

Framework for the role of self-organisation in the handling of adaptive challenges

Abstract

This paper extends the concept of self-organisation from the natural sciences to management and proposes a framework for the role of self-organisation in the handling of adaptive challenges by enterprises. The process of self-organisation is a characteristic of those complex adaptive systems that are far-from equilibrium, and results in the creation of order in a system by the internal interactions between agents leading to stronger adaptive capability. This paper presents a synthesis of the concept of self-organisation suitable for management with communication as its central focus. Results from an empirical study in three Australian small and medium sized enterprises (SMEs) indicate that an adequate level of three key factors – trust level, open communication and strength of the value system in an enterprise – is needed for self-organisation to occur.

Key words: Complex adaptive systems, self-organisation, communication, SME, management

1. Introduction

Managers today are faced by an increasingly turbulent and unpredictable environment with rapid changes in the market place (Morgan, 1988; Merry, 1995; Brown & Eisenhardt 1998; Pascale, 1999; White, 1999; Meyer, Gaba & Colwell 2005). The changing reality for organisations has led to the long-held Newtonian paradigm in management being challenged by the view offered by chaos theory (Zimmerman, 1993; Wheatley, 1994; Tetenbaum, 1998; Tasaka, 1999). Chaos theory offers a view of the world as dynamic where change is the norm not the exception, and where prediction is impossible. Complexity theory contends that organisation can arise spontaneously and is adaptive (Frederick, 1998). In the natural world “astonishingly simple rules, or constraints, suffice to ensure that unexpected and profound dynamical order emerges spontaneously”, and this self-organisation has been termed “order for free” (Kauffman, 1995). Self-organisation along with selection creates a system’s capacity for adaptation to environmental conditions (Kauffman, 1993).

A number of disciplines in the natural sciences have led the study into the concept of self-organisation— for instance chemistry (Prigogine, 1968, 1976; Nicolis & Prigogine 1977; Prigogine & Stengers 1984), physics (Klimontovich, 1991; Shalizi, Shalizi & Haslinger 2004), and biology (Ulanowicz, 1979; Jantsch, 1980; Kauffman, 1993, 1995; Camazine *et al.* 2001). While the idea of self-organisation has been taken up by management theorists (Weick, 1977; Foerster, 1984; Ulrich & Probst 1984; Drazin & Sandelands 1992; Comfort, 1994; Molleman, 1998, 2000; Biggiero, 2001; Stacey, 2001), there is a limited amount of empirical research—indicating a gap in the understanding of complexity science’s application to the social

world. Researchers have pointed out the need for appropriate consideration when applying concepts from the natural sciences to the social sciences. As Comfort (1994) notes “the concept of self-organisation needs to be redefined and reinterpreted in order to assess both its presence and functions in the performance of social systems in rapidly changing environments. This paper extends the concept of self-organisation from the natural sciences to management using a cross-disciplinary approach and examines this theoretical framework in light of empirical results.

2. Need for applying complexity theory to management

Numerous books aimed at management practitioners (Peters, 1989; Goldstein, 1994; Watson, 1994; Wheatley, 1994; Nonaka & Takeuchi 1995; Axelrod, R & Cohen 1999; Haecke, I 1999; Ralls Jr. & Webb 1999; Wood, 2000) and the general public (Waldrop, 1994; Merry, 1995) have raised awareness for the potential application of complexity theory”. However as Mitleton-Kelly (2003) notes, “ by comparison there is relatively little work on developing a theory of complex social systems despite the influx of books on complexity and its application to management”.

The dynamics of complex adaptive systems, such as their ability to evolve and learn over time, can provide organisations with insights into developing the capabilities to handle adaptive challenges. Organisations that can tap into the property of self-organising or self-renewing systems have been termed adaptive organisations where the task determines the organisation form (Dumaine & Anderson 1991). A firm that can self-organise has the internal capacity for “spontaneously emerging structures”, depending on what is required (Wheatley, 1994).

