

Understanding and Modelling Factors of Emergence in Turbulent Business Environments

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Abstract

Modern turbulent business environments are characterised by rapid change stemming from increased competition, global challenges, and market shifts that makes businesses unpredictable and unplannable. As a result of such turbulence, complexity theory and emergent behaviour practices, are increasingly being seen as important in addressing the problems that such turbulence brings. Modelling emergence factors in social business contexts has been undertaken by interpreting complex adaptive systems (CAS) theory and social autopoiesis in order to identify factors that facilitate social emergent behaviour. This led to the identification of various elements or concepts of complexity and the development of a framework for understanding and utilising these concepts. Examples of intangible elements of emergence relating to social construction dynamics are communication, collaboration and interaction. Whereas adaptive dynamics, such as short-term orientation, small-scale, rapidity, flexibility and simplicity, were identified as tangible factors that make responsive behaviour possible. This together with the necessary enabling infrastructure, such as management style, organization structure, work culture etc. and the control mechanisms, such as feedback, reviews, flexible rules etc., form the rest of the framework. Such a framework is currently missing and, it is argued, will help in the understanding of social complexity and organizational emergence as well as the practical application of such concepts in information systems development in turbulent business environments. A case example of the development of an e-Commerce business portal is used to illustrate the application and use of the framework.

Keywords: turbulent business environment, emergence, complex adaptive systems theory, social autopoiesis, factors, social construction dynamics, adaptive dynamics, enabling infrastructure, controls, case-study

1. INTRODUCTION

In turbulent business environments organizations need to react quickly and creatively to make the most of new opportunities and business models (Goldman et al., 1995). These new imperatives of business practice require organizations to become more responsive and flexible to handle change. Of key importance to organisations in responding successfully to change is the concept of emergence.

Montuori (2003) explains how our lives today are riddled with complexity and that the unforeseen and the ambiguous, indeed disorder, and individual subjectivity are the norm. The sciences of complexity show us the role of chance, uncertainty and contingency in the world of frequent and continuous change. 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 and seek to provide new ways of thinking and reasoning in relation to emergent behaviour.

In this paper factors of emergence have been identified by interpreting complex adaptive systems theory (CAS) and social autopoiesis with the aim of identifying mechanisms of emergence in social contexts. Based on this a framework has been derived. 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 information systems development in a real world, business to business e-commerce portal.

2. MODELLING FACTORS OF EMERGENCE IN SOCIAL CONTEXTS

Most of the work on complexity and the development of complexity theory has been undertaken in the context of the natural sciences and there is relatively little work on developing or applying such theory in the social sciences, with some notable exceptions such as the work of Luhmann (1986) on social autopoiesis, Arthur (1996) in economics and Stacey et al. (2000) and Mitleton-Kelly (2003) in management. The literature generally suggests that there is a fundamental difficulty in attempting to formulate social complexity theory because of the nature of human beings and human interactions, and specifically the notions of emotion, conflict and cultural elements. However, Mingers (1995) utilises Varela's ideas of social autopoiesis as a system of concepts, ideas, descriptions or messages that interact and self-produce. Similarly soft systems and critical systems thinking deals with this problem to some extent and Checkland (1981) argued that human systems are better understood as systems of meaning i.e. ideas, concepts and values.

Complexity theory may be applied to social contexts by mapping complexity concepts from the natural sciences to social contexts to see if they are relevant and/or appropriate. But in this paper it is argued that complexity theory in a social context requires an explanatory framework that also focuses on intangible elements, such as emotions, ideas, creativity etc., as well as the dynamics of social interactions and inter-relationships. The next sub-sections identify various groupings of interest from the complexity and social autopoiesis literature that we characterise as factors of emergence as they represent elements or strategies that facilitate emergent behaviour in social contexts.

5.1. Social Construction Dynamics

First, the social drivers and stimulators are identified, from the literature. These are concepts that have been suggested as important in facilitating emergent behavior in social contexts. These are identified in bold as follows (they are inevitably somewhat overlapping):

- The development of autopoietic society requires **communication, meaning and consciousness** that form essential drivers of emergent behaviour (Luhmann, 1986).
- Autopoietic or self-referential social organizations are continuously self-making via the vehicle of **discourse and communication** (Baskerville et al., 1992).
- **Constant dialogue** is an essential social driver that creates a willingness to **communicate** with a growing level of **trust**, both of which enable co-evolution of social enterprise. For example trust facilitates better communication, which in turn enables the formation of activities and processes as response to the problem situation (Mitleton-Kelly, 2003).
- Facilitation of interaction in the development of social organizations put **co-operative interaction** and relationships at the centre of organizational development, which can be achieved through **participation, collaboration and team working** (Stacey et al., 2000).

