Derivation of factors facilitating organizational emergence based on complex adaptive systems and social autopoiesis theories

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Abstract

Modern turbulent business environments are characterized by rapid change that make businesses unpredictable, which brings emergence to the core of modern organizations. Deriving factors facilitating organizational emergence has been undertaken by drawing on complex adaptive systems (CAS) and social autopoiesis theories. Social autopoiesis was particularly chosen as it focuses on social elements, such as communication, morale, trust, etc. and their relation to social emergence, whereas CAS theory concentrates more on adaptive mechanisms that make a CAS produce emergent order, such as inter-relations, interactions, edge of chaos, feedback, etc. This led to the identification of various factors facilitating emergence and the development of a framework for utilizing these factors that were organized into two dimensions. First the factors are classified as either tangible or intangible. Second, the factors are classified as either dynamic, i.e., realize emergent properties, or they are concerned with the enabling infrastructure, i.e., enable the dynamic factors to become effective, or they are controlling factors, i.e., they attempt to balance excessive change with stability to prevent descent into chaos. The framework was applied to an Information Systems Development (ISD) project which showed that it is applicable to any type of business sector. This framework is argued to be a step forward to realize organizational emergence based on complexity principles derived from literature. The split between factors facilitating emergence and generic principles of CAS is not clear in the complexity literature and it is argued to be an important contribution of the paper.

Introduction

In turbulent business environments organizations need to react quickly and creatively to make the most of new opportunities and business models. These new imperatives of business practice require organizations to self-organise and become more flexible to handle change (Goldman et al., 1995). Of key importance to organizations in responding successfully to change is the concept of emergence. Complexity science, it has been argued, is a way of addressing and improving such capabilities in organizations, as it is concerned with the role of chance, emergence and contingency in the face of frequent and continuous change (Montuori, 2003). McKelvey (1997), Stacey et al. (2000) and Mitleton-Kelly (2003) illustrate the growing interest in understanding organizations and new management practices in terms of theories of complexity that seek to provide new ways of thinking and reasoning in relation to emergent behavior.

In this paper factors facilitating organizational emergence have been identified by interpreting complex adaptive systems (CAS) and social autopoiesis theories with the aim of identifying mechanisms or strategies that raise the emergent properties of social business enterprises. Social autopoiesis was chosen as it focuses on social elements of emergence, such as communication, collaboration, morale, trust, etc., whereas CAS theory concentrates more on adaptive mechanisms that make a CAS produce emergent order, such as inter-relations, interconnectivity, edge of chaos, feedback, etc. A thorough literature review of management-related contributions in the field of complexity and social autopoiesis theories was undertaken to extract mechanisms or strategies that are argued will facilitate the emergence of new work arrangements in the face of frequent change. Based on this a framework has been derived that summarizes the so-called factors that facilitate organizational emergence. The framework classifies factors as tangible and intangible, and it differentiates between dynamics, enabling infrastructure and controls, amongst emergence factors. Preliminary validation of the framework was carried out through its empirical application in the context of an information systems development (ISD) project, a business to business e-commerce portal. Results show that the framework is generalizable and can be applied to any kind of business sector. It provides insight into the various elements of emergence realized or missing in the business enterprise. By enforcing factors facilitating emergence and avoiding factors prohibiting emergence, it is argued that organizational emergence will be leveraged leaving space to project teams to innovate and continuously evolve appropriate solutions in order to adapt to an ever-changing business environment.

Complex Adaptive Systems Theory and Organizational Emergence

Emergence: Complexity and Organization
Complexity science seeks to explain the process of self-organization, emergence of new properties and the spontaneous creation of new order. The behavior of complex adaptive systems (CAS) is typically unpredictable, but exhibits various forms of order and regulation. Complexity principles emphasise that emergence of properties and creation of new order are not explicable from a purely reductionist viewpoint, but the whole is greater than the sum of the parts (Kaufman, 1993). Therefore the focus of attention shifted from understanding the parts or entities of which the whole was composed to the interaction of subsystems (agents) to form a system (Lewin, 2000). Heylighen (2001) defines CAS as a system composed of interacting agents, which undergo constant change, both autonomously and in interaction with their environment. Heterogeneous agents exhibit various agent behaviors that can be defined in terms of “simple rules” where they adapt and evolve through their interactions and by changing their rules through learning as experience accumulates (Holland, 1996).