Based on the laws of motion with a mechanical world view, there has been a diffusion of the concept of equilibrium from Newtonian physics, into neoclassical economics and then to organisation theory (Meyer, Gaba & Colwell 2005). In the field of economics, the Newtonian paradigm interpreted the economy as “a closed, autonomous system, ruled by endogenous, mutually interdependent factors of a highly selective nature, self-regulating and moving toward a determinate, predictable point of equilibrium” (Weisskopf, 1979). Equilibrium in organisation theory is “a condition in which all acting influences are canceled by others, resulting in a stable, balanced, or unchanging system” (Meyer, Gaba & Colwell 2005). In the Newtonian organisation, “if nature or crisis upset this state the leader’s role was to reestablish equilibrium” (Tetenbaum, 1998). In the Complexity paradigm the world view is of “Chaos” – a system that is ‘far-from-equilibrium’ and characterised by constant change and by never reaching equilibrium (Fuller & Moran 2001). In the Newtonian view of organisations, the role of the leader is to maintain equilibrium, while in the complexity view, management is a social function and the role of the manager is as a facilitator of self-organisation.

3. Self-organisation –from natural science to social science

Three characteristics referred to in self-organisation process in the natural sciences can be related to the social sciences. These characteristics are emergence of complex behavior through iteration, rules guiding behavior, and the presence of attractors.

Self-organisation in the natural sciences refers to the dynamic emergence of order, structure or patterns from the interactions of the elements inside the system. Iteration leading to complex behaviour is found in various systems—including mathematical, biological and social systems. In chaotic systems the iteration of a few non-linear equations can lead to the creation of a range of possible behaviours. Iteration is referred to in the literature on self-organisation in biological

systems as the 'multiple, iterative interactions' (Camazine *et al.*, 2001). In a similar sense, Luhman (1986) refers to iteration in social systems as recursively produced and reproduced communication in a network. A social system has the ability to generate complex behaviours as a result of simple communicative events iterated over time. The link between communication and self-organisation has been made by a number of researchers (Katz & Kahn 1966; Simon, 1976; Jantsch, 1980; Comfort, 1994; Olson & Eoyang 2001; Hammond & Sanders 2002). Jantsch (1980) notes:

... communication, however, is the key to complexity ...The world is full of vibrations originating in the manifold dynamics of dissipative self-organization. These vibrations are the communication media of a dynamic world.

Besides iteration, social and biological systems have another similarity in the description of self-organisation in the literature that relates to the importance of rules guiding behaviour. In biological systems, interaction occurs between individuals executing rules of thumb (Camazine *et al.*, 2001), while in human systems interaction occurs between participants having mutual acceptance of communicative rules (Scheidel, 1972). The shared frame of reference is linked to the concept of psychological orientation (Mortensen, 1972) which is an individual's attitude to communication, and the individual's predisposition to respond to message cues in characteristic ways. The term social schema is also used to denote this shared frame of reference. There is an apparent link between the social schema that lead to communication being a form of interaction and the schema mentioned by Gell-Mann (1995) that govern the behaviour of agents in a CAS. A shared frame of reference is a requisite feature of the communication needed if self-organisation is to occur in human systems. Shared values and culture play an important role in

creating a shared frame of reference among individuals. This strengthens the interaction in the complex adaptive system and therefore enhances the learning capability of the system.

The third characteristic of self-organisation in natural sciences is the presence of “attractors”. Long-term behaviour of a chaotic system tends to settle down into a smaller number of behaviours or states. Attractors have been found in man-made systems like a Boolean network (Kauffman, 1995); mathematical sets like the Mandelbrot set (Briggs, 1992) ; and models of natural systems to predict weather (Gleick, 1988). A strange attractor “consists of an infinity of points, in the plane ... these points correspond to the states of a chaotic system” (Ruelle, 1995). Descriptions in management literature refer to strange attractors as binding or limiting the behaviour of a system; for example, “if an attractor has multiple points of attraction within a finite space it is called a strange attractor and it limits a system’s unstable behaviour within those limits” (Mitleton-Kelly, 2003) and strange attractors represent “a basin of attraction that the system is drawn into, pulling the system into a visible shape” (Wheatley, 1994).

