Chapter 9
A Complex Adaptive System Framework for Management and Marketing Studies

Gianpaolo Basile and Gandolfo Dominici

Abstract This theoretical work aims to analyze the choice of strategic management activities, taking into account a complex systems perspective. Following this approach, we represent the firm as a complex adaptive system, in which the management must be able to develop and implement different behaviors in order to dynamically ensure the viability of the firm or system. This implies that the management governing the firm or system is capable of choosing, from among a number of heterogeneous entities, the relevant stakeholders within the competitive context and of creating and maintaining significant relationships with them, which are considered to be relevant in a turbulent environment.

As an expression of the relational dynamics between the direct and indirect stakeholders, the firm exchanges energy and information with the reference contexts, in order to survive. As part of these exchanges and adaptations, both the firm and its stakeholders disperse energy, producing a dissipative phenomenon (Prigogine I, Order out of chaos. In: Livingston P (ed) Disorder and order: proceedings of the Stanford international symposium (Sept. 14–16, 1981). Anma Libri, Saratoga, pp 41–60, 1984), which we describe—in an analogy with the second law of thermodynamics and complexity theory—as entropy.

Our research question is thus:

> Can complex adaptive systems theory help decision makers to deal with the dynamism of organizations and brand in turbulent environments?

Through a theoretical and descriptive framework, we will draw our conclusions to this research question.

G. Basile (✉)
Sociology and Political Science Department, Business Systems Laboratory, Roma, Italy

Faculty of Arts and Philosophy, University of Salerno, Salerno, Italy
e-mail: gianpaolo.basile@bslaboratory.net

G. Dominici
Business Systems Laboratory, Roma, Italy

Department S.E.A.S., Polytechnic School, University of Palermo, Palermo, Italy
e-mail: gandolfo.dominici@libero.it

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9.1 Introduction

In the last 40 years, several management scholars have argued that we need new paradigms and practices to make sense of the changes that have come about through the global restructuring of the economy and advances in social, political, and cultural sphere [26, 36, 37, 51]. The systemic approach, together with the concept of entropy, in the fields of economics, strategic management, and marketing, has been discussed since the mid-1970s by many scholars, including Kangun [33], Monieson [46], Bass [3], Georgescu-Roegen [23], Boulding [6], Reidenbach & Oliva [52], and Layton [40]. These studies contextualized and validated well-established principles in the field of market dynamics.

The firm can be depicted as a partially open system which is in constant change and adaptation induced by the influences of the context, by the endogenous organizational dynamics, and by the effect of exchanges of energy, information, materials, symbols, and ideologies with heterogeneous and relevant stakeholders, all with the aim of obtaining sustainable advantages [2, 4, 13, 15, 18, 21, 24, 39].

In order to gain its final objective of sustainable viability through the achievement of sustainable advantages, the firm must be able to effectively acquire and manage its dynamic capabilities. Therefore the firm needs dynamic capabilities; these are the capacities of the organization to purposefully create, extend, or modify the resource base [25].

The continuous exchange of energy with the context and the relevant stakeholders constitutes the state of entropy. Entropy is given by an *informative chaos* requiring the continuous ability to decode and adapt in terms of cognitive, behavioral adaptive dynamics [49].

In this regard, the parallel developments in the thermodynamic theory of irreversible phenomena, in the theory of dynamical systems, and dynamic capabilities theory [50] have converged to show, in a compelling way, that the gap between "simple" and "complex," between "disorder" and "order," is much narrower than previously thought.

9.2 Theoretical Framework

On the basis of the above, we are conducting a scientific effort with an analogical approach to consider complexity theory against the background of the laws of thermodynamics. We aim to show how the survival of the firm is based on its abilities to create and maintain relationships with different and heterogeneous stakeholders (the complexity condition), transforming energy in interactions by means of self-organizing activities, so as to create a dynamic order.

The second laws of thermodynamic assert that, in a system without environmental exchanges, entropic disorder will unavoidably increase. These laws, in fact, point out the relevance for any living system (including the firm) of continuously exchanging information with relevant stakeholders [47].