Many contributions define CASs and describe their main characteristics and principles. While a uniform description or interpretation of CAS is still not provided, several key aspects that characterise CAS were suggested in the literature. Different authors surveyed various complexity literature (e.g., Axelrod & Cohen, 2001; Dooley, 1997; Holland, 1996; Kauffman, 1993; Lewin, 2000; McKelvey, 1997, 1999) and based on that characteristics/principles of CAS were outlined. For example, Benbya & McKelvey (2006) derived eight main characteristics of CAS to include large number of components, variation and diversity, self-organization, dynamism and liveliness, adaptation to their environment, interactions, non-linearity and selection. Mitleton-Kelly (2003) identified ten generic principles that characterise CAS, these include connectivity and interdependence, coevolution, far-from equilibrium/edge of chaos, space of possibilities, feedback, historicity and time, path-dependence, self-organization, emergence and creation of new order. Whereas, Webb & Lettice (2005) suggested six pertinent complexity science principles that include self-organization, edge of chaos, diversity, historicity and time, unpredictability and pattern recognition. The different characteristics/principles of CAS are summarized in Table 1, which illustrates how the literature overlap and also complement in order to form a broad overview of the major characteristics of CAS. From the comparison (Table 1) it is apparent that Benbya & McKelvey (2006) were more concerned with the agent-based interpretation of CAS, where CAS consists of large number of agents that interact and re-structure their inter-relations and behavior as response to change (American view of CAS), whereas Mitleton-Kelly (2003) & Webb & Lettice (2005) interpret CAS as energy-driven actors residing at the edge of chaos/ the far from equilibrium transition phase (European view of CAS).

Organizations can be defined as complex adaptive social systems that evolve and produce emergent behavior in an unpredictable way (McKelvey, 1997; Mitleton-Kelly, 2003). As according to Baskerville et al. (1992) organizational emergence is characterized as the

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organization being in continual change, following no predefined pattern and never reaching a steady state. Although CAS theory is traditionally associated with natural sciences, Kim & Kaplan (2006) argue that CAS in management domains can be interpreted as actors, interacting with their environment and other actors within neighborhoods, and employ a variety of context-bound strategies in steering the behavior of actors towards maximizing the perceived interests or benefits of the organization. CAS in management contexts marks a fundamental paradigm shift from a mechanistic perception of an organization towards a self-organizing, autonomous understanding (Stacey et al., 2000). The past view of organizations is seen as a hierarchy of
components, whereas organizations are now seen as social networks of autonomous components or actors that are organized by themselves and exhibit the previously discussed CAS characteristics (Table 1).

Social Autopoiesis and the Autopoietic Enterprise

Luhmann (1986) redefines social systems as entities of communications that recursively produce and reproduce, which he refers to as social autopoiesis. The word autopoiesis means “self-production”, so a living, biological system is called autopoietic as it produces and is produced by itself (Mingers, 1994). Essential features of autopoietic systems are that they are autonomous, bounded and self-making. They consist of components that have specific properties where the overall behavior is generated through interactions between the components (Mingers, 1994). Human societies also possess features of autopoietic systems, as they are capable to survive by their own and change their entire structure and appearance (Beer, 1995).

Considering human societies as autopoietic systems is useful in analyzing enterprises in terms of the form and structure they take and how they transform and reform over time (Whitaker, 1995).