- Individual **motives** or intentions and individual **emotions** act as the driving force of co-evolution influenced by **interests**, social context and forms of **co-operation** and **collective behaviour** directed toward achieving a specific goal (Küppers, 1999).
- Furthermore individual and group **morale** is a pre-requisite for emergent behaviour, e.g. organizations in emerging environments need to be **motivated** and **adventurous**, to take risks and try new ideas, but they should not take unnecessary risks, nor should they be blamed if the experiments do not work (Highsmith, 2002).

Thus, we identify and condense the important social construction dynamics as communication, collaboration, interaction, trust and learning. These appear to be the important elements that facilitate emergent behaviour in social contexts, they are not necessarily the only ones but they are significant. They are responsible for the creation of understanding and stimulation of the appropriate responses to the needs of specific situations. Next we look at the more mechanistic or adaptive dynamics of emergence.

5.2. Adaptive Dynamics

According to Whitaker (1995) the dynamic of an evolving entity is the set of inter-component relationships which identify its form and internal arrangements. Complex behaviour arises from the inter-relationship, interaction, and inter-connectivity of elements within the social system and between it and its environment. In the same way as for the social construction dynamics we now identify the set of adaptive dynamics that improve the ability of the social system to re-arrange and adapt to change. These include the following:

- Systems theory implies that the internal dynamics and form of a system play a major role in determining its behaviour. 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** (Stacey et al., 2000).
- 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 can lead to inflexibility because as one entity tries to evolve or adapt and improve its fitness other entities may respond by hindering this process and causing 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. Also the quality of **interactions** between human agents is a function of the diversity, density, and intensity of those relations. They may be formal or informal, designed or un-designed, implicit or explicit (Mitleton-Kelly, 2003).
- Systems thinking is about wholes and complex inter-relationships and 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 (Stacey et al., 2000).
- Difficulties are created by the complexity and unpredictability of human processes and interdependencies, therefore **short-term** orientation and **simple solutions** are likely to result in better outcomes and more predictable developments. It is argued that long-term solutions are likely to fail, as requirements and conditions can only be articulated and understood as events evolve (Highsmith, 2002).
- 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 (Highsmith, 2002). This also implies **small-scale orientation** in order to quickly try out various options and get quick feedback without requiring large scale resources, effort and time.

From this we identify and condense the more mechanistic adaptive dynamics as the degree of interdependence and connectivity, short-term orientation, the drawing of boundaries, simplicity and small-scale focus. These elements help facilitate fast response and quick internal adaptation of system components.

The social construction dynamics are responsible for the creation of understanding and the stimulation of creative thinking. This is important because they enable the triggering of appropriate solutions and actions in particular situations. On the other hand the more mechanistic adaptive dynamics help to facilitate fast response and quick internal adaptation of the system components. Both social construction dynamics and adaptive dynamics are required for emergent outcomes and form one of the dimensions of the proposed framework. However, because of the problems associated with the terminology of the CAS and autopoiesis literature we simplify these dynamics and classify them as **intangibles** and **tangibles**. The **intangible dynamics** are the social construction elements that uniquely characterise social/human systems from natural ones, whereas **tangible dynamics** represent the elements responsible for the internal and more mechanistic dynamics of the system components themselves. We now turn attention to other groupings of factors that are important in emergence.

5.3. Enabling Infrastructure

In order to facilitate emergent behaviour in social contexts, an enabling infrastructure is required that allows emergence to occur. Without such an infrastructure dynamic and emergent behaviour will be limited or repressed. Aspects of an enabling infrastructure that facilitates emergence include:

- **Hierarchy** and **structure** are pre-conditions that enables or inhibit the emergence of new behaviours and working ways (Heylighen, 2001).
- Action of organization members is shaped to a high degree by the existence of specific **organizational structures** (Wulf, 1996).
- Conditions that facilitate the day-to-day **management** of an organisation, for example, **good leadership** and the provision of psychological space and freedom together with **physical space** and **resources** are necessary for learning and emergence to occur (Mitleton-Kelly, 2003).
- Emancipation from domination and **human freedom** are important in overcoming individual or powerful group interests beyond that provided by formal negotiations and contracts (Küppers, 1999).
- **Cultural** conditions facilitate new work habits and intensions such as manoeuvrability and risk-taking in certain ambiguous or uncertain situations (Kelly, 1994).
- Analysis of the influence of external factors like **power**, **money** and control **regulations**, for example contracts and conventions, are also important as these often act as constraints that limit social dynamics in complex situations (Stacey et al., 2000).