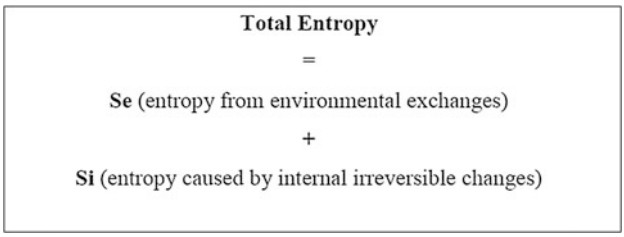

Fig. 9.1 Total entropy

Indeed, if isolated, all such systems undergo a reduction of transformational activity. This tendency towards exhaustion or dissipation of energy results in the state of disorder, entropy, or chaos—culminating in the implosion of the closed system.

Interaction with other systems which lack energy or information exchange processes is the cause of the dissolution of the system over time, due to growing disorganization. Therefore, any isolated system naturally evolves towards the state of maximum disorder.

At this point, we point out that entropy is a term that evokes a dynamic condition of survival—namely, the continuous transformation of energy. Hence, we can assert that the entropy in open systems is due to the disorder or dynamism caused by the combination of so many inputs, some coming from the contexts and some from natural business organizational processes which involve a loss of energy (see Fig. 9.1).

For several years, scholars of thermodynamics held that a system reaches a point of equilibrium in the absence of an external input. Prigogine [47] applied this principle to open systems and argued that they could reach a state of dynamic equilibrium in the event of minimal production of entropy. This implies that, to reach this condition, the firm needs to be able to stay synchronized with stakeholders' changes by growing its dynamic capabilities [50].

9.3 The Partially Open Adaptive Systems

The 'Opening' condition (Se) is fundamental to avoiding the negative entropic effect. Therefore, the system survives if it is open or partially open, and thus able to transform the energy possessed in interactions with other contexts.

Contextualizing these concepts in the firm, we can say that the firm survives if it is able to establish, develop, and/or modify its appropriate informative, cognitive, and adaptive behaviors and skills, allowing it to receive and provide answers in the area of systemic exchange [12, 35].

In this sense, the firm could covey a different approach to create dynamic capabilities that could be summarized as *inside-out* and *outside-in*.

In the *inside-out* approach, the management plans the behavior of the firm on the basis of the resources or capabilities that will be modified through the market–consumer relationships. The *outside-in* approach is based on a continuous dialogue between firm or brand and the consumer, through the medium of some spaces (virtual or actual) in which the firm can observe and meet the consumer's needs. (Here we can think about Amazon offering the consumer some access to their cloud computing network in order to meet their web service needs).

These adaptive conditions represent the state of systemic balance on which survival is founded and which, given continuous adaptation or anticipation, we could define as the condition of "dynamic order" in dissipative systems.

Prigogine's work is pivotal in arguing that it is not that the lack of informative exchange allows a steady state or orderly condition to be achieved, but rather that this lack contributes to an increase in entropy. Indeed, the absence of informative exchanges represents the isolation of a system which, if it is to achieve the condition of order, should become self-organizing, generating the conditions of its survival independently based on deterministic behavior ([1, 5], [20]: 241–257).

In a management studies, a similar situation might be that of a firm operating in a static condition (such as in a monopolistic industry) with managerial approach based on deterministic, linear, exact, cause-and-effect planning, and not on probabilistic planning, considering performance feedback on the basis of inside-out, routinized processes.

Under current markets conditions, the firm is a partially open system; it is somewhat isolated, but must be able to anticipate and respond to environmental turbulence and changes in order to survive, exchanging information and energy with the appropriate language-behavior (in branding, marketing, and communication) with heterogeneous stakeholders (the conditions of complexity). This "language" develops based on the partners' needs and on common coenetic variables (such as variables, input, stimuli, influences, interference, standards, and rules), inasmuch as they belong both to the cognitive schema of the system under analysis and to those stakeholders/partners considered relevant by decision makers. The relevance is expressed by the stakeholders' possession of resources that are essential for the survival of the system [4, 16, 24].

The system's ability to survive requires facilitators in reading and in dialogue (e.g., partner–consultants and managers) and arises from the moment in which it can:

- use resources to understand the inputs (the opening phase of the system),
- achieve output–behavior–language (the closing phase of a self-organizing system),
- propose responses to changes in the contexts (the opening phase of the system)
- acquire and adapt behavior in response to the contexts.