The issue of how autopoiesis can be applied to social systems pointed out difficulties in the transfer of the natural sciences’ concepts of autopoiesis to social domains. As autopoiesis implies the production and reproduction of the constituent components, so for social systems it is difficult to specify what do they exactly produce and reproduce (Mingers, 1994). There are two primary approaches in applying autopoiesis to social systems (Whitaker, 1995):

Enterprises as Autopoietic Systems

This view advocates applying concepts of autopoiesis theory, such as autonomy, self-making and self-reference, on the social system. It is criticized in terms of its straightforward applicability on social system’s constituents that are human beings and that need according to autopoiesis theory to re-make themselves (Varela, 1981). In addition social systems do not exhibit topological boundary that is another attribute of autopoietic systems (Mingers, 1994). Therefore, Luhmann (1986) redefines social systems as entities of communications, or in other words the constituent elements of social systems are communications. He argues that autopoiesis of social systems is realized through production of communications, i.e., in social systems communications recursively produce and reproduce. Another interpretation characterizes social systems as a system of concepts, ideas, descriptions or messages that interact and self-produce (Varela, 1981).

Enterprises as a Medium for Autopoiesis

Maturana (1988) argues that social systems are not themselves autopoietic but constitute the medium for autopoiesis, i.e., social systems interact in a way that autopoiesis of actions and interactions contribute to the survival of the social system. Thus, this view advocates that the social system is constitutively emergent from interactivity among its participants. This generates networks of interactions and relations through structural coupling between participants and the social system. In that regard Küppers (1999) suggests the analysis of social interactions and their dynamics of reformation.

Regardless of the two different interpretations of social autopoiesis it is important to identify and understand the emergence of new behavior within social contexts and what social mechanisms may drive social interactions and their reformation. Thus, the application of autopoiesis in social contexts needs to take into consideration the dynamics of social interactions and inter-relationships, as well as the network of communications that develops between the actors. For this paper we will explore social autopoiesis literature and review their interpretations and arguments towards improving the emergent properties of a social enterprise. Based on the analysis carried out in the rest of the paper it is argued that communication, collaboration, interactions, trust and morale are the driving force of social autopoiesis. Furthermore, it is important to develop an understanding of the intersection between the literatures of social autopoiesis and CAS, as this area is still nascent and under research.

Why Derive Factors of Emergence?

Mitleton-Kelly (2003) suggests that the complexity approach to management is about fostering and creating enabling conditions, which will permit an organization to explore the space of possibilities and facilitate the creation of new organizational forms that will be sustainable in a constantly changing environment. This means it is important to identify elements/factors of emergence that improve the ability to respond to change and let work arrangements emerge according to what the situation implies, rather than being dictated in advance. Alaa and Fitzgerald (2004) support the same view and emphasise the need to instill into organizations habits and dynamics that improve their emergent properties instead of leaving them happen by chance. It is important to identify factors that will encourage and reinforce emergence and avoid those that suppress or inhibit such activities. Once inhibitors are removed and enablers put in place, new behavior emerges enabling the business enterprise to quickly adapt to change.

Generic principles CHARACTERISTICS OF CAS, I.E., CONDITIONS AND ATTRIBUTES THAT CHARACTERISE CAS WERE WIDELY IDENTIFIED IN THE LITERATURE (SEE TABLE 1). BUT HOLLAND (1996) OUTLINED MORE SPECIFIC ELEMENTS OF CAS, I.E., MECHANISMS THEY ADOPT TO REALIZE SUCH
characteristics. These included aggregation of interactions, flows, internal building blocks and structure hierarchies, which ensure free propagation of change, adaptation and emergence of new order. Thus, Holland (1996) outlined constituent elements of CAS and mechanisms they adopt to realize emergent behavior rather than characteristics/properties of CAS. This split between mechanisms/factors that facilitate emergence and generic characteristics/principles of CAS is not clear in the complexity literature and it is argued to be an important contribution of this paper.

It is argued that in order to harness complexity concepts in business contexts an explanatory framework that identifies enabling factors of emergence is required to put generic characteristics/principles of CAS (Table 1) into action. Therefore this research aims at identifying factors of enabling conditions that could improve the emergence of new order in organizations. Various factors facilitating emergence were suggested in scattered literature that will be surveyed and collated into a framework in the following section. This will show how the different factors that would facilitate organizational emergence can be integrated and interlinked. The framework provides a roadmap that guides based on complexity principles managers and employees to harness emergent properties in their organizations.