A number of authors have suggested that values are the attractors in organisations. Thietart and Forgues (1995) refer to an organisation in a chaotic state as being “attracted to an identifiable configuration”, and Frederick (1998) interprets a corporation’s strange attractor as its value system that permits change within constrained limits. On this view, a corporate system’s phase space is the total range of value variables available to any given corporate dynamical system while its phase portrait is a set of swirling values that represents all possible behaviours (Frederick, 1998). Agents’ behaviours in a system are governed by a few rules based on a small number of shared values (Lewin & Regine 1999).

The movement of a system from one attractor to another attractor is proposed as signifying the process of self-organisation by Goldstein who notes that:

The idea of non-linear systems passing through the various attractor regimes is one of the startling discoveries of the new science of chaos and far-from-equilibrium thermodynamics ... the emergence of the new attractor signifies the onset of self-organisation (Goldstein, 1994).

According to Goldstein (1994), when an organisation is under the sway of an “equilibrium attractor” it resists change, as opposed to the organisation that can self-organise by moving from one attractor to the next.

4. Self-organisation in management

One of the earliest references to the term ‘self-organisation’ in management literature (Ashby, 1947) defines it as processes in which systems become more highly organised over time, and these are self-induced changes of organisation, with no external order being imposed. A more recent description, similar to Ashby’s concept, is that self-organisation represents a system’s affinity for evolving into modes of functioning exhibiting more complex and coherent patterns (Goldstein 1994). In synergetics (Bushev, 1994), an example of a self-organised process is the occurrence of regulated behaviour that results in joint action to produce a product by workers receiving no external orders, but doing so by some kind of mutual understanding (Haken, 1978). The description of self-organisation by Haken (1978), is close to that of Molleman (1998) who considers self-organisation as the local autonomy to make decisions on both the transactions to be realised and the way transformation processes are organised to achieve these transactions.

Autogenesis is a self-organising perspective of organisation that explains organisation by “observation and categorisation of the interactions of independent actors whose behaviour is governed by a system of recursively applied rules” (Drazin & Sandelands 1992). There are three

levels of structure in autogenesis, where the inner-most core is “Deep structure” or the tacit rules that govern action and interaction among actors, “Elemental structure” is the interactions among the actors, and “Observed structure” is the social facts constituted by the interactions. The tacit rules or deep structure guide the behaviour of the individuals without the need for external order. The joint action of the individuals is the creation of organisation.

All five descriptions of self-organisation in management literature (Ashby, 1947; Haken, 1978; Drazin & Sandelands 1992; Goldstein, 1994; Molleman, 1998) have the common theme of: a) creation of organisation without external direction or external order b) joint action by the constituents of the system for the achievement of a shared goal—higher organisation, complex patterns, products, or transactions.

5. Research Methodology

The study sets out to test the contention, made by Kauffman (1993), Axelrod (1999) and Goldstein (1994) that organisations that have a greater ability to self-organise will adapt more effectively to environmental change than those with a lesser ability to self-organise. Based on a review of cross-disciplinary literature, self-organisation is characterised for the author’s study (Carapiet, 2006) as:

a collective process of communication, choice, and mutual adjustment in behaviour based on a shared goal among members of a given system [without external order] (Comfort, 1994)

The phenomenon of self-organisation is studied in the specific context of ‘an event’—an organisation change or adaptive challenge faced in the past twelve months by the company.

Event is used in this study in the sense of a 'significant experience'. Complex adaptive systems learn and evolve based on 'experiences'. Evidence of self-organisation and the factors affecting self-organisation is gathered in each case from four sources: interviews with agents; OCS questionnaires; documents; and observation. The research design is a multiple-case study where the case study protocol has been followed consistently in each case.