In fact, this response is intended to create a new condition of equilibrium with respect to the context, which has been altered by causal interference or disruption

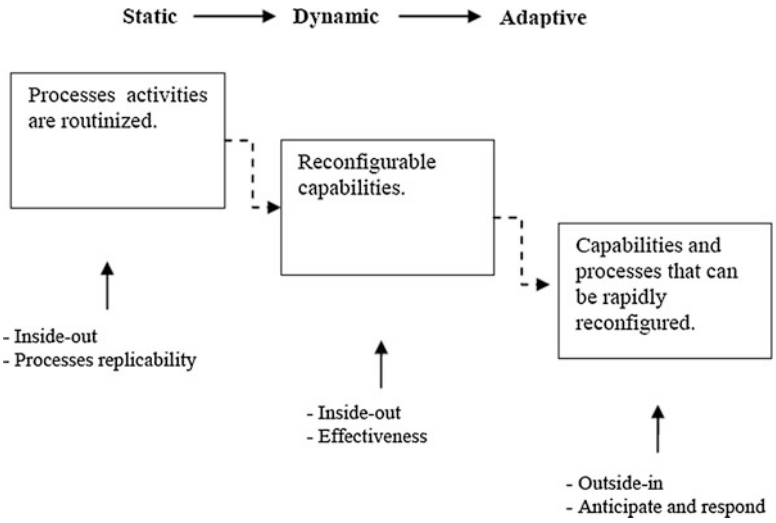

Fig. 9.2 The firm as adaptive system

caused by the contexts. This dynamic adaptation is the phenomenon of homeostasis and occurs by means of processes of self-organization [4, 44, 45].

Self-organizing phenomena are thus defined as processes in which a new dynamic order spontaneously emerges out of a chaotic state [8, 34].

The control of company dynamics, in any form, is the typical process supporting the homeostatic phenomenon (control of management, cost, finance, production, etc.), together with the processes needed to adapt to changes in the standards (laws and rules of conduct) that govern the dynamics of the system–market. These forms of control act as regulators that aim to correct a disruption in the context of systemic relations.

Hence, we can see control as a process directed towards achieving, in a certain period amount of time, a dynamic order—namely, the reduction of entropy caused by informative chaos; where entropy is a way of measuring both the state of equilibrium of the system and the degree of disorder and, possibly, the dissipation of the system itself (see Fig. 9.2).

Fantappiè [21, 22] argued in this regard that such negentropic processes are characterized by the principles of finality—that is, they are based on future results and not on past conditions, differentiation, order, or organization. Systemic survival is, therefore, supported by a vision of the future of the context and by the ability to create a dynamic order—that is, the coincidence between the variety of information that allows sharing of interpretive information and of influences coming from the contexts and the needs of relevant stakeholders.

Clearly, the ability to create dynamic order must be greater than the production of entropy, in order to ensure survival conditions ([32]: 161]).

9.4 The Adaptive Systems Approach in Marketing

Taking the traditional definition by Kotler [38], which describes direct marketing as a facilitator for meeting human wishes and needs through the purchase of products, services, or (even better) through brands, it could be argued that marketing is designed to meet the social needs of the individual, for himself and for his social identity, and the economic needs of the enterprise, for competitiveness and creation of value.

The continuous interactions between the agents thus create the business environment on the basis of the two major dimensions of complexity and turbulence. The complexity shows the richness of the heterogeneous and different stakeholders that compose the business environment, and with whom the firm must continuously create and maintain relationships [43].

The turbulence, on the other hand, conveys the level of competitiveness and change in the business environment [53].

The definition of complexity expresses three important characteristics. First, complex organizations stimulate outputs that cannot necessarily be predicted simply by understanding all of the inputs. The second characteristic is that complex organizations create behaviors that are neither predictable nor unpredictable (they lie on the edge of chaos). Third, the system's history is irreversible [17].

For these reasons, marketing objectives are reached by means of ever-more dynamic strategic and operational planning that takes into account, or anticipates, the many coenetic variables that make the context chaotic and dynamic.

In fact planning, in the field of marketing studies, tends more and more to take the capacity of stochastic analysis into consideration, due to the variability of rules and norms, and thus the behavior, of the components of the market and the contexts.

