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

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 Benbeya & 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

Table 1

Characteristics/ Principles of Complex Adaptive Systems.

	Benbya & McKelvey (2006)	Mitleton-Kelly (2003)	Webb & Lettice (2005)
Large number of components	x		
Variation and diversity	x		x
Connectivity and interdependence		x	
Far-from equilibrium/edge of chaos		x	x
Unpredictability and non-linearity	x		x
Space of possibilities / adaptation to environment (context)	x	x	
Interactions	x		
Feedback		x	
Pattern recognition/learning			x
Historicity and path-dependence	x	x	x
Selection and Self-organisation	x	x	x
Coevolution		x	

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 straight forward 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 Table1). 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).

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).

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

Fig. 1: Figure 1

Framework of Factors Facilitating Organizational Emergence (Organizational Emerge Framework)

Fig. 2: Table 2

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

pharmaceutical trading supply chain. For example, the order lifecycle was decomposed into order preparation, order placement, order fulfilment, etc., also the 'return of expired products' lifecycle was identified and was extensively analyzed. During the fieldwork, over a period of five months, problems were identified with the use of the *heavy-weight development* approach (*no high-level/agile rules*). It was systematic, comprehensive and plan-driven, which tended to limit and inhibit emergence in turbulent business environments, such as e-commerce. For example, the researchers identified problems and drawbacks resulting from the developers becoming overwhelmed with too much detail from the comprehensive analysis of the e-commerce workflows. This made the team produce *complex*, rather than simple *designs* and led the developers to ignore requests for changes. As the project progressed it became clear that the requirements needed to be re-thought and that some degree of innovation, as the business environment shifted, was required and yet this did not happen, at least partly because of the work already invested in the complex designs and a reluctance to abandon this.

Development and Maintenance

The IT application was outsourced and in contrast to Ciranet and its management, the development team of the outsourcing company adopted a more *incremental, iterative development* 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 *small-scale* and *feedback* mechanisms. The team also used *prototyping* techniques that facilitated *small scale and incremental development*, this also helped and enabled some *reflection and learning*. For example, the first prototype covered the basic functions, such as the catalogue and shopping cart, and then the prototype was refined through *feedback* from the clients. *Rapidity* was achieved through *short development cycles* and *parallel development* that quickened the development cycle. Furthermore, the portal was implemented with *component-based* technology that provided some degree of *flexibility* as it utilized *re-usable components as the technical architecture*. Then the modules were *tested* to fix errors and *customer reviews* were arranged to identify any flaws or problems with the business rules, which helped assure the *quality* of the software product (*quality controls*). But after launch of the application there were no attempts to continuously *adjust* and *re-develop* it to cover updates and deal with the changing necessities of the business context which prohibited the emergence of the IT application.

The different factors that facilitated or prohibited emergence at each stage of the development process in Ciranet are illustrated in Table 2 that distinguishes between the factor of emergence and the way/strategy to realize it in ISD discipline. The factor represents the factor that will facilitate emergence, whereas the strategy is the way that will operationalize this factor in the particular domain under consideration, i.e., ISD for this case (see Table 2).

Thus, from the analysis of the case above it is found that social construction elements, such as collaboration, trust, etc. were missing in Ciranet. For example, the lack of collaboration between the business consultant and the development team, the command-control culture, etc., and this inhibited emergent response. But some tangible dynamics of emergence existed as introduced by the outsourcing company, such as rapidity, realized by short development cycles and parallel development. Small scale aspects were realized by incremental development, and flexibility was achieved by component-based development. However, other dynamics were found that inhibited emergence, e.g., the long-term orientation and complex designs. Also, the enabling infrastructure was found to be mainly inhibiting emergence. For example, the command-control management style, hierarchical organizational structure and optimization oriented work culture. Whereas, the technical architecture was found to contribute to the facilitation of emergence, as it was based on a component-based, re-usable architecture. Additionally, the control mechanisms in the case were too rigid as Ciranet relied on heavy-weight development methods that produced rigid designs and thus limiting the developers' freedom, despite the more agile approach adopted by the outsourcing company. So, based on the analysis of Ciranet and the application of the "Organizational Emergence" framework (Figure 1), many factors were found that potentially inhibited emergence (according to the framework) and yet there were also a number of other factors that should have facilitated emergence. Thus, complete emergent properties were not fully-realized in the case but this is perhaps not surprising as most projects are probably somewhat mixed in relation to emergent factors. Figure 2 summarizes the analysis that was undertaken as illustrated in Table 2. Factors helping to encourage emergence are in plain text and factors inhibiting emergence are in italic, whereas between brackets are the strategies that were taken to operationalize the factors in

the ISD domain.

Reflection

The proposed framework that outlines factors facilitating organizational emergence (Figure 1) was utilized to analyze an information systems development (ISD) project in turbulent e-commerce environments. It is found that the "Organizational Emergence" framework is useful as it represents an *interpretive analytical tool* that provides insight into the elements that facilitate or prohibit emergence in real case projects (Figure 2). The case is an example of an unclear situation where the tangible factors, such as flexibility and rapidity might have been expected to enable emergence more than they did, while ignoring intangible factors, such as communication, collaboration and trust have dramatically prohibited human stimulation and self-organization, thus limited emergent response. It also shows the importance of the enabling infrastructure and the controls in determining whether emergence will occur and without anarchy or not.