Derivation of Factors Facilitating Organizational Emergence

Most of the work on complexity and the development of complexity theories have been undertaken in the context of the natural sciences and there has been relatively little work on developing or applying such theories in the social sciences. The literature generally suggests that there is a fundamental difficulty in attempting to do this because of the nature of human beings and human interactions, and specifically the notions of emotion, conflict and cultural elements. However more recently a number of attempts have been made to apply complexity principles in social and management disciplines. A thorough review of complexity and social autopoiesis literatures is undertaken in this section with special focus on management-related contributions to extract mechanisms or groupings of factors that are argued will facilitate emergence in social and management contexts. The analysis resulted in a classification into several groupings; dynamics (social construction factors/intangible dynamics and adaptive factors/tangible dynamics), enabling infrastructure (tangible and intangible), and control factors (tangible and intangible). Dynamics are factors that realize emergent properties, the enabling infrastructure include elements that enable the dynamics to become effective, whereas controlling factors attempt to ensure balance of dynamics to prevent descent into chaos.

Social Construction Factors/Intangible Dynamics

The review of the literature resulted in the identification of social drivers and stimulators that have been suggested as important in facilitating emergent social behavior. These are identified in bold and are of course frequently overlapping, as follows:

- The development of autopoietic society requires communication, meaning and consciousness that form an essential driver of emergent behavior (Luhmann, 1986);

- Constant dialogue is an essential social driver that creates a willingness to communicate with a growing level of trust, both of which enable coevolution of a social enterprise. For example trust facilitates better communication, which in turn enables the formation of activities and processes as response to problem situations (Lewin & Regine, 2003);

- Facilitation of interaction in the development of social organizations put cooperative interaction and relationships at the centre of organizational emergence, which can be achieved through participation, collaboration and team working (Stacey et al., 2000);

- Interactions are important in the business ecosystem in order to respond to the problem situation and take appropriate actions. Local interactions are responsible for new order creation and emergence of global structures (Lewin, 2000);

- The quality of interactions between human agents is a function of the diversity, density, and intensity of those relations. These may be formal or informal, designed or un-designed, implicit or explicit (Mitleton-Kelly, 2003);

- Individual motives or intentions and individual emotions and morale act as driving forces for social autopoietic systems influenced by interests, social context and forms of cooperation and collective behavior towards achieving a specific goal (Küppers, 1999).

Thus, the important social construction factors are communication, collaboration, interaction, trust and morale. These appear to be the important elements of complex social systems as they are responsible for social interactions and stimulation of creative thinking that will lead to human empowerment and leveraging self-organization. Next we look at more mechanistic or adaptive factors/tangible dynamics.
Adaptive Factors/Tangible Dynamics

According to Whitaker (1995) the dynamic of an evolving social entity is determined by inter-component relationships that outline its form and internal arrangements. Complex behavior arises from the inter-relationship and inter-connectivity of elements within the social system and between it and its environment (Mitleton-Kelly, 2003). Thus, adaptive factors are required to improve the ability of the social system to re-arrange, re-form its structure and quickly respond to change, these include the following elements:

- Complexity theory implies that the internal dynamics and form of a system play a major role in determining its behavior. In a social context each individual belongs to many groups and different contexts and the contribution depends partially on the other individuals within that group and the way they inter-relate (Lewin, 2000; McKelvey, 1997);

- Propagation of influence through an ecosystem depends on the degree of connectivity, interdependence and strength of coupling (Heylighen, 2001);

- The degree of interdependence between entities may not always have beneficial effects and lead to flexibility because as one entity tries to evolve or adapt and improve its fitness other entities may respond by hindering this process and impose additional effort or cost (Küppers, 1999);

- In human systems, connectivity between individuals or groups is not a constant or uniform relationship, but varies over time (Mitleton-Kelly, 2003);

- Complexity thinking is about wholes and complex inter-relationships. This requires boundaries to be drawn around issues and the break-down of the problem under consideration into manageable wholes for better understanding of the problem situation (Holland, 1996);

- Difficulties created by the unpredictability of complex human processes and interdependencies are problematic, therefore short-term orientation and simple solutions (simplicity) are likely to result in better outcomes and more predictable developments whereas long-term solutions are likely to fail, as requirements and conditions can only be articulated and understood as events evolve (Stacey et al., 2000);

- Conditions for experimentation and exploration of possibilities need to be provided as complexity theory suggests that several different chances and attractors will be possible and need to be explored. This also usually implies small-scale orientation in order to quickly try out various options and get quick feedback (rapidity) without requiring large scale resources and time (McMillan, 2004).