As a result of this planning, the social actor, the firm, and the individual consumers or stakeholders all tend to decrease their informative asymmetries in the dynamics of creating and maintaining relationships with partners. This effort is clearly intended to limit the dissipation of energy (entropy), due to the lack of correspondence both in the variety of information (in the input phase) and in the semantics between the meanings of language and behavior in the context of the creation and maintenance of relationships between social partners (in the phase of creation of relationships with stakeholders) [35].

In this regard, Wiener [55] argues that

> [...] *learning is a form of feedback in which the behavior of the model is modified, also, by past experience* [...]

Thus feedback, as a form of behavior, represents a learning process in which comparison is made between the conduct and the result to be achieved, so that success or failure alters future behavior.

Any planning process—in particular that of marketing and communications—is the result of the creative abductive, inductive, and deductive cognitive ability

used by the governing body, management, or decision makers, based on the level of knowledge and learning (informative and cognitive variety) gained from impulses originating in the contexts [2].

In fact, the aim of planning and control, when applied according to a systemic methodology, is to detect or anticipate any gaps between what is expected from the applied model and what actually happens (a loop which represents the first homeostatic phenomenon), with the purpose of both observing the inability on the part of the model and the supporting variety in the contexts, and, finally, to reformulate the model for next time.

According to Ashby's Law of Requisite Variety "*only variety can control variety*" [1]; therefore, the variety of contexts can be addressed by management through equally informative varieties that act as an attenuating factor on complexity (Emery 1973).

At this stage, the following questions naturally arise:

Does corporate management, at the decision stage, act in accordance with a deterministic or a complex model?

As an effect of the complex dynamics, do different types of marketing models exist?

How can these adaptive capabilities be built?

The firm, as a complex adaptive system, has always needed to consider the development of various kinds of relationships with a number of heterogeneous stakeholders—investors, institutions, employees, customers, partners, competitors, and others. Market globalization has produced an exponential growth in the number and heterogeneity of the subjects with which each company develops its relations.

This proliferation of relationships, made possible by new tools and new ways to communicate, is also accompanied by an increase in their speed or, to put it better, a different way of exploiting the time taken in business processes.

This scenario represents both the market and the firm as transient systems that increasingly express a kind of a probabilistic nature.

In addition to this is the time variable which, as an exogenous element compared to the life of the enterprise, and due to the globalization of relationships and dissemination of modern digital communication technology, has become a critical variable in competition. Each firm chooses whether and how to speed up their processes, when to activate them, and how to define their relative duration from a competitive perspective (time-based competition).

In the global context, businesses must therefore adopt a competitive approach to the market (market-driven management) or their relationship with components of the market (relation/complexity-driven management). This orientation demands not only the ability to know the market, the operators who work in it, their key characteristics, and their products, but also that the firm be able to constantly seek the opportunity to create and maintain "lasting" relationships with the relevant actors.

The focus of the relationship differs, therefore, from traditional approaches, because it brings out a form of company management in which, as a continuous process, the acquisition of cognitive input from the actors, along with the relationships

between them, is placed before understanding the demand. The market is made up of these variables, and understanding them supports planning for determining both the present and the future of the enterprise system.

However, from the perspective of relationship/complexity-driven management, if marketing management states that knowledge of demand is the prerequisite from which all competitive developments in the market derive, then proposing a product that meets the defined expectations and ensures the firm or brand a competitive advantage causes the orientation of the relationship to become cooperative and competitive.

In global markets, extremely heterogeneous realities coexist within relationship systems that are composed of a number of different actors, both near and far away in terms of physical and competitive distance. In contrast to what was simulated in classical and neoclassical economic models, the diversity of competitive conditions is not based on the number of bidding businesses, but on the cooperative and competitive intensity that develops between businesses—namely the system of relations (competitive and partnership) established between the firms in the competitive market space.

In all markets characterized by scarcity of supply relative to demand, or by low turbulence levels (a stable environment), the bidding business not only governs demand by determining the quantities produced and then sold, but also has all the necessary knowledge (the variety of information) to set up future activities (e.g., Coca-Cola, Nutella, and all those companies and brands that operate as leaders in their markets in the mature stage of their life cycle).

When the entire production has been sold at a price defined by the manufacturer, who does not normally accumulate stocks of the finished product, the company information system tends to coincide with the system of internal records management, according to the inside-in type of information management model; this is characterized by the collection and processing of predominantly internal information, and an internal projection of the results of these calculations.