Thus, we identify an enabling infrastructure as important because it helps to ensure that the social and adaptive dynamic elements are effective (or the enabling infrastructure is such that they are inhibited). The important elements of the enabling infrastructure are; management, culture, information, structures, hierarchies, regulation and people.

5.4. Control Mechanisms

Complexity theory in social contexts is designed to enable creativity, spontaneity and emergence but it also requires some kind of moderating or control mechanisms to balance possibilities with constraints, innovation with tradition, etc. (Montuori, 2003)

- In order to adapt to a changing environment, a system needs a variety of **stable states** that are large enough to react to all changes but not so large as to make its evolution uncontrollable and chaotic (Küppers, 1999).
- The mechanisms by which complex systems maintain control and achieve their goals is by **feedback, learning** and **frequent small adjustments** to counteract any excessive tendencies to change (Mitleton-Kelly, 2003).
- Stability is sustained by the property known as the **edge of chaos** that limits the destruction of the system. Change and stability are balanced and the edge of chaos is a critical point of the system, where a small change can either push the system into chaotic behaviour or tip the system back into a more stable state (USENET Newsgroup, 2001).
- Edge of chaos is controlled by **Equilibrium** models that 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 counteracts excessive change before it endangers the essential organization.
- Continuous **reflection, learning** and **circular causality** mutually reinforce social relationships and interactions (Küppers, 1999).
- Control in emerging entities should take a **distributed** form, which means that it should not be centralized but be a collective of all components (Mitleton-Kelly, 2003) and (Stacey et al., 2000).
- Simple **generative rules** are a way to achieve a balance between dictation and freedom enabling team members to interact with each other guided by these rules (Highsmith, 2002).

Another important grouping is thus the controls to balance and maintain a system in equilibrium. They facilitate emergent behaviour because without them complete chaos or anarchy or even destruction of the system may occur. The identified set of controls are; reflection, circular causality, learning, feedback, continuous re-adjustment, edge of chaos, distributed control, and generative rules.

The different groups and elements of each category are illustrated in Table 1 and it is argued that this forms a useful framework for modelling and understanding complexity factors that facilitate emergent behaviour in social contexts.

	Dynamics	Enabling Infrastructure	Controls
Intangibles	Communication Collaboration Interaction Trust Morale	Management (style, power, leadership) Culture Information (Knowledge)	Reflection Circular causality Learning

Tangibles	Degree of inter-connectivity (inter-relations, coupling) Drawing boundaries Simple solutions Short-term orientation Small scale	Structures Hierarchies People Regulations	Feedback Continuous re-adjustment Edge of chaos (Balance) Distributed control Generative rules
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Table 1: A Framework of Factors Facilitating Emergent Behaviour in Social Contexts

3. The Case of Emergent Information Systems Development (Emergent ISD)

Having created the framework a preliminary application and validation was undertaken. A real case of the development of an e-Commerce (business to business) digital portal in the pharmaceutical sector in Egypt was utilised. The authors were involved in this development as part of a different study. The portal offered electronic trading tools directed at the pharmaceutical industry covering drugs, cosmetics, medical supplies, personnel and childcare products, etc. The portal was a good example of the development of an information systems in a fast-moving and turbulent business environment.

The portal application had already been developed before the authors became involved. The original analysis and design approach focused on business process modelling of the pharmaceutical trading supply chain using traditional systems development methods (heavy-weight methods in agile development terminology). A life-cycle (waterfall) approach was used and the developers sought to fully identify the systems requirements before moving forward to development. For example the order lifecycle was analysed and decomposed into order preparation, order placement and order fulfilment, etc. and the 'return of expired products' lifecycle was identified and extensively analysed.

When the authors became involved it was clear that there were problems and that the system was inadequate and not meeting expectations, of the company, the users or the customers. Over a period of four months, problems were identified with the use of heavy-weight methods as they were too systematic, comprehensive and plan-driven. This clearly limited and inhibited any emergence in such a dynamic business environment in which the users did not know what they wanted, the company did not know what would work and the customers had to be persuaded and attracted to buy. The developers had become overwhelmed with the detail produced from the comprehensive analysis, resulting in over complex designs but most importantly the approach ignored, or failed to deal with adequately, changing and evolving requirements. In addition the researchers identified other managerial and structural problems. For example, the adoption of long-term planning policies tended to freeze the organization based on assumptions that had changed due to the environment. Furthermore problems were identified with the hierarchical organizational structure and command-control management of the project where, in particular, the business consultant was dominant and over-powering in defining the requirements and producing the designs, often ignoring other team members' ideas and contributions that might have made the project more successful. This further limited collaboration and reduced trust among team members and project stakeholders.

