Chapter 1
Eco-Holonic as a Framework for the Design of Sustainable Autopoietic Cyberphysical Systems

María Jesús Ávila-Gutiérrez
https://orcid.org/0000-0002-2801-1153
University of Sevilla, Spain

Francisco Aguayo-González
University of Sevilla, Spain

ABSTRACT

The concept of autopoiesis created by scientists Maturana and Varela to specify the necessary and sufficient conditions of living systems has been strongly criticized by different authors. In spite of the constant attempts to introduce it to the sciences in general, it has only managed to be partially installed, although very strongly, in the social sciences. This chapter will seek to clarify what kind of problems the concept of autopoiesis presents and, in accordance with this, will present a new perspective. The concept of autopoiesis will be analyzed, placing it within the systems theory, critically evaluated, and its deficiencies made evident. Based on this, the concept of interpoiesis for the resolution of the deficiencies presented in the autopoiesis will be presented in order to install this new concept in the discussion. Finally, the concept will be evaluated from the Holonic paradigm shortened a case of application for business from the circular economy.

INTRODUCTION

Autopoietic systems are enactive systems that are coupled to the environment through loops of perception-cognition-action in a state of flow (Ramírez-Vizcaya & Froese, 2019) with the capacity for self-reproduction, self-organization, self-reference, and self-management (Ulrich, 1984), equipped with

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organization and structure through relationships of constitution, specificity, order and reference, which provide homeostasis and structural stability.

The conceptual framework of autopoiesis that has its origin in biology (Varela, Maturana and Uribe, 1974), has been extended to other fields such as: sociology from Luhmann's perspective (Luhmann, 1997), and information systems (Schatten & Bača, 2010). From the point of view of autopoiesis in biology, the original idea was to develop a concept - autopoiesis - that defined the living being or life as an emergent property, associated to it a new perspective on perception and cognition arises, affirming that the active cognition is a phenomenon of the living. Thus, it was necessary to find out what characterizes living systems as the core of this perspective.

Varela established that autopoietic systems are organized as a network of production processes (transformation and destruction) of components that produce components that through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; on the other hand, these are constituted as a concrete unit in the space in which they exist specifying the topological domain of their realization as such a network.

Autopoietic systems function as homeostatic systems that have their own organization as the fundamental variable and actively maintain it constant (Maturana & Varela, 1973; Varela et al., 1974). Thus, the concept of autopoiesis implies the preservation of the organization and the (re)production of components. It is important to note that the initial theory was developed for microorganisms, so the definition of autopoiesis has to be expanded to adhere to more complex living systems such as primates, humans, social systems as well as organizations and information systems.

Summarizing the concept of autopoiesis, the system has three fundamental characteristics; (1) element as momentary event, (2) limit reproduction of the system, (3) constitution of the element based on the system (Iba, 2010). In autopoiesis, changing the element's point of view is considered a crucial aspect. The element of the system is conventionally considered to continue to exist, for example the cells in the living system or actor in social system, however, in the theory of autopoietic systems, the elements are temporary events that have no duration which implies that the elements disappear as soon as they are realized. This means that the system has to produce elements to stay in existence. The limit of the system is determined circularly by the production of elements, which is why it is called an autopoietic system.

The attempt to extend autopoiesis and its conceptual frameworks beyond living systems must consider that these can be classified according to their emerging properties and levels of complexity into physical-chemical (inert), biological (living), psychological (cognitive) and socio-technical (social) systems, which since autopoiesis have been classified as first, second and third order. In all these classes of systems, it is possible to distinguish entities, their attributes, relationships, processes, boundaries, interaction with the environment, emergent properties, similar ontological complexity and characteristics of the theoretical framework of autopoiesis that was originally derived from the field of biology by Maturana and Varela (Maturana, 2002; Varela et al., 1974). This chapter is composed of three central sections that will constitute the main body of the chapter and which are detailed below.

In the first section, the conceptual aspects will be presented and characterized, starting with an introduction to the complexity and emerging properties of the different types of systems whose properties and complexity make them autopoietic. Next, the autopoietic systems and their properties will be defined, with special emphasis on the coupling to the environment in a co-evolutionary way and the accumulation of knowledge in its structure through enactive processes of coupling to the environment, situating the autopoietic paradigm as a transversal epistemic framework in the domains and levels of the complex systems with differentiated emergent properties. Subsequently, the contributions of the