collectivity. We propose to adopt a method based on the concept of "value" in the meaning receipted in the European Standards UNI EN 1325-1:1998, UNI EN 1325-2:2005 - Value Analysis - VA - and UNI EN 12973:2003 - Value Management, introducing a "sustainability index" developed as the ratio between "sustainability quality" and global costs in service life.

This paper will briefly show this approach and it's benefits comparing with other tools for sustainability measure, with a case study in building field.

2. VALUE ANALYSIS AS A TOOL FOR SUSTAINABILITY ASSESSMENT

Value Analysis is a method based on an technique which makes possible to evaluate and measure customer/user satisfaction in order of explicit and implicit requirements of the entity under consideration, with reference to the global costs [3].

VA is based upon an organized group activity, interdisciplinary, carried out for the customer or user by experts of different disciplines and by non experts, under the guide of an expert VA coordinator. Such an activity is aimed at finding out a value index of the functions performed by the

entity in the hypothesized solution and in alternative solutions proposed by the VA group, these also inside the limits of the disposable resources. Solutions are shown in order of priority according to their value to the project management.

Value Index is originally defined as the ratio between worth W and cost C. The first is the utility related to the considered primary function esteemed as *"the minimum price estimated by the VA team, which allows the considered function to be carried out, in a defied place, time and environmental conditions,"* while costs are referred to the component that performs the primary function itself. The cost C can be assumed as production's cost or as global cost in service life.

With this method it is possible to analyze the service given by the product in question, with reference to functions it carries out in dynamic terms. VA team doesn't only consider the efficiency and the effectiveness at the time the product starts to be used, but during all it's service life, considering the importance of the performance of the object in the course of time, analyzing all the components which assure the lasting of the performances.

Briefly Value Analysis teach that everything can be enhanced in functional terms, in connection with the disposable resources, if only the approach is a interdisciplinary one with a leading expert as coordinator. VA coordinator can bring to synthesis several contributions and analysis on a entity regarded as a set of function with a certain utility in a defined service life, in order to add value to the service provided.

Sustainability concept is now well defined by various researches performed in the '90 (CIB Agenda 21 is one of the main products of this activity). Thinking of sustainability in design decisions and in technical choices involves a multidisciplinary approach, which is necessary to integrate all the analytical appearances in a vision that esteems the attainment of this strategic objective.

3. VALUE INDEX AND SUSTAINABLE DEVELOPMENT

The use of value analysis (value engineering) to approach sustainability gives a brand new focus on this theme. It's clear that VA tools and the interdisciplinary approach are useful to manage every complex sector, but value index, in particular, can become a significant element for a new strategy towards sustainability issues.

We can define the value index for the sustainable development as:

$$Is = \sum Ws / \sum Gc$$

$\sum$Ws is the total sum of sustainability worth, and $\sum$Gc is the sum of global costs of the items analyzed in service life.

Sustainability worth can be defined as the function–related cost of components that perform a sustainability requirement (i.e. an insulating panel in a energy saving building), in analogy with the general VA definition of worth [Miles, 1972].

Global costs are necessary to esteem the impact in service life of any component introduced to

improve sustainability and can be useful to remark the investment breakdown (i.e. global cost in service life of solar panels should be related to investment breakdown to demonstrate savings of their use).

Cost analysis are also necessary for a real sustainability assessment because any product development towards a sustainability quality must be justified in order of a global assessment. We should remember in fact that a final user cost is a sum of materials, work, tools and marketing that are all important for a sustainability policy: less work, material, instruments and market can induce a better sustainability for a product.

Value Analysis has been introduced in Italy by public works law (L. 109/94) as a method of supporting planning and as a technique for plan verification, by means of tools like Functional Analysis, global cost appreciation, with the support of other decision help tools like ELECTRE and TOPSIS .