Communication is the primary mechanism for the iterative interaction that drives self-organisation. In this study, communication in each organisation is assessed in two ways. Firstly, the interview protocol contained questions pertaining specifically to the communication processes in the company. Secondly, an instrument was used to gauge organisation communication. The "Organizational Communication Scale" or OCS by Roberts and O'Reilly (1974) was selected as it has been shown to be to be reliable and valid across quite a variety of organisation types including SMEs and has been used in recent studies .

In this study, the value system of a company has been linked to the measurement of self-organisation. Interaction between the agents is according to a set of rules or 'schemata' (Yin, 1981), or by a "system of recursively applied rules" in organisations such as CAS (Gell-Mann, 1995). Shared values create norms of behaviour. Strong shared values lead to similar behaviours of individuals at various levels of an organisation (Drazin & Sandelands, 1992), learning (McMillan, 2004), and act as an attractor so that behaviour remains within certain bounds (Senge, 1990). According to Weick and Sutcliffe (1998) a culture with a small number of shared values (three or four core values) that have been converted into norms of behaviour will be coordinated, resilient and opportunistic.

The research path was cyclical and non-linear and ideas were revisited as new data was gathered. Refinement of conceptual insights emerged in the research. For instance, after the second case study the concept of the ASO Index was developed, and some of the outputs were subsequently discussed with the contact manager in the third case study during the interview that followed the fieldwork.

Research Participants

Three Australian SMEs (small and medium sized enterprises) participated as case study companies. The selected cases offered diversity in terms of industry, company size, and organisation structure as shown below in Table 1.

[Table 1 about here]

These companies are referred to as Tech Enterprises (TE), Training Corporation (TC) and Telecom International (TI). Tech Enterprises is a system engineering company, Training Corporation is a management education training college, catering mainly to overseas students, and Telecom International is a software development company focusing on the telecommunications sector. Tech Enterprises and Training Corporation are 'stand-alone' business units forming part of larger corporations, whereas Telecom International is an

independent company. A common element in all these cases is that the employees are highly qualified and that knowledge or information is a significant part of the value chain.

TI is the smallest company in terms of the number of employees and turnover, with 30 staff and annual revenue of AUD 2 million. TE generates AUD 50 million annual revenue with 200 staff. Both TE and TC are stand-alone units of a larger company, while TI is a stand-alone business. There was evidence of self-organisation in TE in the past year, and in TC in 2005.

The relevance of the study of organisations as complex adaptive systems has been underscored with evidence of the extent to which contemporary organisations operate in far-from-equilibrium conditions. In all three case study companies, the year leading up to the fieldwork saw a major retrenchment, with change in senior management, and increased pressure on profitability.

The search for cross-case patterns would be more effective with a greater number of cases (Eisenhardt, 1989); however, the selected cases in this research project offered an opportunity to analyse the handling of an adaptive challenge in different enterprises. Given the project constraints—one researcher, limited resources, and time available, the number of case studies conducted in this research was therefore limited to three firms.

Data Collection

Four sources of evidence were collected in this study: interviews with agents, a questionnaire, observation, and documents. Data has been collected in each company by using the same interview protocol and questionnaire. The observation data has also been collected in two defined categories.

A total of twenty-one semi-structured interviews were conducted using the interview protocol. The number of agents interviewed is six to eight in each company. The use of a systematic protocol and questionnaire allows for future replication of this study and thereby contributes in satisfying the criteria of “transferability and confirmability” (Denzin & Lincoln, 1994). Detailed notes were taken during the interviews, while observations were recorded as notes in the case file before and after the interviews. In order to avoid any inhibition in interaction, interviews were not audio-taped (Minichiello, Aroni & Sanders, 1995).

In the first case study company there was evidence of self-organisation, therefore a second round of interviews was conducted with a supplementary interview protocol that provided a more ‘in-depth’ information. The interviews-data provided partial answers to the research questions of this study. The OCS discussed here next, was another important source of data.