As the "Organizational Emergence" framework was derived from contributions in social and management contexts that it is applicable to ISD projects provides support to the framework and its generalizability. Thus, the identified factors facilitating emergence; e.g., flexibility, small-scale approaches, short-term orientation, communication, collaboration, etc. are generic to any social enterprise/business sector. But the strategies that realize the factors are specific to the business domain under consideration. As shown in Table 2 different strategies were adopted in the ISD domain to operationalize the generic emergence factors identified in Figure 1. For example, prototyping technique operationalizes both a small-scale approach, as well as an experimentation tool to support reflection and learning, component-based development realizes flexibility, iterative development represents a feedback mechanism and leads to adjustment of the IT application, etc.

Thus, Figure 1 addresses generic emergence factors in social and management contexts, whereas Figure 2 provides the same framework but with special attention to ISD requirements and targeting strategies that will operationalize these factors in the ISD domain. But there are some factors specific to ISD, as derived from the above analysis of the case (Figure 2). For example, technical architecture and quality controls were not addressed directly in the management literature, these factors reflect enabling infrastructure and control elements. The technical architecture is a key element of Information Technology (IT) infrastructure whereas quality controls are used as a way to control the development process and ensure the quality of the software product. Furthermore, it is found that unlike in management discipline ISD focuses more on the internal project elements, e.g., technical architecture, development methodology and techniques, etc., not paying much attention to external factors that affect the emergence of the project.

In addition it is important to notice that the introduced framework is holistic where the identified factors do overlap and sometimes produce counteracting tension. For example, it is unlikely to collaborate, unless you communicate and interact, there is also no way to reflect and learn unless you have a kind of feedback mechanism, etc. Other factors produce counter-acting effect, e.g., extensive analysis of flexibility and producing re-usable designs might be time consuming and therefore will
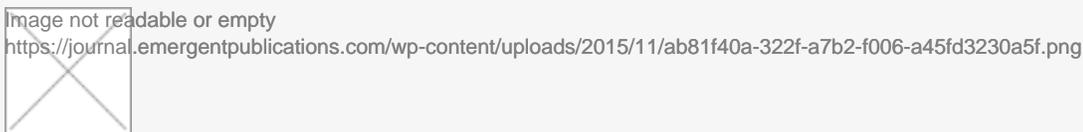

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Fig. 3: Figure 2

Organizational Emergence Framework for Ciranet (Inhibiting Factors of Emergence in Italic)

counter-act the rapidity factor, etc. The project team needs to manage and balance this uncertainty and tension as a way of surviving in a turbulent environment.

In light of this discussion it is concluded that the "Organizational Emergence" framework represents a foundation to realize social/organizational emergence by enforcing factors that facilitate emergence instead of leaving them happen by chance. The framework is a step forward on generic characteristics and principles of CAS (see Table 1) as it provides a way to realize these principles through factors and strategies in action. It is also important to note that the framework does not provide pre-planned business solutions or so called all-inclusive rules that model all possible business settings. Instead it raises the emergent properties of organizations so that project teams can freely innovate and evolve suitable business solutions to address the particular business context. The framework provides the following uses and benefits to business and industry:

Creates a way to articulate intangibles of organizational emergence The framework articulates the importance of intangible factors of emergence in social contexts, such as communication, collaboration, morale, etc. These have been previously missed out or partially acknowledged intuitively.

Creates an emergence mirror of the enterprise 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.

Creates a way to manage and align emergence factors Emergence is a holistic phenomenon where the identified factors are intertwined and sometimes produce counteracting tension. As the framework portrays the different factors under consideration it is possible to determine the importance of each of them and how to align them and balance their effect.

Creates a way to balance emergence and avoid anarchy It offers a new lens in balancing between enabling conditions of emergence and complete chaos. This is achieved through the control factors that need to be not too restrictive.

Conclusion

In this paper complex adaptive systems theory (CAS) and social autopoiesis have been interpreted with the aim to identify factors realizing emergent properties in organizations. Social construction elements, such as communication, collaboration, interaction, trust, etc. are argued to be critical drivers of human empowerment and thus self-organization, whereas mechanistic, adaptive dynamics like flexibility, short-term orientation, small scale approaches, simplicity and rapidity will ensure fast response and quick adaptation to the problem situation. However, emergence cannot be fully realized without the necessary enabling infrastructure that will allow the dynamics of emergence to become effective, e.g., management style, work culture, organizational structure etc. Also appropriate control mechanisms, such as feedback, reflection, learning, etc., need to be in place in order to balance absolute freedom and restrictive structure to ensure emergence to happen without descent into anarchy. The elements or factors in each category have been identified and related in a framework, to help understand and analyze the phenomenon of emergence in social organizations.

It is important to point to the difficulty we faced in identifying factors facilitating organizational emergence. As complexity principles emphasise that emergence is a spontaneous process, so how can a framework represent this phenomenon? In that regard it is important to note that the introduced framework guides project teams with factors or strategies that will enhance their free response to problem situations rather than dictating them with pre-planned business solutions. The framework can be seen as a significant improvement on generic complexity principles suggested in literature, such as diversity, large number of agents, interactions, edge of chaos, etc. that refer to emergence characteristics but without providing a clue on how to realize these concepts in action. A case, a business-business e-marketplace application, has been used to show how the framework can be used and how the factors can enhance the emergent properties of the project.

Especially, it is important to notice that the framework represents a holistic approach where the various identified factors are intertwined and some of them may produce counteracting effect. This uncertainty and tension are major characteristics of the emergence phenomenon and if managed properly it is argued will determine the success of organizations in modern turbulent environments. Future research will focus on further validation of the framework through other empirical applications. Especially of interest is to test if the framework does help companies better understand and manage the emergence phenomenon and put forth intentionally factors that raise the emergence of new work arrangements, or not? Generalizability and completeness of the framework are also important to test in future work.

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