The Sustainable Development of Industry Clusters: Emergent Knowledge Networks and Socio Complex Adaptive Systems.

Dr Susu Nousala
Research Fellow
Spatial Information Architecture Laboratory
(SIAL)
RMIT University
Melbourne, Australia

Abstract

In a highly competitive global economy the development of sustainable, innovative responses from Industry is now vital. Many industries globally need to respond rather than react to current economic climate through sustainable (economically and environmentally) development. The steel industry is a critical player in the urban landscape. Like many industries, small, medium enterprises (SMEs) are vital players within the steel industry supply chain. The Australian SME steel housing sector (based in rural and regional areas) are still developing systemic capabilities with the aim of realizing its full potential. The question of an effective sustainable industry is much larger than any one player.

This paper aims to present a proposed methodological approach for sustainable cluster development based on previous industry wide investigations. Through the lens of scalability of a socio complex adaptive system, SME development becomes arguably the most significant player with regards to industry cluster development. By starting with SME development it's possible to build an understanding of a simultaneous two layered approach, "bottom up – top down" whilst including a very diversified group.

1 Introduction

This paper explores the importance of SMEs in particular and their significance in the development of industry clusters through findings from an industry wide investigation of Australian steel housing SMEs and their supply chain.

"SMEs are an important part of the national economies in APEC, and an important part of the international or regional APEC economy. SMEs make up about 99% of enterprises. Estimates of SME contribution to GDP are difficult to obtain for the Asian region, but typically the contribution is somewhere between 30% and 60% of GDP. They employ between 40% and 80% of the workforce. The contribution of SMEs to employment growth is even higher, if contentious; figures for Asia are not available, but in more mature economies and where reasonably reliable studies are available, as much as 70% or more of net employment creation is attributable to SMEs. In Asia, SMEs contribute as much as 35% of direct exports, and the indirect contribution is even higher. The weighted contribution of SME exports to GDP is about 12%, almost double the contribution in OECD economies"(APEC action agenda, Hall).

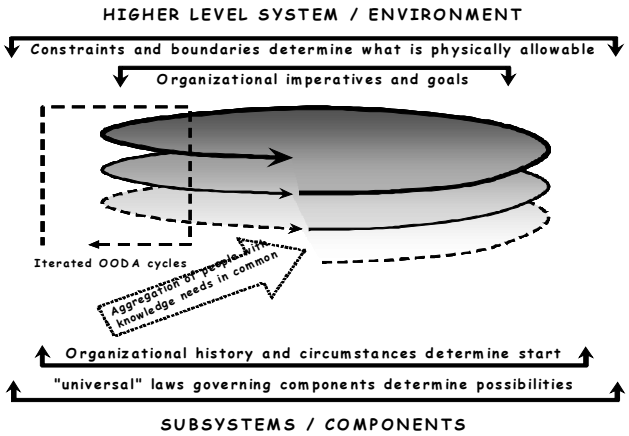
SMEs are defined by the European Commission as independent enterprises that have fewer than 250 employees with an annual turnover not exceeding 40 Euro/£25 million or a balance-sheet total not exceeding 27 Euro/£17 million (European Commission 1996). Many Australian SMEs are much smaller than their European or Asian counterparts and the Australian steel housing SMEs are no exception. Globally, 80% of organizational entities are currently SMEs, making up for a significant proportion of many countries' GDPs (gross domestic product). However, a disproportionate amount of resources have to date been focused on the large companies.

There is a growing need to understand the role of the SME in sustainable organizational, industrial and regional development. Australian steel housing SMEs are isolated with a reliance on geographical distributed supply chains. There is an increasing inter-connectedness between international global markets and their impact on multiple levels of the industrial supply chains. The impact on global supply chains can affect the delivery of goods and services for Australian SMEs and their local markets. There is a pressing need to extend investigation into the interaction and development of local and global issues within and between the steel housing sector, manufacturing and other allied industries (including SME and working divisions of larger firms, and professional industrial associations).

