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SUSTAINABLE DEVELOPMENT USING FUZZY LOGIC

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INTRODUCTION

The sustainable development is defined as “the development that satisfies needs of the present time without endangering the capacity of future generations to satisfy theirs”. The term “sustainable development” represents that balance between the satisfaction of present needs and the future ones, offering options of technological and social growth for reducing the risks meaning trends of topical increase.
The idea of sustainability can be analysed from three perspectives: environmental, social and economic

SUSTAINABLE DEVELOPMENT

The concept of sustainability means a new philosophy of the Economy because it introduces the environmental compatibility to consider the economic development.
The *impacts* characterization consists in the description of the identified impacts, considered significant or remarkable, according to an attributes series, although the consideration of an environment impact such as the alteration, modification or change of the environment quality made by a human activity is much known. This classification is subjective and the knowledge can be incomplete. Therefore, the problems of scale and incertitude are going to stay present when it comes to determining the environmental effects and impacts, which are made due to a specific activity, especially in the case of the secondary ones or of those that are shown in the medium or long term.

In this paper, we are going to try to achieve an *evaluation of a social, economic and environmental impact.* An environmental impact is identified by the effect of a simple action from an activity about an environmental factor. Both elements, action and factor, should remain explicit in the definition made of it.

THE FUZZY LOGIC AS A TOOL SECTION

All things considered, this paper proposes to follow the classic methodology of projects evaluation to use the Fuzzy Logic and the computer systems with words by changing the following aspects:
•To decide if an effect is an impact and the nature of it, which increases the firmness when it comes to form, to deduce and to take decisions about concepts of great subjectivity.
•To assess the importance: The knowledge is uncertain, vague and insubstantial. That is why the systems of fuzzy control may assess the importance of each impact. The linguistic variables that define the magnitude: extension, moment, reversibility, etc., are calculated and represented in the interval [0, 1]. The fuzzy wholes allow working with vague concepts and with numerical and vague values.
•To calculate the “best” indicators in order to measure the magnitude and to calculate its value.
•The scales of the variables used in the calculation of the magnitude are not homogeneous, which distorts the results and the weight of them in the importance value for each impact. The functions of transformation are fuzzy sets that allow transforming the measured magnitudes from heterogeneous to homogeneous. There is a subjectivity grade in the selection of the transformation functions that depends on the expert.
•The selection of different t-rules allows studying other possibilities to measure the value (qualitative and quantitative) of each impact, taking into account its standardised importance and its standardised magnitude.
•To classify each impact in “compatible, moderate and critical.”
•The functions of addition, which were studied in the Fuzzy Logic, allow obtaining the total impact f each alternative of a work, using the weights of the environmental factors.
•To develop a strategy to calculate the correcting steps that must be added to the project, assuming the previous assessment. All these impacts, whose assessment is considered that it is not within the acceptable limits, must be reduced through these steps. Now, the way to do it could be on the contrary. Coming from the final value that it could have, the necessary measures must be fixed to get it, using an approximate reasoning.

The identification of the indicators when it comes to evaluating some projects

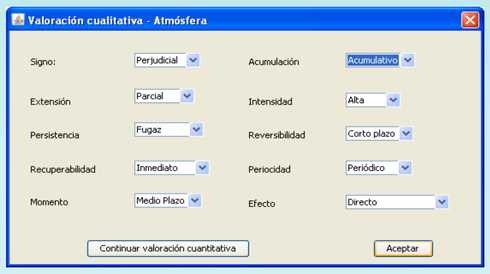
As the *environmental impacts assessment* is concerned, the use of indicators is suggested, whenever possible, for the quantification of the effect that has already been fixed, in order to make more explicit the reached size by it. If we begin with this supposition, the necessary actions must be developed in order to avoid or to counteract the impact, if it is negative; or in order to seize the opportunity of the benefit if it is a positive impact.
The first step of this methodology consists in the identification of the physical, biologic, socioeconomic and cultural processes that may be affected by the suggested action. It is at this moment where the studies already made about the subject that inform about the “condition of the environment” are taken into account before the project starts. The main focusing is to unify the available information or to produce the necessary one within a specific area, in order to use it for the next phase of the impact assessment: the prediction of impacts. It is about to choose the effects that can really take place among the identified ones and that they deserve a special attention.
The following concepts for the *evaluation of the importance* could be used:
Impact: Beneficial (B), Harmful (H).
Certitude: True (T), Probable (P).
Size: Small (1), Medium (2), long (3).
Reversibility: Temporal (T), Permanent (P).
Period: Immediate (I), Medium (M), Long (L).
Action: Yes (Y), No (N).

Why a system of indicators for the sustainability?

