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Indicators of urban sustainability for a model of change.

The Ecological Urban Interaction Matrix (MIEU): a methodology –based on bio-construction- to plan the quality of life and the environment of urban settlements.

Author: Pàmpols, David; architect MSc. Master Bio-construction.University of Lleida (UdL) – Lleida (Spain)

Abstract: *The city as biophysical matrix maintains relationships with its geographical location. These express themselves through ecological and anthropogenic processes at different spatial and temporal scales, where there exist interrelationships capable of being modified reciprocally. The current city demonstrates in its settlement patterns configuration, uses of soil and activities, expressed as diverse ecological landscapes within a heterogeneous, fragmented and multiple mosaic that is comprised. But is it our analytical approach, using current urban indicators, holistic enough to deal with this complexity?*

The purpose of this paper is to promote discussion on three aspects that are being studied for many teams across Europe. The first one addresses the methodology of approach to the problem, comparing the analytical model: pressure, state, response, with the analytical - theoretical model: system – environment. The second one shows, under the theoretical prism system – environment model, a proposed methodology – MIEU: Ecological Urban Interaction Matrix - and proposes a set of models and basic indicators of the city and its metabolism and defends a more complex approach to the problem of social planning of urban settlements. Finally, some indicators of human appropriation of natural resources from the bio-construction favoring a more holistic view to the discussion, from the perspective of subjectivity; the concept of quality of life and the analysis of the sustainability of our frames of social relationship.

In short, this way of making the city incorporates the proposed methodology, based on a comprehensive vision, the values that enable sustainability, socially equitable and environmentally balanced energy efficient urban planning.

Keywords: ***indicator, planning, sustainable development, bio-construction, urban***

Basic indicators for urban sustainability planning

We are aware that the process or path to urban sustainability demands a collective raising awareness and concrete action on the part of the administration. To channel these actions there arise initiatives of urban management and planning. The conceptual imprecision associated with the paradigm of the sustainability must not be an obstacle for the creation of indicators that, in this case, must be a result of a creative local process that overcomes problems and conflicts. It is imperative to choose meaningful indicators for the aims proposed in each case and then to establish a parallel action plan or an effective performance that allows improving progressively the results of the indicators in order that the city is sustainable. Without a change of mentality in people with facts such as recycling, reuse, civility, mutual respect, etc. the results will not be more favorable to the sustainability. Also it is necessary to establish priorities, that is to say, to know in what situation we are to decide where to start.

The aim of our study is to provide a methodology for searching and selecting the most appropriate indicators in each case for sustainable development and analyze how sustainable development can and must be planned and based on clear and precise actions for a place or a context . These actions must be binding, which is possible only through planning.

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The usefulness of indicators

An indicator must be clear, understandable, trustworthy and, in the planning, should help to meet targets for improvement. Indicators should respond to identified needs or problems or just intuit to elaborate on them, limit them and be able to find solutions. Indicators, providing information about the current state of resources, intensity and direction of possible changes, can help consensus among citizens reality of sustainable development or its absence in a locality and orientate the formulation of policies so that they propose concrete actions that are going to have acceptance among the citizens. Do we assess sustainability techniques and methods for the sustainable use, for its conservation and restoration or are we stating the unsustainability of the model of existing development without proposing effective and binding solutions? Might it be the unsustainability of the development a major motivation than the search of the sustainability? Or it will be furthermore to see how our health cracks unless we change many of the daily habits? What specific indicators to be adopted then?

Basic concepts on indicators

Definitively, the indicator is a measure of the observable part of a phenomenon that can assess other unobservable portion of the phenomenon (Chevalier et al.,1992). The indicator must allow a succinct, understandable and scientifically valid reading of the phenomenon under study. In this sense, the approach of Gallopín (1996) turns out to be more interesting from the optics of the Theory of Systems on having defined the indicators as variables (and not as values), that is to say, operative representations of an attribute (quality, characteristic, property) of a system. The indicators are therefore images of an attribute, which are defined in terms of a measurement procedure or particular observation. Each variable can be associated with a set of values or states through which it demonstrates.

Considerations on the current systems of environmental indicators

Departing from an initial[1] model of the reality under analysis based on the Theory of Systems, a system of indicators provides an analytical instrument to represent that so comprehensive instrument and track variables based on the degree to which specified target levels. In the area of environmental policy, in particular on information about the state of the environment, a considerable summit has been produced in the use of indicators, called strictly environmental.