Qualitative Data Analysis

Data analysis techniques for the qualitative data (Miles & Huberman, 1994) collected in this study include data reduction by writing summaries and coding responses to questions, data display by preparation of data matrices, as well as conclusion drawing and verification. Qualitative data collected mainly through semi-structured interviews was managed systematically by taking detailed notes. A clear indexing system has been used to distinguish among raw field notes, documents, and interpretive analytic materials. The field notes and other data collected by analysing archives have been reduced by preparing data summaries. Data categorising techniques (Miles & Huberman, 1994) were used to aid analysis. Data display techniques, such as diagrams and matrices with text have been used to compress the data and to aid reflection on its meanings.

The organisation data sources, both qualitative and quantitative (Dey, 1993), were used to gauge process outcomes for comparison with interviewee opinions. Triangulation was used by checking results with respondents, comparing interview comments with documentary evidence, and cross-checking the responses of different interviewees to a similar issue.

In order to analyse whether organisations with a greater ability to self-organise have a strong value-system based on a few core values, content analysis (Weick & Sutcliffe, 2001) was used to analyse data of interviewee responses to questions on the organisation culture, value system, and management control in their company. The data is in the exact words used by the interviewees.

The aim of the content analysis is to ascertain the strength of the value system “attractor” by measuring the presence of three core values: in my study they were, Honesty, Openness and Trust. The selection of these values was made for two reasons. Firstly, the words were mentioned by different respondents during the interviews and therefore indicated that these were ‘shared values’. Secondly, there was mention of ‘Openness’ and ‘Trust’ in the literature (Krippendorff, 1980; Eisenberg & Witten, 1987; Harkins, 1999; McMillan, 2004). Content analysis was a good method to use here as it is not only unobtrusive but effective in analysing qualitative data.

Quantitative data analysis

The OCS uses a 7-point Likert scale to record responses to a number of questions. There is an ongoing debate about the data-analysis techniques suitable for data generated by Likert scale responses (Lewin & Regine, 1999). The controversy surrounds the view of the data from the Likert scale as ‘ordinal’ or ‘interval’ (Jamieson, 2004). Wang *et al.* (1990) note that “the

controversy over treating ordinal scales as interval scales remains because of different views on the relevancy of measurement scales to permissible statistics”.

According to Jamieson (1999) “Likert scales fall within the ordinal level of measurement, that is the response categories have a rank order, but the intervals between the values cannot be presumed equal”. However a number of researchers use Likert data and analyse it as interval data, and I found a number of recent studies that use factor analysis on Likert data (Jamieson, 2004; Botha, 2005; Sarros *et al.*, 2005). While the debate on whether Likert data is ordinal or interval continues, for this study the OCS data generated using the Likert scale is treated as ordinal, and to avoid any distortion and incorrect interpretation of results the statistical techniques used are suitable for ordinal data. A consideration in the choice of non-parametric statistical methods is the small sample size (Thomas-Sabado & Gomez-Benito, 2005), with a total of 21 respondents.

In the first instance, responses for each question have been analysed on a case-to-case basis. Then for major findings in particular questions, cross-case comparisons are made. The statistical package SPSS has also been used for analysing the data from the questionnaires. Responses to select questions have been mapped to variables used in SPSS analysis, with the statistical analysis of the quantitative data using SPSS being done in three ways; descriptive statistics of data in each case, Spearman rank correlation co-efficient in each case to find significant relationships among the designated variables that comprise the measure of self-organisation ability; and Categorical principal components analysis (CATPCA), through optimal scaling, is used on the combined data from all three cases to identify dimensions in the data, and its results have been compared with the other analysis conducted on the data.

6. Empirical Results and Framework for Self-organisation

Self-organisation is the process where order emerges dynamically in response to a significant experience or event. Enterprises were identified that faced environmental pressures—such as competition, technological changes, and economic forces which challenged their ability to survive. Such turbulent conditions as “the space for creativity in an adaptive system” (Wilcox 2005) were considered to be suited to the study of the self-organisation process. It is anticipated that evidence of self-organisation would correspond with an enterprise having higher adaptive performance reflected in better profitability and employee loyalty.