Under these conditions, business phenomena are especially significant, and are closely monitored and governed in order to continue to foster a company-system that focuses on itself, seeking continuous improvements in internal performance parameters. (For the authors, these situations characterize a static, predictable, and implosive system).

Certainly, sectors of the economy that are experiencing conditions of cooperative and competitive intensity are much more numerous in global markets. This situation of excess supply is characterized by the presence of saturated demand, with no possibility of increasing purchases and consumption, and encouraging diversification policies, research and innovation, and respect for market participants. In these markets, the only truly predictable phenomenon is the continuity of change operated by the actors (e.g., information technology market and social networking companies and products, such as Facebook and Google+).

The collection of information is therefore aimed at producing trends or offering profiles that are able to intercept and aggregate the preferences of a variety of buyers

(conditions that characterize highly dynamic situations). This scenario represents an irreversible and unstable condition, in which the result of planning is not a certainty, but only a possibility, that an event or condition may occur.

Planning system behavior, therefore, aims to supply the dynamic result that we can define above as dynamic order or consonance–resonance [2, 15]. These conditions express the temporary ability to meet the needs of the stakeholders, who formerly communicated impulses and created disorder through their behavior (products and services, social impact, environmental impact, and so on).

9.5 Determinism vs. Complexity

The imperfect circularity represented in the previous process expresses the condition in which the firm and its management seek survival. This condition is no longer the expression of a purely deterministic approach, corresponding to cause and effect, but is rather a complex scenario in which the cause of a given future effect is absolutely indeterminable.

It is relevant to consider that, in contrast to the numerous studies that tend to blame the deterministic approach as being outmoded or inadequate in relation to the evolution of the discipline, the firm and therefore the management and decision makers find themselves working in market conditions that could require both a deterministic and a complexity approach [28].

Such a scenario also emerges, by analogy, from Prigogine's [43] studies of dissipative structures; he argued that relatively isolated systems could evolve into qualitatively different states, thanks to the continuous exchange of energy and information with the context (i.e., the stakeholders).

This consideration leads us to represent the firm as a system that can find itself in temporary conditions of balance, order, and reversibility, or experiencing conditions of nonequilibrium, chaos, and disorder (see Fig. 9.3). The point that separates the deterministic from the complex conditions can be named the discontinuity or the edge of chaos (see [7, 27, 29, 30, 41, 54]). This area is characterized by a limited condition between the government of a static, predictable, and implosive system and one in which order may be upset by minor changes and which, therefore, requires the capacity for stochastic analysis to support the creation of new features [56] (Fig. 9.4).

In this regard, Prigogine and Stengers [48] point out that the historical and temporal path that the system or firm goes through (market information, market share, total invoice, and others) is characterized by two kinds of conditions:

The first is a stable condition, in which deterministic approaches are applied. Here, we can see by analogy the management working in a dynamic and competitive environment, but with a regular relationship with the stakeholders. This situation is illustrated by a firm with a top-down organizational model, a strong brand, and a strategic approach based strongly on the imitative strategies and behaviors of