Thus, the more mechanistic, adaptive factors reflect the degree of interdependence, connectivity, structural coupling and quick re-formation of internal arrangements represented in flexibility, short-term and small-scale orientation, simplicity and rapidity. These elements help facilitate fast response and quick, internal adaptation and re-formation of system components.

Enabling Infrastructure

In order to facilitate emergent response an enabling infrastructure is required that allows emergence to occur, without such an infrastructure dynamic and emergent behavior will be limited or repressed. Aspects of an enabling infrastructure that facilitates emergence in social contexts include:
• **Hierarchy and structure** are pre-conditions that enable or inhibit the emergence of new behaviors and working ways (Heylighen, 2001);

• Action of organization members is shaped to a high degree by the existence of specific *organizational* form and *structures* (Levinthal, 1997);

• Conditions that facilitate the day-to-day management of an organization, for example, *management style*, good *leadership* and the provision of psychological space and freedom are necessary for learning and emergence to occur (Lewin & Regine, 2003);

• Enabling infrastructures also include *cultural conditions* that facilitate new work habits and intensions, such as manoeuvrability and risk-taking in ambiguous, uncertain situations (Kelly, 1995);

• Established research in complexity suggests that rigid procedures and bureaucratic *regulations* hamper emergent behavior. (Carlisle & McMillan, 2006);

• Analysis of the influence of *external factors* like power, money and control *regulations* like contracts and conventions is also important as these often act as constraints that limit social dynamics in complex situations (Stacey *et al.*, 2000).

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**Control Factors**

Complexity theory in social contexts is designed to enable creativity, spontaneity and emergence but it also requires some kind of moderating or control mechanisms, which seeks to balance excessive change with stability, possibilities with constraints, innovation with tradition, etc. (Lewin, 2000; Montuori, 2003). In order to adapt to a changing environment, the system needs a variety of stable states that is large enough to react to all changes but not so large as to make its evolution uncontrollable or chaotic (Küppers, 1999).

• Stability is sustained by the property of the *edge of chaos* that limits the spread of destruction through the system. Change and stability are thus balanced and the edge of chaos is a critical point of the system, where a small change can either push the system into chaotic behavior or tip the system back into a more stable state (McKelvey, 1997);

• *Edge of chaos* is controlled by equilibrium models which attempt to bound a system to ensure that the system is always pushed back to stable conditions and will not result in absolute chaos (Whitaker, 1995). Also termed stability dynamics (Heylighen, 2001) which counteract excessive change before it endangers the essential organization;

• The mechanisms by which complex systems maintain control and achieve certain goals is by *feedback*, *learning* and *frequent small adjustments* to counteract any excessive tendencies to change (McMillan, 2004);

• Continuous *reflection*, *learning* and *circular causality* mutually reinforce social relationships and interactions (Küppers, 1999);

• Simple *high-level rules* are a way to achieve a balance between dictation and freedom enabling team members to interact with each other guided by these rules (Stacey *et al.*, 2000).

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Based on the above analysis of literature we identify the first grouping of factors facilitating emergence, i.e., *dynamics* that include those factors that operationalize the emergent behavior. The factors of a complex social system are also classified into *intangibles* and *tangibles*. Intangibles represent the social factors that uniquely characterise social human systems, as opposed
to natural systems, whereas tangibles represent the mechanistic/adaptive factors, those elements responsible for the internal connectivity of system components. Social construction factors include communication, collaboration, interaction and trust. These are important to raise human empowerment and self-organization. On the other hand adaptive/mechanistic factors reflect the degree of interdependence, connectivity and quick internal adaptation of the social system components. This is represented in flexibility strategies, short-term and small-scale orientation, simplicity and rapidity mechanisms that will facilitate fast response and quick re-arrangement of the entities within the enterprise.