The inclusion of indicators in common analytical structures: the model pressure-state-response (P-S-R)

Today, the dominant framework of analysis is called Pressure-State-Response, first developed by Frien and Rapport (1979). This framework, introduced strongly in the set of countries of the OECD , as having constituted the model of development of environmental indicators of this international organization, is based on the concept of causality "human activities exert pressures on the environment and change their quality and the amount of natural resources." Society responds to these changes through environmental, economic and sectoral policies. The utility of this model that anyone adapts to the steps of a decision-making model and that any decision on the other hand, it is common to the way of thinking about whom they decide and about the scientific community.

[1] As recalled in most studies on the topic (MMA, 1996), if the scientific model a priori is not coherent and consistent, the system of indicators will not be trustworthy.

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The demand for clear, simple and added to the description of a problem to decide faces information on this model with the absence of an appropriate theoretical framework, making it difficult to discern between different information without any theoretical hierarchy. Faced to such a lack, one chooses in many occasions to integrate a large number of variables in the system, for fear of leaving significant variables out, returning to the starting point: a huge amount of data that do not transmit the necessary information to make decisions.

The inclusion of urban indicators in integrative theoretical models: the model system-environment

All individual systems and ecosystems in nature have a tendency to increase complexity in the time. Indeed the evolution of species and succession in ecosystems show a path of successive organizations whose trend is the increase of its complexity. A trend that gets onto the next step so as to better control the environment variables and ensure a better future. The "control" of environment variables supposes the capacity of anticipation that has the system to get accommodated to the messages in the shape of materials, energetic and information flows that environment sends (the environment is also a system). A deeper analysis allows us to identify the variables with a minor flexibility and therefore the indicators that might be established to do a follow-up of the unit SYSTEM – ENVIRONMENT trends in its future projection.

Some issues for discussion

Is the P-S-R analytical model the right one for the development of urban indicators? System-environment model is a model with theoretical content enough for the diagnosis, planning and monitoring of urban management models? Is it a calculation instrument interesting and viable enough? Does it make sense to establish indicators without having proposed a plan or program on the question that is meant? Without a management model that framed, indicators make sense? Urban indicators to go to where? Indicators should be participated and agreed with civil society? Is it possible to compete with an information-based strategy and not in the consumption of resources one: land, materials, and energy? Are processes towards the sustainability incompatible with the current economic logic?

MIEU: Urban Ecological Interaction Matrix. An indicators methodology for a model of change.

After the foregoing analysis, the set of indicators proposed are incardinated in each of the axes of the compact mediterranean city model in which the morphology and functionality of the system is evaluated. The model of complex city that it aims to measure the urban organization, the efficient city that seeks to ascertain the degree of consumption of resources and the efficiency thereof and finally the city socially stable model aims among other know things social cohesion proposed in planning processes and planning of our cities.

Evolution of the concept: quality of life

At first, the term Quality of Life appears in public debates concerning the environment and the deteriorating urban living conditions. The term began to be defined as an integrating concept that encompasses all areas of life (multidimensional character) and refers both to objective conditions and to subjective components. To avoid this confusion is suitable to

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distinguish between needs (determined by human nature purposes) and satisfiers (culturally determined means).

Incorporation of subjectivity

The social character of subjectivity is one of the axes of reflection on the concrete human being. Preferences are defined in the realm of the subjective-particularly, are a competence of each person, and do not threaten, therefore, the suppositions of rationality of the market. Concerning, instead, to fundamental human needs requires from heading placed in the plane of the subjective-universal, which turns sterile any mechanistic approach. The analysis of the human needs can never be considered to be a closed and finished product, and that in any case, must be judged by the own interested persons; multidimensionality can not cloud the other inalienable aspect of quality of life: **subjectivity.**

Village vs. urbanization

The methodology set out on this issue (MIEU), bet for the city (village), not for the urbanization: the urban minimal phrase from which to build the development of urban settlements, from a necessarily holistic and complex approach, based on the compact Mediterranean city model and with a dimensional identical approach to energy sustainability, social relations of its members and that allows personal development from public space and the meeting of complementaries. That is the scale of the village. And this introduces for its own approach, SUBJECTIVITY as the necessary ingredient for the development of urban indicators.

Social relationship frameworks sustainability

It is more plausible to consider that economic development is a modification of the technological and social context that causes a change, not of the needs, but of the most urgent lacks and of the most accessible means to face them. The economic development changes, certainly, available satisfiers and its effective use, which has implications in satisfaction of the diverse needs. Under this perspective we should be comparing the subjective satisfaction in different cultures and evaluate the suitability of the specific satisfiers.