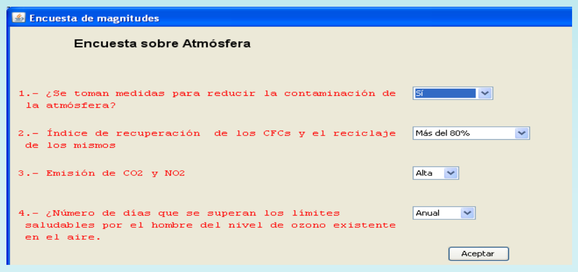
A system of indicators to assess if a project is sustainable or not is going to allow us:
To make an effective monitoring about the application of plans of Economic, Social and Environmental Action.
To evaluate the economic, social and environmental evolution with regard to the carried out actions.
To favour the obtention of quick and effective information.
To offer information to the citizens in an easy and instructive way.
To determine the implication grade of the agents.
To help to adopt political decisions with regard to the environment.
To obtain a totalizing vision of the predominant interests in each municipality

The sustainability tool

For this paper, the use of the XFuzzy tool is thought out, because it has a suitable environment. All the calculates are done with fuzzy logic.
The application calculate the sustainability of a project. It evaluates seven factors for social sustainability (social inclusion, identity, participation, health and safety, environmental education, quality of life and population), eight for environmental sustainability (agriculture, environmental management, water resource, waste, air, noise and energy) and five for the economic (production, utility, affordability, employment, private sector). To evaluate each factor, the system measures its importance and magnitude. The result is the (fuzzy) merge of the sustainbility of each factor.



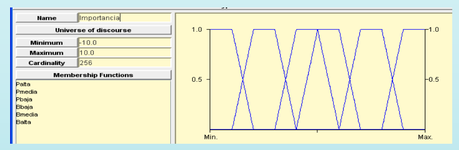
Importance evaluation of the factor Atmosphere. (Environmental sostainability).



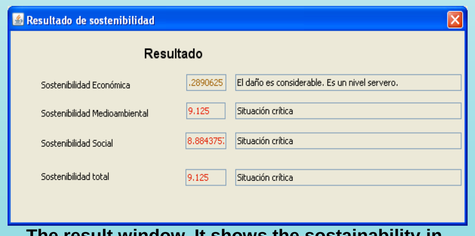
Survey to get how the indicators influence in the factor and the system calculates the magnitude.

Rule			Premise		Conclusion
0	1.0	if	(mag == MuyPoco & imp == Palta)	->	factor = Pmedia
1	1.0	if	(mag == MuyPoco & imp == Pmedia)	->	factor = Pbaja
2	1.0	if	(mag == MuyPoco & imp == Pbaja)	->	factor = Pbaja
3	1.0	if	(mag == MuyPoco & imp == Bbaja)	->	factor = Bbaja
4	1.0	if	(mag == MuyPoco & imp == Bmedia)	->	factor = Pbaja
5	1.0	if	(mag == MuyPoco & imp == Balta)	->	factor = Bmedia
6	1.0	if	(mag == Poco & imp == Palta)	->	factor = Pmedia
7	1.0	if	(mag == Poco & imp == Pmedia)	->	factor = Pmedia
8	1.0	if	(mag == Poco & imp == Pbaja)	->	factor = Pbaja
9	1.0	if	(mag == Poco & imp == Bbaja)	->	factor = Bbaja
10	1.0	if	(mag == Poco & imp == Bmedia)	->	factor = Bmedia
11	1.0	if	(mag == Poco & imp == Balta)	->	factor = Bmedia
12	1.0	if	(mag == Medio & imp == Palta)	->	factor = Palta
13	1.0	if	(mag == Medio & imp == Pmedia)	->	factor = Pmedia
14	1.0	if	(mag == Medio & imp == Pbaja)	->	factor = Pbaja
15	1.0	if	(mag == Medio & imp == Bbaja)	->	factor = Bbaja
16	1.0	if	(mag == Medio & imp == Bmedia)	->	factor = Bmedia
17	1.0	if	(mag == Medio & imp == Balta)	->	factor = Palta
18	1.0	if	(mag == Alto & imp == Palta)	->	factor = Palta
19	1.0	if	(mag == Alto & imp == Pmedia)	->	factor = Palta
20	1.0	if	(mag == Alto & imp == Pbaja)	->	factor = Pmedia
21	1.0	if	(mag == Alto & imp == Bbaja)	->	factor = Bmedia
22	1.0	if	(mag == Alto & imp == Bmedia)	->	factor = Balta
23	1.0	if	(mag == Alto & imp == Balta)	->	factor = Balta
24	1.0	if	(mag == MuyAlto & imp == Palta)	->	factor = Palta
25	1.0	if	(mag == MuyAlto & imp == Pmedia)	->	factor = Palta
26	1.0	if	(mag == MuyAlto & imp == Pbaja)	->	factor = Palta
27	1.0	if	(mag == MuyAlto & imp == Bbaja)	->	factor = Balta
28	1.0	if	(mag == MuyAlto & imp == Bmedia)	->	factor = Balta
29	1.0	if	(mag == MuyAlto & imp == Balta)	->	factor = Balta

Inference rules to calculate a final factor value from the magnitude and the importance.



Importance Fuzzy Set of a factor:
P- Harmful; B- Beneficial



The result window. It shows the sostainability in each sector and the global sostainbility. The result can be negligible, moderate, severe and critical.

The sustainability software in java can be tested at http:/www.fdi.ucm.es/profesor/lgarmend/SC/sostenibilidad.jar

Conclusions

We can see through this article the interest for the society of the sustainable projects evaluation teaching, the necessity of investigating a model that allow helping to make decisions about certain aspects of the social, economic or environmental impacts of the project, using the Fuzzy Logic.