The second grouping is the enabling infrastructure that enables or allows the social and adaptive elements to either be effective or inhibited. This includes organizational structure, hierarchies, management style, work culture, leadership, etc. These elements can also be tangible, such as structures, hierarchies and external factors or intangible, such as culture, management style and leadership. The third grouping is control, as in order to facilitate emergent behavior without complete chaos or anarchy, controls need to be in place and maintained, but they need not to be too restrictive. This will ensure a balance between excessive change and stability (edge of chaos). For example, reflection, circular causality and learning are intangible controls, whereas feedback, continuous adjustment, and generative rules are tangible controls. The different groups and elements of each category are illustrated in Figure 1 that collates the various factors extracted from literature. It is argued that this forms a useful framework for identifying and understanding factors that facilitate organizational emergence.

A Case Study: An e-Marketplace Portal

We now move on utilizing the “Organizational Emergence” framework (Figure 1) to interpret an information systems development (ISD) project in modern, turbulent environments. Ciranet is a B-B (business-business) e-marketplace relevant to the pharmaceutical sector in Egypt. It offers electronic trading tools for the pharmaceutical industry covering drugs, cosmetics, medical supplies, personnel and childcare products. A portal application had already been developed before the fieldwork was carried out. The development approach the company adopted covered planning and management, analysis and design, and development and maintenance activities towards the implementation of the IT-based marketplace application. The framework (Figure 1) will be applied to the different stages of the development process which identifies factors that facilitated and/or inhibited emergence in the ISD project. In so doing it is possible to identify if this project possessed elements of emergence or not.

Planning and Management

The management team adopted a long-term planning approach that caused some problems, as it froze the organization with a set of assumptions that were likely to change, due to rapid changes in the environment. Problems were also identified with the hierarchical organizational structure and the command-control style of management adopted. For example, one individual, the business consultant, was dominant in defining the requirements, often ignoring the ideas and contributions of other team members that might have made the project more successful. This limited collaboration and reduced trust among team members and project stakeholders. The researchers, in an Action Research mode tried to intervene and introduce a more agile approach into the organization but this was resisted by the management who were used to the optimization-oriented work culture.

Analysis and Design

The original analysis and design approach focused on business process modelling of the
Reflection

Development and Maintenance Framework of Factors Facilitating Organizational Emergence (Organizational Emerge Framework)

was achieved through


and


approach, where the systems modules were incrementally implemented and more flexibly improved with new features and add-ons as deemed appropriate. These represent a kind of

and

technology that provided some degree of


Creates a way to balance emergence and avoid anarchy


Rapidity

It is important to point to the difficulty we faced in identifying factors facilitating organizational emergence. As ...

Rapidity


interpretive analytical tool

Thus, from the analysis of the case above it is found that social construction elements, such as collaboration, trust, ...

interpretive analytical tool

and led the developers to ignore requests for changes. As the project progressed it became clear that the requirements ...

and led the developers to ignore requests for changes. As the project progressed it became clear that the requirements ...


It provides a mirror for the company to identify what factors of emergence have been stipulated and what other factors have been undermined or completely missed out.

heavy-weight development

In addition it is important to notice that the introduced framework is holistic where the identified factors do overlap ...

re-develop


and led the developers to ignore requests for changes. As the project progressed it became clear that the requirements ...

and led the developers to ignore requests for changes. As the project progressed it became clear that the requirements ...


that quickened the development cycle. Furthermore, the portal was implemented with

feedback

Analysis of Factors Facilitating Emergence and Ways to Realize Them in Ciranet/ ISD Project (Inhibitors in Italic)

and led the developers to ignore requests for changes. As the project progressed it became clear that the requirements ...

and led the developers to ignore requests for changes. As the project progressed it became clear that the requirements ...


interpreted

the...