The situation was so bad that a new development approach was adopted and the portal was re-developed. The new approach adopted incremental, iterative development where the systems modules were incrementally implemented according to priorities and continuously improved with new features and add-ons. The team used prototyping technique that facilitated small scale and incremental development, as well as trying to encourage reflection and learning.

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. Rapid development was achieved through short development cycles and parallel development that accelerated the development cycles. Furthermore, the portal was implemented with component-based technology to enhance flexibility as it utilised re-usable components and modules. The modules were tested to identify any programming errors and customer reviews were arranged to uncover flaws in the business rules, incorrect assumptions about the customers, and to understand what attracted customers.

This more agile or lightweight approach was found to be more appropriate for such development, in which emergence was required, and overall a more successful system was developed, as it proved. However, there were still many problems. In particular it was difficult to change the development culture and instil an agile culture into the organisation. This was resisted as employees were used to optimisation-oriented and command-control culture, which had not changed in the organisation as a whole.

The developed framework of Table 1 is now utilized in relation to the case. It is not applied to the original development situation because it is obvious that almost everything mitigated against emergence. Rather it is applied to the second development which was thought to be more amenable to emergent outcomes. Table 2 is the result of the analysis and it includes the factors that facilitated and inhibited emergent ISD in the portal development project.

Some tangible dynamics for emergence were in place, such as rapidity realised by short development cycles and parallel development. Small-scale focus was realised by incremental development and flexibility by component-based development. Others, however, were missing. For example, long-term orientation was found to be inhibiting. In relation to the social construction elements (Intangible Dynamics) it was found that collaboration and trust were missing which inhibited emergent responses. The enabling infrastructure was found to be mainly inhibiting rather than facilitating emergence, for example the command-control management style, hierarchical organisational structure and optimisation-oriented culture acted against emergence. The technical architecture was in some ways helpful to emergence as it was relatively flexible based on a component-based architecture. The control mechanisms were mixed in their support for emergence. Reflection and learning was encouraged although it did not go beyond the development environment which negated some of its benefit. Feedback via iterative development also occurred. However, the developers did not fully adopt the agile culture and did not really practice continuous adjustment, preferring to stick to what was originally decided within an increment. Adjustment worked well with respect to testing and reviews with customers. The generative rules of agile development did allow some flexibility and emergence to some extent.

It is apparent from the analysis and via use of the framework (Table2) that although there were some factors that facilitated emergence other factors tended to counteract or outweigh them and therefore emergent information systems development was not fully-realized in the case and this was witnessed by the problems the researchers identified during the case fieldwork.

Dynamics	Enabling Infrastructure	Controls
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Intangibles	<i>Lack of collaboration</i> <i>Lack of trust</i>	<i>Command-control management</i> <i>Optimisation-oriented, command-control culture</i>	Reflection Learning (<i>but only within development arena</i>)
Tangibles	Rapidity (short development cycles & parallel development) Small-scale (incremental development) Flexible, component-based development <i>Long-term orientation</i>	<i>Hierarchical organization structure</i> Flexible, component-based technical architecture	Feedback (iterative development) <i>Little continuous development or adjustment within an increment</i> Quality controls (testing & reviews) Agile generative rules

Table 2: Factors Facilitating/Inhibiting Emergent ISD in the e-Marketplace Case (Inhibitors in italic)

4. CONCLUSIONS

In this paper we have interpreted complex adaptive systems theory (CAS) and social autopoiesis and identified factors of emergent behaviour in social organizations. Social construction elements such as communication, collaboration, interaction etc. are argued to be critical drivers to stimulate emergence, whereas mechanistic, adaptive dynamics like short-term orientation, small scale, and simplicity that facilitate fast response and quick adaptation. However, emergence cannot be realised without the necessary enabling infrastructure and controls to balance structure and freedom to ensure emergence without descent into anarchy. The elements or factors in each category have been identified and related in a framework to help understand and analyse emergence in social environments. A case has been used to illustrate and validate the framework. It shows how the framework can be used and that the factors can enhance or inhibit emergence. The case is an example of an unclear situation where the tangible dynamic factors might have been expected to enable emergence more than they did and it shows the importance of the enabling infrastructure and the controls in determining whether emergence will occur or not.

The framework has been developed and it hopefully represents a foundation for understanding and enabling organizational emergence, based on discrete elements and factors that actually facilitate emergence. This should improve emergence in practice as currently it is usually just left to intuition or chance. For example, most agile development methods, although paying lip-service to emergence as a desirable property, fail to address how it might be enabled or inhibited.

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