Chapter 10
Fractal Approach in Sustainability Modeling

ABSTRACT

This chapter addresses conceptual modeling of sustainable performance designed to meet social and environmental accounting, through qualitative approaches in research of reporting tools. The debate is based on successive qualitative-correlative approaches, of fractal type, for complex phenomena. The research is completed with behaviors generating sustainability that may be used in performance management. The research method focuses on appropriate tools for complex and dynamic relations between the economic entity, society and environment. These interact to develop new relationships and new entities. The most important result of the research is modeling sustainability by cyclic structures and commutative diagrams explaining the complexity mechanisms which engage and generate the state of balance or imbalance, analyzed, controlled and corrected through crisis management. This chapter supports and argues the need for a new framework for corporate performance reporting, including risks and uncertainties arising from social and environmental factors.

INTRODUCTION

Complex instruments, rather than linear approaches, are more adequate to describe sustainability mechanisms. Such instruments are centered on the relations between information flows and data or material accumulations presented throughout the models described in this chapter. Thus, even if, methodologically, the measurements are still tributary to quantitative aspects, qualitative and correlative components are emerging as a response to nonlinear catastrophes generated by financial, social and ecologic crises. This phenomenon implies a large scale conceptual innovation in the form of a multi-stage transition to a new perception of reality and also a transfer of the new perceptions into new conducts and technologies.

The complexity sciences have brought forward a new perspective on the measurement trends relevant for the understanding of dynamic and complex mechanisms representing the relationship between the human society and the natural environment, relationship that ensure the reliability of financial and non-financial reporting based on sustainability. Each complexity science approaches another direction of

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reality measurement complementary to quantitative approaches and conventional accounting models. The normative position of efficient sustainability can be directly translated into eco-efficient constraints on technology, allowing for the definition and modeling of economic growth. A strong eco-efficient sustainability position leads to different points of view on economic growth and environmental improvement, as well as eco-efficient choices (Neumayer, 2003; Dietz & Neumayer, 2007). Short term policies can contribute to the development of specific product – technology combinations. On the long term, the development trends will be set by institutions (North, 1981; North, 2005; Freeman & Louça, 2001; Mokyr, 2002).

Sustainable development is a strongly disputed concept. In addition to the economic aspects, it encompasses numerous social, environmental, and cultural dimensions. The issues are multidisciplinary, while complexity and uncertainty are the norm. Sustainable development is also a very ideologically loaded concept. The conflicts of interests range from the business-as-usual approach to radical changes. The conventional cost-benefit debates highlight sustainability issues. Sustainability measurement models are used to prove the characteristics and potential of participative alternatives in environmental protection. McDonough and Braungart (2002) highlight the idea that "in practice, triple bottom line accounting tends to focus on economic concerns, with ecological or social benefits sometimes considered as an afterthought" (p.253). Whether the number of directions where the information needs to be correlated grows, there is an imperious need for the development of a convergent processing model and for reality modeling able to face the challenges of system's logic and to allow quantitative, qualitative and correlative data to be processed.

Even if the use of complex analytical or structural models has brought a new level of understanding of economic laws, this classical twentieth century approach no longer fits to dynamic situations, such as a crisis or a catastrophe, because it does not provide valid predictions (Taleb, 2012). This is the reason why the use of complex models developed in the XXth century is required for a proper analysis of situations, phenomena prediction and sustainable policy making.

CONCEPTUAL MODELLING ELEMENTS FOR SUSTAINABLE PERFORMANCE

Complexity sciences function with interconnected systems, dynamic situations and approaches with several levels of complexity. Unlike classical mechanical sciences that have led to linear thinking and to the measurement model current accounting methods are based on, the complexity sciences that govern the entire process and not individual stages, the process and not the measurable results, the exceptions able to change the rule and not the standard behavior.

Complex models, already used in economics, relay on mathematical representations of how systems operate, made up of chained equations, like Markov chains used to design cyclic cultures. Some of these equations are structural, meaning they represent visions of relations between variables (for example, more money on the market leads to an increase of expenses); others represent identities that sum up variables (for example, the total amount of expenses is composed of governmental plus non-governmental expenses). A pioneer in the field is Nicolaus Georgescu Roegen (1973) who has used models inspired by Ilya Prigogine's theory of dissipative systems.

Complex models are frequently used to understand and predict the behavior of complex systems, such as weather patterns, pollution effects, economic patterns, or issues created by demographic growth. Life