More recently a conference on Globalization[1] has been an important event to underline a possible role of Value Management as a tool for sustainability assessment. In the final report of the conference, concerning teaching for sustainability, is was wrote:

> *At Universities climate change related issues are taught in several disciplines. Research is done on renewable energy, biofuels, and many more issues. By combining chemistry, engineering and other fields of study innovative solutions can be created. The "value analysis" approach, which looks at the sustainability of whole ecosystems, is such an approach. Now it is used by the International Organization for Standardization (ISO) resulting in environment and sustainable development standards that take into account the whole value chain.*

The sustainable development concept synthesize a complex of themes, it's to say how to set social, economic and environmental issues together, in a worldwide dimension that preserve opportunities (and resources) for future generations. The accurate balance of those tree dimensions can successfully overlook every single project of social equity, economic growth, or environmental conservation [11] . A triangle diagram can so be used to represent the sustainability concept.

We can introduce in this representation sustainability index Is by a fourth dimension, the global cost, on another plane. With reference with the tetraedron in image 1 (next page), vertex A represent economic efficency issues, like energy savings, vertex B represent cultural and social development issues, vertex C the ecological dimension. If we set this triangle on four dimension we can introduce a vertex D that represent global costs for project and transformations. A sustainable choice can maximize a single aspect, or a set of two ore tree, but the more the necessary transormation costs, the less this choice will be sustainable.

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[1] Centre for European Policy Studies (CEPS)- Brussels. "Workshop Regionalism and Globalisation in Climate Policy" Montecatini Terme, 25 spet. 2003 – in the hambit of a United Nation University "Regionalism and Globalisation in Climate Policy" set of conferences.

Each solution, also for a techniocal choice, can so be described in order of it's sustainability as a set of four functions :

$$S = F (A, B, C, D)$$

Using concepts previously described we can define the set (A, B, C, D) as the utility assessment of solution A regarding sustainability issues.

A: economic efficency

B: social development

C: environmental maintenance

D: global costs

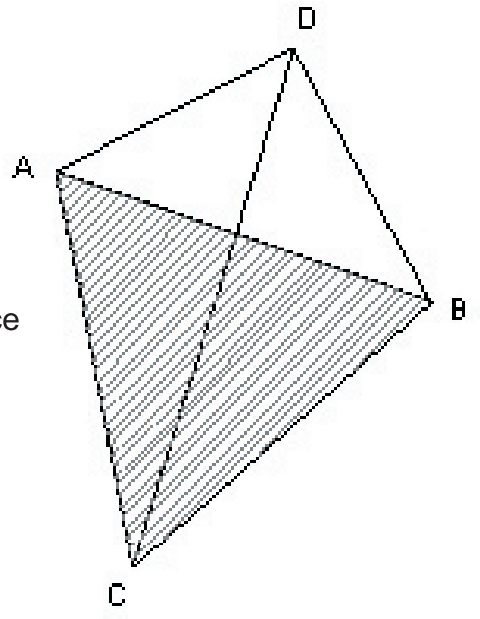

Image 1. The sustainability tetrahedron (R. Boccaccini)

It's clear that VA can be an useful approach for assessments on sustainability and that a parameter derived from value index, that we can call index of sustainability, can be introduce to measure and compare diffrent solutions for products and services development.

Starting from a general enunciation, the set (A, B, C, D) can be better defined for a specific case of interest; this activity can be carried out using Function Analisys or other hierarchical tools, like ELECTRE [10].

4. A CASE STUDY: VALUE ENHANCEMENT OF A LOW COST HOUSING BUILDING

We can now apply this general approach on a case history in the building field: a sustainability improvement of a low business housing block. An original project of this building was made by a public housing society and it was set in a more general project for the realization of public works in San Miniato (Pisa), Italy.[2] Since the initial design, that we will call solution A, didn't define any strategy for energy savings and social cohesion of inhabitants, we tried to perform some design alternatives, with the final aim of demostrating the sustainability improvement and a correct use of public money.