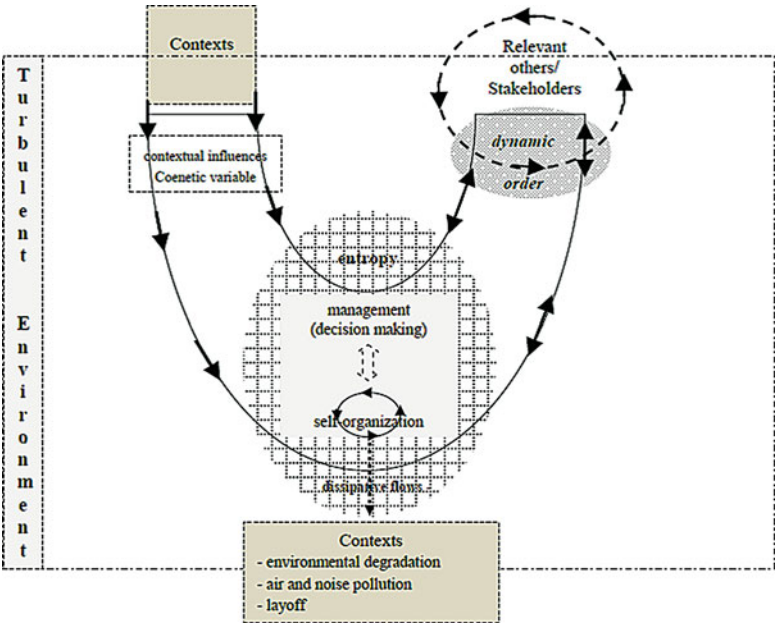

Fig. 9.3 Adaptive systems

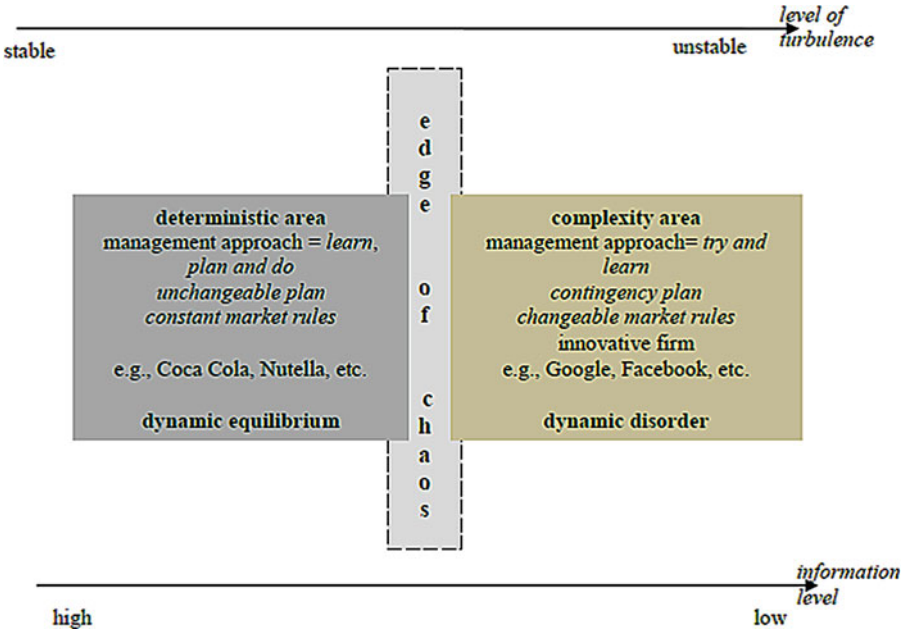

Fig. 9.4 The edge of chaos

competitors—the "me too" approach (e.g., the competition between Coca Cola and Pepsi Cola, whose strategies are strongly imitative and whose organizational models are both top-down).

The second is an unstable condition, near the edge of chaos, in which the firm chooses different strategies and behaviors on the basis of the level of information about the stakeholders. In this case, the firm presents a bottom-up organizational model that shows a networking approach with the stakeholders and competitive strategies that we could describe as "with you or between us" (e.g., Apple, which planned a connective strategy and behavior adding to its historical business as a producer of hardware and software; consider also its move into mobile phone production and computer-based entertainment). In this case, the firm works to go towards the edge of chaos, strengthening the relationships and the brand.

The difference between firms that work in the deterministic area and those that operate in the complexity area is that the former represent conditions in which the dynamic order is more enduring and the structural or organizational changes occur only in less frequent turbulence; while the latter represents the area of action, where the firm works in circumstances that are far from orderly. So, in the second case, the firms and brands operate in different industries and are frequently characterized by multifaced brands.

9.6 Entropy, Sustainability, and Curative Marketing Management

If the reduction of entropy in terms of the relationship between the firm's system and the stakeholders is not taken properly into consideration, there is a tendency for environmental entropy (whether social, economic, or natural) to arise. In this regard, the concepts of systemic entropy and dissipation are often associated with unethical, illegal, and immoral behavior.

At the planning phase, the behavior of the firm or system is aimed at competitive survival and the reduction of entropy, in order to be permanently sustainable. The consequences of such behavior, not only for the consumer or for market performance, but also on the environment suprasystem, must be taken into consideration [52].

In the last 20 years, the mainstream of marketing studies has focused on the process by which demand is satisfied by means of a set of products, and where environmental and social impact are the remit of consumer choice [9]. According to this branch of research, environmental and social entropy is a sacrifice—a price to be paid by the company—because the individual consumer achieves social progress by expressing greater economic well-being.