Quality of Life and sustainability

The measurement of quality, as we know, turns out to be an almost impossible task by our proper ignorance of human nature, which also applies to the measurement of social costs; nevertheless, for the environmental costs one relies on slightly more precise derivative instruments of knowledge of the physical sciences.

Methodology proposed

It has been a question of establishing a methodology to help to look for solutions to the environmental problems from a holistic perspective. This methodology allows us to define or establish a series of criteria to select indicators (some already suggested by the legislation) that may lead to concrete actions. Citizen participation must be present throughout the process and start with the most significant indicators and a systematic follow-up does not exclude going expanding over time to analyze indicators. These measures must be gathered in the planning.

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The interaction matrix

The factors and the natural environment variables interact with each other, so it is difficult to establish a clear boundary between them. However, due to this fact they can relate the variables that a priori are involved in the growth and genesis of an urban settlement. With this intention, the methodology incorporates the main factors of interaction between the Natural Environment and the Urban Environment and their interaction with the environment is evaluated. The relationship among the natural and urban environment can be summarized as an interaction matrix or counterfoil, a Cartesian box with environment variables on the horizontal axis and the urban environment in the vertical one. The cells are completed with a detailed list, existing in turn empty cells when such a interaction does not take place.

Environmental optimization criteria

To realize a few Environmental Optimization Criteria on a settlement, the methodology proposes to evaluate, in detail, almost all the aspects that determine this interrelationship. A matrix to interrelate these aspects, in order to be able to numerically gauge their impact on the design of the settlement is established for that purpose. (These and other indicators tracking model are presented in an extended document analysis)

Implementation of the methodology MIEU

The methodology of the Urban Ecological Interaction Matrix is implemented from a series of simple resources, based on the open-source culture, allowing easy and efficient management adjusted to all available resources and situations. It uses well-known, public and accessible to the general public technologies and allows the critical edition of results on a simple, fast and effective way, but at the same time complex and holistic.

It is developed on the basis of five (5) stages of development and consecutively interrelated.

I. ***Needs and satisfactors.*** *Survey of needs among users (or potential users).* A survey of 10 items will be performed, rating from 1 to 5, among actual or potential future users, on the social, economic and environmental aspects of the interaction matrix.

II. ***Indicators***. *Rating certain environmental variables (planner).* The planner might value from 1 to 5 the suitability of the compliance of the design respect to the interaction matrix, on about 75 factors, and for each of the 5 environmental optimization criteria boxes.

III. ***QFD Analysis***. *Needs and satisfiers funtion deployment.* QFD (Quality Function Development) is a method of quality management based on transforming user demands into design quality, to deploy the functions that provide higher quality, and implement methods to achieve design quality into subsystems and components, and ultimately to specific elements of the manufacturing process. The MIEU methodology proposes an analogy in using this system of quality management for existing or planned urban settlements. So it proposes the incorporation of data derived from the survey among users as *client's demands* and the analysis of the environmental parameters from the interaction matrix as the aspects of the *manufacturing process* of the new settlement.

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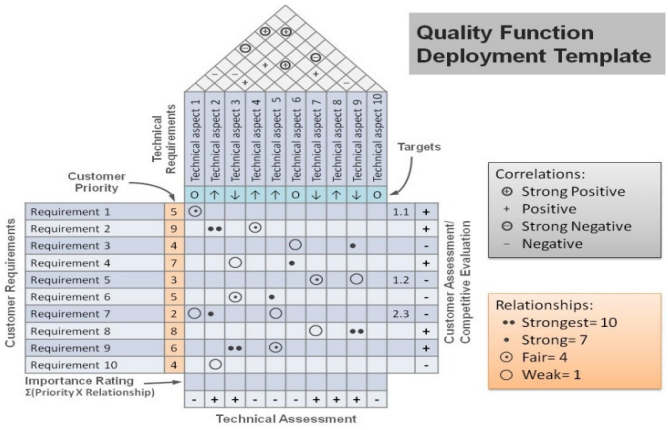

Image 1: Functional diagram of the QFD analysis and interrelationships

IV. ***Radar charts***. *Graphical analysis of results.* From the weighting obtained in the QFD analysis for the planned settlement, the data are entered into a spreadsheet that compares the items obtained whith those would arise in such an ideal situation (needs and satisfactors above the QFD analysis and optimal results obtained through the environmental interaction matrix rating).