First of all the VA team has defined a set of specific design objectives for an alternative solution of the building: those were

1. Use of renewable energy and energetic efficiency improvement

[2] From the degree Thesis of Marco Fioravanti (with P.L. Maffei, F. Fantozzi, R. Boccaccini, A. Annunziati)

2. Improve socialization of inhabitants
3. Introduce natural elements for environmental integration

With reference to image 1 we can see that objective 1 refers to sustainability strategy A, objective 2 refers to strategy B and objective 3 to strategy C.

Those specific objectives can be translated using Function Analysis in functions to be performed by parts of the building. Those were in particular:

1.1 use of solar technology for water heating;

1.2 design of a optimal insulation for the building;

1.3 introduce hi-efficiency systems for energy use;

2. introduce some spaces for socialization inside the building

3.1 use of natural ventilation,

3.2 use of trees and other plants to reduce heat transmission in summer

For each of those functions worth has been calculated as the minimum cost of components that perform it.

service life:	25 years
function worth:	10.000 €
cost of construction:	12.000 €
cost of maintenance:	300 €/year
savings from production of warm water:	13.200 e/year
global cost:	42.940 €

For instance, function 1.1 worth has been calculated has the cost of construction of solar water panels with minimum standard performances.

For this function VA team has calculated global cost of the whole system, that is made by panels, structures, insulated pipelines, pumps, water boilers. The collected data were:

Doing the same for all the other functions is possible to determine a index of sustainability for each solution.

After this kind of analisys inner solution results to have a sustainability index of Is1 = 0,1 while the value enhanced solution has a Is2 = 0,35.

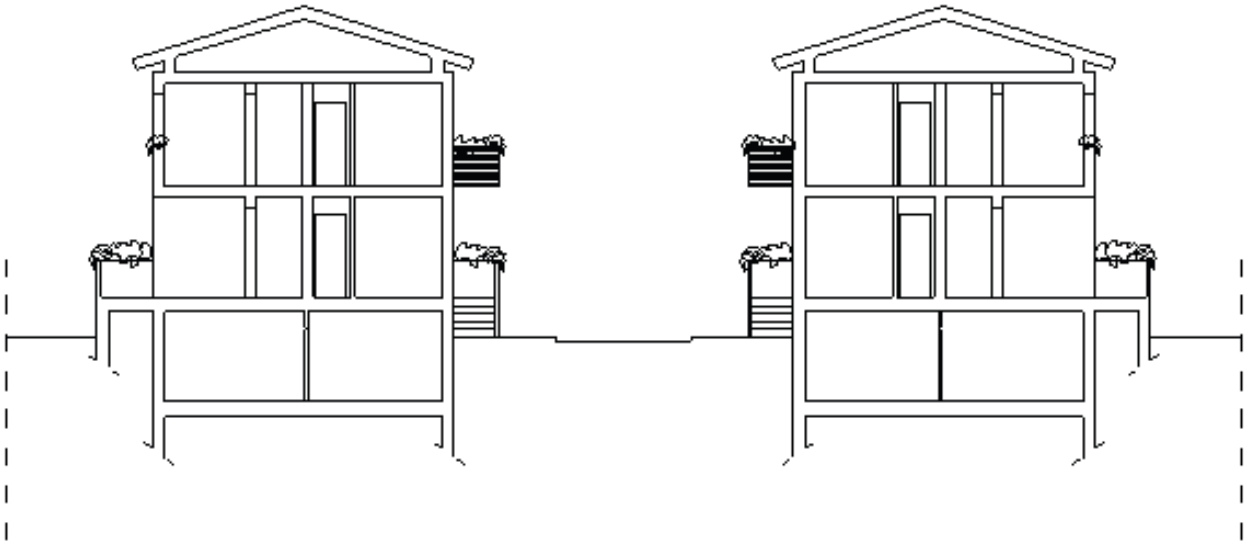

Image 2. Original design solution for the low cost housing – section (M. Fioravanti)