Evidence of self-organisation has been documented in TE in response to the ‘event’, or adaptive challenge, faced by the company. The lack of external order was apparent in the self-organisation process as the agents interacted with each other to achieve a mutual goal; namely, the removal of the Acting General Manager and the appointment of their own choice to the post. This process has been termed by the agents as a ‘management coup’. The appointment of an outsider who threatened their ability to maintain the culture and work as they had before, disrupted the organisation culture to which they were accustomed and resulted in a bottom-up change process. The self-organisation process resulting in a restructuring of the management team is an example of high-order self-organisation where the agents are highly capable and autonomous. TE is an organisation that gives its employees a high level of autonomy. They have a saying “seek forgiveness not permission”, which encourages employees to be entrepreneurial and to take risks. The extent of managerial control was one of the factors identified in the literature as affecting self-organisation and the evidence in TE concurs with the view that a lower level of managerial control facilitates self-organisation. Content analysis results indicate that TE has the strongest incidence of ‘trust’ as a value among the three cases, indicates the importance of this factor in self-organisation.

Content analysis of the qualitative data from all three cases was conducted in order to ascertain the strength of the value system “attractor”. Table 2 presents the results of content analysis conducted on the data from the interviews. The data tables consist of the exact wording used by the respondents interviewed in each case-study company—in response to questions on the organisation culture of the company, its value system and its level of managerial control.

The content analysis has been conducted for two categories: with Category 1 being Honesty/Openness and Category 2 being Trust. Words and phrases conveying a similar meaning have also been included while counting the incidence.

[Table 2 about here]

The content analysis indicates a strong consistency of category 1 in Training Corporation's responses (83.34%), which is lower in Tech Enterprises (75%) and non-existent in Telecom International. Category 2 is highest in Case 1 (62.5%), lower in Case 2 (50%), while once again it is non-existent in Case 3. It would appear that Honesty and Openness are highly valued in Training Corporation and Tech Enterprises. It is significant that in Telecom International, none of the respondents used any word or phrase conveying the meaning of honesty, openness, or trust.

While the self-organisation process was not evident in TC during the fieldwork, this study found that TC has a strong ability to self-organise. Evidence collected during the interviews with the

agents in TC, and the quote of the General Manager of TC in a trade journal article in 2005, both support the view that the agents in TC self-organised to change the ownership of the company in 2005. There was no evidence of self-organisation in the third company TI and this was consistent with evidence of a low ability to self-organise.

Statistical analysis has been conducted on the quantitative data from all three cases as a joint data-set, using the module CATPCA or Principal Component Analysis of Categorical Data in the statistical package SPSS. Results from the CATPCA indicate that there is a significant pattern in the data that shows that in the first two case study companies' agents (TE and TC) cluster together in their responses and are in the quadrant that indicates a high desire to interact and a high level of open and honest communication. The agents in TI are scattered in their responses. Figure 1 below is a plot of the respondents (referred to here as objects labeled by the numbers 1–21) on the two dimensions of Open and honest communication (Dimension 1) and Desire to interact (Dimension 2). The numbers 1–8 represent the respondents in TE, 9–14 represent the respondents in TC; and 15–21 are representative of respondents in TI.

[Figure 1 about here]

As Figure 1 shows, there is a cluster of the respondents in the lower left hand quadrant of the biplot. The quadrant represents a favorable position in both dimensions—Open and honest communication (Dimension 1) and a high desire to interact (Dimension 2). In the OCS, a score of 1 is the most favorable response for each variable analysed here. The cluster consists of

respondents from TE and TC only (objects 1, 4, 5, 6, 8, 9, 10, 12, 13 and 14). The ten respondents account for 71.5% of the respondents from the first two case study companies. Respondents from TI are scattered on the biplot away from the cluster.

CATPCA reduces data into a small number of dimensions that capture a high degree of the variance. Twelve variables were analysed using CATPCA for the twenty-one respondents that filled out the OCS. Two dimensions were identified. Table 3 shows that both dimensions identified by the CATPCA have high reliability, and consequently account for a high variance in the data.