In Reidenbach and Oliva's [52], words

> [. . .] the marketing function, while extending our human existence, is reducing the ability of our environment to support our continued existence.

In recent years, some marketing scholars have begun to address behaviors aimed at reducing environmental and social entropy and supporting the survival of business systems or macromarket systems, from an environmental, economic, and social perspective [11, 12, 42]. On the basis of these developments, both the laws of thermodynamics—understood as irrefutable laws of nature to which all activities of social actors are subject—and the application of these laws have been brought into economic and marketing studies. This latter refers mainly to branches of sustainability marketing, medicinal marketing, and the bioeconomy.

In this regard, Nicholas Georgescu-Roegen [23], founder of the bioeconomic field of studies, has developed an economic theory that calls into question the "fundamentals" of decline in each production process, by applying the second law of thermodynamics to economics, and particularly to the economics of production. The author argues that this phenomenon does not decrease entropy on the planet, but increases it irreversibly, or at least leaves it equal—that is to say, the more energy is transformed into an "unavailable" state, the more energy will be subtracted from what is available for future generations, and therefore the more entropy (proportional disorder) is returned to the environment that surrounds us. The author, therefore, argues that it is not the quantity of production that adversely affects the environment, but the planning of this production in terms of the compliance and use of materials, in the very long-term view.

Relative to the condition of entropy and the role of marketing managers, Czinkota et al. [11, 12] introduced *curative international marketing*, asserting that restoring and developing international economic health may be the next marketing direction. By 'Restoring,' the authors mean "something lost which once was there;" 'Developing' refers to new issues addressed with new tools and frames of reference, and 'Health' underlines how the issue is essential to overall welfare, which marketing needs to address, resolve, and improve. Marketeers must deliver joy, pleasure, fulfillment, safety, and personal growth, while advancing towards a better society, and to do so across borders [10].

In line with these considerations, we may assert that marketing, both on the micro and macro levels—is beginning to overcome the past approaches of the mainstream widespread convictions, where it was regarded as a facilitator of individual economic well-being at the expense of the survival of future generations [31].

9.7 Conclusion

We have shown how complexity theory can be useful in providing a new lens through which to look at and analyze organizations and their ability to adapt their behavior by creating dynamic relationships with an ever-increasing number of heterogeneous stakeholders.

In this sense, the paper has presented a scientific and methodological framework to stimulate empirical research. Our study presents several ideas for further research aimed at overcoming the perceived abstraction of theory of complexity. We believe that managers and decision makers could benefit by considering complexity theory as a new way of reading dynamics and planning behaviors.

Empirically, this condition would be met by developing the propensity to identify potential entropic performance represented by a number of contextual variables, and to create interactive plans to continually adapt the behavior of the firm and brand to stakeholders needs.

Variables such as average income, consumption capacity, changes in turnover of distribution channels, and others, if treated stochastically, will allow managers to identify possible dissipative phenomena. Given that management and decision making are increasingly nonlinear activities and processes, we highlighted how a complexity management approach would allow marketeers to identify marketing and communications behaviors and conduct necessary for the company to contribute to the adaptation of the market system and, therefore, in reducing the instability that would otherwise be generated.

This study does not aim to provide marketeers with a contribution in terms of specific models or new planning practices, but rather aims to raise their awareness to a new concept of management and marketing, understood as a process conducted in chaotic/unstable environments that no longer requires a rational or linear approach from businesses/managers, which is designed to maximize results, but uses greater analytical capabilities to increase the level of information so as to better understand the dynamic environment governed primarily by stochastic influences.

We are confident that the disruptive shock to the system from the internet era will spawn a new generation of insights into how markets work and how organizations can anticipate and respond to fast-moving market signals.

Acknowledgements To cope with regulation on Academic publishing we declare that although this study is based on a collaborative effort by all authors, Sects. 9.1 (Introduction), 9.2 (Theoretical Framework) and 9.7 (Conclusions) can be attributed to Gandolfo Dominici; while Sects. 9.3 (The Partially Open Adaptive Systems), 9.4 (The Adaptive Systems Approach in Marketing), 9.5 (Determinism vs. Complexity) and 9.6 (Entropy, Sustainability, and Curative Marketing Management) can be attributed to Gianpaolo Basile.

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