Chapter 40
Using Quantum Agent-Based Simulation to Model Social Networks:
An Innovative Interdisciplinary Approach

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ABSTRACT

This research aims to apply models extracted from the many-body quantum mechanics to describe social dynamics. It is intended to draw macroscopic characteristics of organizational communities starting from the analysis of microscopic interactions with respect to the node model. In this chapter, the authors intend to give an answer to the following question: which models of the quantum physics are suitable to represent the behaviour and the evolution of business processes? The innovative aspects of the project are related to the application of models and methods of the quantum mechanics to social systems. In order to validate the proposed mathematical model, the authors intend to define an open-source platform able to model nodes and interactions within a network, to visualize the macroscopic results through a digital representation of the social networks.

INTRODUCTION

In recent years new organizational forms are emerging in response to new environmental forces that call for new organizational and managerial capabilities. Organizational communities are becoming the governance model suitable to build a value-creating organization, representing a viable adaptation to an unstable environment (Clippinger, 1999).

The theoretical framework used in this project to describe the nature and evolution of communities is known as *complexity science*. According to this approach organizational communities are

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viewed as "complex adaptive systems" (CAS): they co-evolve with the environment because of the self-organizing behavior of the agents determining fitness landscape of market opportunities and competitive dynamics. A system is complex when equations that describe its progress over time cannot be solved analytically (Pavard & Dugdale, 2000). Understanding complex systems is a challenge faced by different scientific disciplines, from neuroscience and ecology to linguistics and economics.

CAS are called adaptive because their components respond or adapt to events around them (Levin, 2003; Lewin, 1999). They may form structures that somehow maintain their integrity in the face of continuing change. The components of a CAS may follow simple rules and yet produce complex patterns that often change over time.

Organizational communities share many of the characteristics that are used to define a complex adaptive system. Social multipliers, positive feedback, non linearity, evolution, self-organization are phenomena that have been used to explore social interaction in the field of complexity theory.

A number of tools have been developed in recent years to analyse properties and dynamics of complex systems. Amaral and Ottino (2004) identify three types of tools belonging to areas well known to physicists and mathematicians: Social Network theory, Quantum Mechanics, Statistical Physics.

A number of researchers have shed light on some topological aspects of many kinds of social and natural networks (Albert & Barabasi, 2002; Newman, 2003). As a result, we know that the topology of a network is a predictable property of some types of networks that affects their overall dynamic behaviour and explains processes such as: the diffusion of ideas in an organization, the robustness to external attacks for a technological system, the optimization of the relationships among the network components and their effects on knowledge transfer.

Social Network Analysis (SNA) and Dynamic Network Analysis (DNA) are becoming increasingly adopted methodological approaches to study organizational networks during the past years (Wasserman & Faust, 1994; Gloor, 2008).

Social Network Analysis proposes methods and tools to investigate the patterning of relations among social actors. It studies organizational communities, providing a visual representation and relying on the topological properties of the networks so measuring the characteristics of the network object of the analysis.

The focus on the identification of the topological structure of the network based merely on the frequency or intensity of connections represents at the same time an innovation factor and a potential limitation of the approach. The analysis of an organization that does not consider the quality and the content of relations might provide a distorted mirror of the real organizational dynamics.

The main limitation of SNA is to be mainly a quantitative social science method, focused on the structural properties of networks and paying not enough attention to the qualitative issues necessary to understand a phenomenon. Its unit of analysis is not the single actor with its attributes, but the relations between actors, defined identifying the pair of actors and the properties of the relation among them. By focusing mainly on the relations, SNA might underestimate many organizational elements which could influence the ability of an organization to reach its goals. It does not measure how different actors' attributes influence the network configuration. Furthermore, perceptive measures are often ignored by SNA. What seems to be missing in current SNA research is an approach to study how the individual actors' characteristics change the network configuration and performance.

The empirical work on network information advantage is still "content agnostic" (Hansen, 1999). As stated by Goodwin and Emirbayer (1999), SNA globally considered is a framework

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