[Table 3 about here]

The Cronbach Alpha indicates the internal consistency based on the average inter-item correlation. Alpha measured on a scale of 0–1 is high for both dimensions in Table 3 (that is, over 0.7). The variance in the total data-set accounted by each dimension is measured by the 'eigen value'. As Table 3 shows, both dimensions have eigen values over 1.0.

Dimension 1 can be described as "Openness and honesty in communication". In an organisation where respondents trust their superiors as being generally fair, and trust their superiors to feel comfortable in having free discussion, there is no pressure to distort upward information, and consequently there is a good feeling about communication in the organisation generally.

In the second dimension, the strong component loading is for the desire to interact with superiors (.811). All the variables that indicate a desire to interact—whether it be with immediate superiors, immediate subordinates or peers—have a positive covariance with the accuracy of information from superiors, and trust in the general fairness of the superior. Dimension 2 can be described as “Desire to interact”. When superiors are considered as fair and providing accurate information, the respondents desire to interact with one another is better in all directions in the organisation—upward, downward, and lateral.

Measures of the Ability to Self-organise

This study led to the development of the ASO Index (Carapiet & Harris, 2007) which measures for the ‘adequacy level of the factors’ for self-organisation. The qualitative data analysis results are supported by the measures of the ability to self-organise. Table 4 shows a comparison of the three case study companies on the basis of the ability to self-organise:

[Table 4 about here]

The above table shows that Training Corporation has the best relative ASO (1.89) of the three organisations studied in this research. TLCOM measures trust level of communication and CQCOM measures the communication quality of the organisation. Tech Enterprises has the best trust level among the three cases.

Based on the theoretical framework derived from earlier literature and the empirical results of this study, a framework for the role of self-organisation in the handling of adaptive challenges has been developed illustrated in Figure 2. In this framework, enterprises face a number of adaptive challenges such as rapid changes in market, technology and within their own organisation. In an Adaptive Enterprise, the agents interact in an iterative manner through communication.

Self-organisation is the process where order emerges dynamically in response to a significant experience or event. The ability to self-organise is affected mainly by three factors (i) trust level between agents (ii) open communication and (iii) a strong value system. When the level of factors is adequate, self-organisation occurs. Value-based rules guide behavior of the agents who share a small number of core values. The enterprises that self-organise have a higher adaptive performance reflected in better profitability and employee loyalty.

[Figure 2 about here]

An adequate level of factors was found in TE and TC which indicated an adequate ability to self-organise. Evidence of self-organisation was found in the absence of external order in TE. A strong value system with three core-values—honesty, openness and trust was found in TE and

TC. In TE a simple value-based rule was found that encouraged employees to be entrepreneurial and to take risks. This rule is to “seek forgiveness not permission”. As an organisation, employees at TE are encouraged to experiment and take initiative. This is consistent with earlier research that links self-organisation with organisations capable of “experimentation” (Thietart & Forgues, 1995; Stacey, 1996). In terms of indicators of adaptive performance, a rise in staff turnover, a fall in profitability and fall in employee loyalty each indicate problems in coping with adaptive challenges. All three indicators for TI, the enterprise with the lowest ability to self-organise, reflect a low level of adaptive performance.

7. Conclusion

Self-organisation is the key for adaptive capability of complex adaptive systems. This paper extends the concept of self-organisation from the natural sciences to management. Characteristics referred to in self-organisation process in the natural sciences can be related to the social sciences such as the emergence of complex behavior through iteration, importance of rules in guiding behavior, and the presence of attractors. Based on the theoretical framework derived from earlier literature and empirical study results in this study, a framework is proposed for the role of self-organisation in the handling of adaptive challenges by enterprises. Evidence of self-organisation was found in two cases where an adequate level of three key factors affecting the ability to self-organise was present. The findings from this study has implications for organisations operating in a dynamic and unpredictable world. In order to improve the handling of adaptive challenges, organisations need to develop the ability to self-organise by having a high level of trust, open communication and a strong value system. The measure for the ability to self-organise (ASO Index) developed in this study is a first step to operationalise self-organisation for management.