V. ***Conclusions and assessment***. *Analysis of results and comparison with the "ideal" scenario.* From the introduction of the data in the radar chart, it is possible to proceed to the critical analysis of the scenes obtained and their attachment to those raised in the ideal scenario. On this one, the necessary alterations are established to improve the planning, until the chart throws the closest to desirable results, which allows to work corrective aspects on the model, to improve it

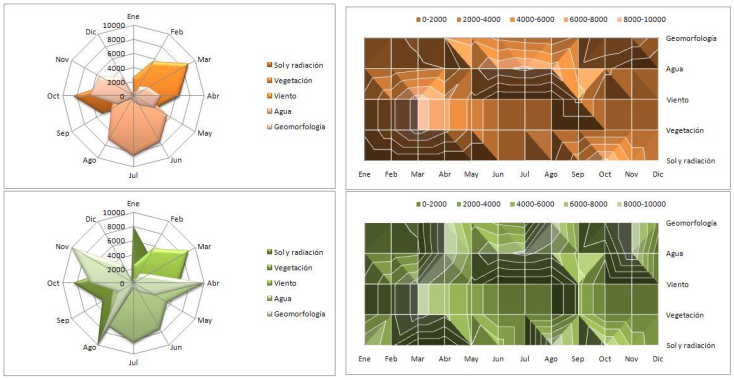

Image 2: Radar charts for a comparative analysis of results

From the point of view of the bio-construction

For everything previously developed, especially as regards the introduction of subjectivity, the needs and the satisfactores in which there is fitted the methodology of Urban Ecological Interaction Matrix (MIEU), this can only be developed successfully under the contribution of bio-construction point of view because it is a way of building and designing the cities so they adjust to parameters of environmental and social sustainability, guaranteeing mobility, the energetic efficiency and livability **both real and perceived.** Bioconstruction is a way to build and plan cities incorporating criteria and techniques for ensuring environmentally friendly healthier, final result, with the use of neither non-polluting nor toxic, reusable and recyclable

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materials, with solutions to save energy use and preference for renewable energies. Buildings constructed under this system have a high degree of functionality with mechanisms for capturing energy (as for example solar panels), recycling and water saving and to the most suitable treatment of residues. As a concept of urban development design of streets and public spaces looking mainly a distribution of buildings that could take advantage from natural energies (sunlight, natural ventilation, energetic potentials of the soil ...). Thus, the space around the buildings reaches a higher level of real and subjective habitability. It is no longer a strange statement for anyone recognizing that the quality of life, as perceived by people, has much to do with the environmental characteristics of their urban environment.

Conclusions

A system of indicators demands a systematical follow-up with continuity in time, what could be done to systematically include in the planning an annual external audit, for example. An excessive number of indicators does not turn out to be operative, so(then,since) in this case the follow-up and control of the environmental performances would not be practical and manageable. It is important to prioritize and summarize the indicators: its interesting them to be a few but significant and to create and promote a true culture of sustainability that passes through a deep environmental education leading to concrete actions. In that sense we have tried to demonstrate with the MIEU methodology the importance of actions that promote sustainability are binding on the population, which is only possible through planning and citizen participation. The specific actions that enable sustainable development constitute the purpose of the raised methodology. These actions can plan them only through a proper selection of indicators and a change in the paradigm of perception of the indicators used for the design and analysis of urban settlements. If the real purpose of the indicator is intended to facilitate the identification of problems for their possible solution, any simplification of it turns out counterproductive, while controversial, since the mathematical mechanisms, however sophisticated they may be, only serve to disguise the arbitrariness of the design.

Final corollary

The experiences analyzed have served us to see that the proposed methodology should be used to rank the most problematic aspects of the analysis of urban planning in relation to sustainability in terms of their severity and towards concrete actions involving alternative solutions planning so that these actions are binding and are agreed upon by the population to assure its viability and effectiveness. For all this it is necessary to introduce a more holistic vision of the analysis wich incorporates the analytic subjectivity as aspect of critical appraisal and that falls, in equal measure, in environmental aspects, the socio-economic ones but also in those who pursue the satisfaction of people with their environment, in what has come to be theorized as the 'Quality of Life'.

It is very important to collect as binding planning clear outcomes and objectives that relate to sustainability and the need to be continuously implemented. Otherwise, it will continue being an object of debate and good intentions without reaching any effective result that supposes an improvement.