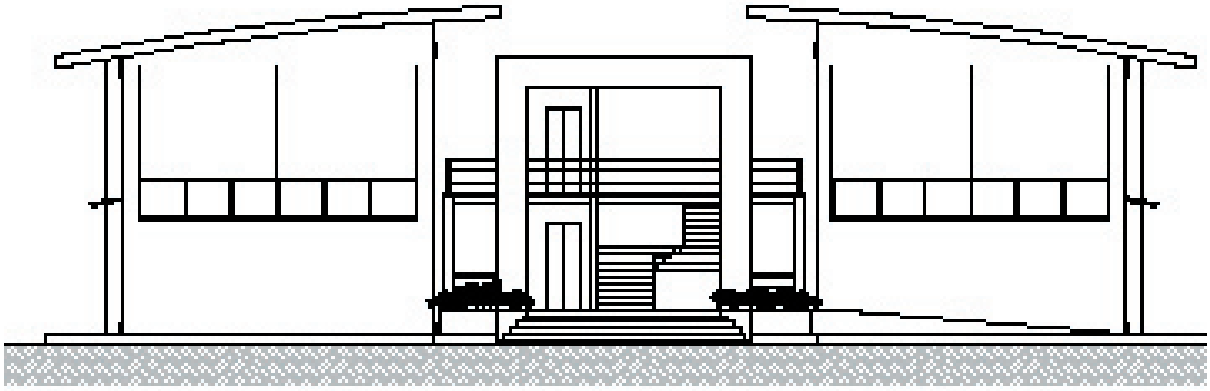

Image 3. Value enhanced design solution for the low cost housing – face with solar panels (M. Fioravanti)

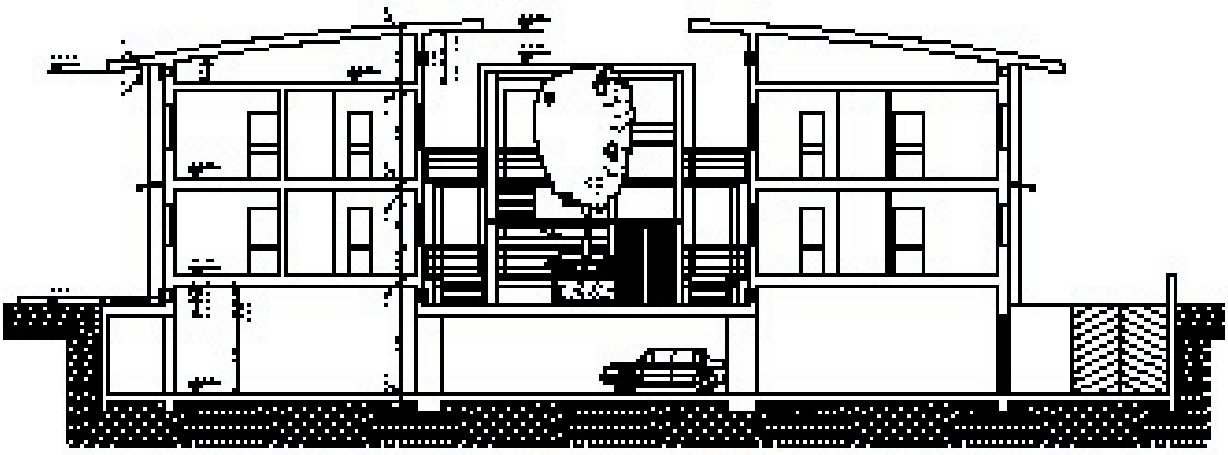

Image 4. Value enhanced design solution for the low cost housing – section (M. Fioravanti)

5. CONCLUSIONS

In conclusion a value analysis approach can greatly improve a strategy for sustainable development, introducing a fourth dimension, global costs, that is furthermore important to sustainable technical solutions for products and services. More than this, a sustainability index can be calculated by value analysis means and it can give a measure on the obtainment of design objectives.

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