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Table 1

Diversity in case companies

Case study	No. of employees	Annual Revenue 2003 (AUDm)	Nature of Business	Company Structure	Interviews	Self-organisation
TE	200	50	System engineering	Business unit of larger company	8 Managers 1 CEO of affiliate co.	Evidence found
TC	90	15	Management training	Business unit of larger company	6 Managers	Evidence found**
TI	30	2	Software development	Stand alone business	4 Managers 3 Engineers	No evidence

* Concept based on a table to analyse variation in cases by Lapointe and Rivard (2005)

** Data indicates the occurrence of self-organisation in 2005

Table 2

Result of content analysis

Case Study Company	Incidence Category 1	Incidence Category 2	Consistency* Category 1	Consistency* Category 2
Tech Enterprises	11	5	75%	62.5%
Training Corporation	8	3	83.34%	50%
Telecom International	0	0	0%	0%

*Consistency is the percentage of total respondents using category

Table 3

Model Summary—CATPCA

Model Summary

Dimension	Cronbach's Alpha	Variance Accounted For
		Total (Eigenvalue)
1	.822	4.052
2	.744	3.144
Total	.939 ^a	7.196

a. Total Cronbach's Alpha is based on the total Eigenvalue.

Table 4

Self-organisation measurement—case comparison

	TE (Case 1) N=8	TC (Case 2) N=6	TI (Case 3) N=7
ASO Index	2.06	1.89	2.79
TLCOM	1.5	1.67	3.0
CQCOM	2.61	2.11	2.44

All scores over 3 are 'Inadequate' according to the rating methodology

Figure 1

Patterns in data—Cluster of TE and TC respondents

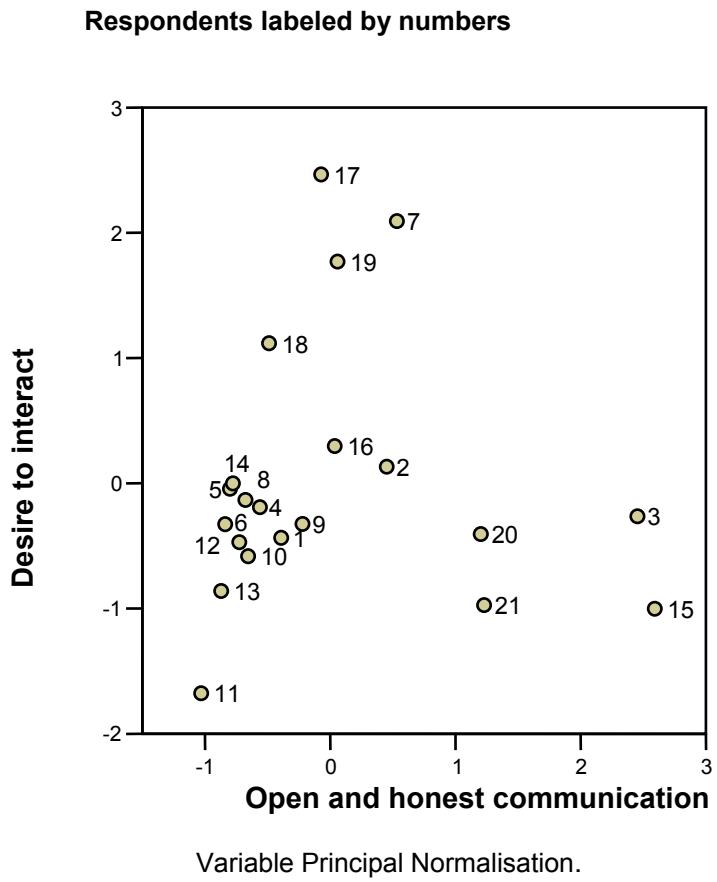


Figure 2

Framework for role of self-organisation in handling adaptive challenges