2 Knowledge networks, clusters and complex adaptive systems

Michael Porter and others (Porter 1990; Johnston 2003; Dahl et al., 2005; Paija 2001; Pedersen, 2005) suggest that the interactive dynamics between industrially related organizations within a circumscribed geographic area can help to form an "industry cluster", where the dynamics helps them to substantially improve their international competitiveness compared to organizations working in isolation. According to Porter (1990), "a cluster consists of industries linked through vertical (buyer/supplier) or horizontal (common customers, technology, channels)

relationships." There are key features that include local linkages and formal and informal interactions which share ideas and knowledge. Johnston (2003) lists circumstances that should contribute to cluster formation, including (1) easy exchange of knowledge, information and ideas between firms – especially tacit and informal knowledge, (2) access to generic qualified labour, (3) access to markets, (4) access to new ideas, (5) access to specialized services or facilities and (6) access to highly skilled and specialized staff. In addition to Johnston (2003) list, knowledge exchange pertinent to organizational survival exists on many levels and in different forms (Nelson and Winter 1982; Wenger and Snyder 2000; Nousala et al. 2005; Nousala 2006; Cohendet and Llerena 2001).



The knowledge spiral process (Nousala 2006).

When cluster members do interact effectively, the result is a powerhouse for concurrent innovation, development and marketing that can contribute significantly to the total export success of their host nations (Hall and Nousala 2007). Following research based on a paradigm of organizational emergence and complex adaptive systems (Hall 2005; Hall et al. 2005) there is a need to facilitate established local industry activities into a multi-layered industry cluster capable of addressing emergent issues on a macro and micro level. As such, economic organizations are dynamic, evolving, hierarchically complex adaptive (i.e., biological) entities in their own rights von Krogh and Roos 1995; Hall 2005; Hall et al. 2005).

From a SME perspective, organizations need to build and use knowledge to remain viable in the face of competition and change. Due to the limits of organizations and the bounded rationality of individual people in the organizations it is impossible to make all of the required knowledge accessible in explicit and readily retrievable formats (Goldstein 1999; Nelson and Winter 1982; Polyani 1958; Nonaka, Takeuchi 1995; Nousala 2006). Understanding the impact of tacit knowledge networks is important for two reasons. First, a true intelligent, adaptive system is one which is self sustaining, and second, tacit knowledge networks can support the sustainability of any organization and its networks in both the social and physical sense (Hall and Nousala 2007; Nelson and Winter 1982; Wenger and Snyder 2000; Nousala et al. 2005; Nousala 2006; Cohendet and Llerena 2001, Nousala and Terziovski 2007, Nousala et al 2008). Organizational policy and systemic systems needs to, at the very least, reflect concepts of sustainability through understanding the holistic influences of socially intelligent networks. In relation to the steel housing industry, socially intelligent networks can accommodate the variety of individuals and organizations within an industry cluster, through the lens of scalability of a complex system (Hall and Nousala 2007; Hall 2003; Nousala 2006).

Organizations (SMEs in particular) need to respond fast to solve problems (Boyd 1996). Yet, the rationality of organizational decisions is bounded by limited processing resources and time to identify, access and assemble relevant knowledge (Hall and Nousala 2007). The best decisions the organization can strive for are just good enough (Simon 1955, 1957; Arrow 1974; Else 2004). These are issues which impact SMEs. Although it is possible for people to articulate and document much of what an organization knows, due to time and cost, this is not done. Snowden's (2002) concept that people "always know more than [they] can tell, and ... will always tell more than [they] can write down". Even where the organization holds large bodies of explicit knowledge, personal knowledge may still be required to access and apply it (Hall and Nousala 2007; Cowan et al. 2000; Tsoukas 2005).

3 Information communication technology (ICT) and small medium enterprises (SMEs)

In Australia, the uptake of process improvement with possible information communication technology (ICT) support has increased dramatically towards the later part of the 90's and into the 21st Century. Reports show that in 1993-94 50% of firms used computers with 30% having internet access; by 2000-01 these figures had increased to 85% and 70% respectively (Productivity Commission, 2004).

The implementation of process improvement often takes the form of a business process re-engineering (BPR) project supported by ICT. Without the necessary guidelines a BPR project can prove to be detrimental with approximately 50-70% of BPR exercises failing to achieve the intended results. Crowe et al (2002) put the figure at 80% of projects either failing or suffering major problems. Despite these high failure rates the need to implement ICT is worth the risk given the competitive pressures placed on business to keep pace with technology (Nousala et al 2008; Crowe 2002).

The problem of deciding upon what or how to implement

process improvement is exacerbated when the statistics on BPR projects have not been well documented with regards to SMEs. The productivity Commission (2004) noted that large firms were earlier and stronger in their uptake of process improvement through ICT than smaller firms and cited several reasons for this occurrence such as expected benefits, cost of equipment and the lack of financial ability to bare the risks of early adoption (Nousala et al 2008). Other barriers cited were a shortage of available skills and the price of technology as major reasons why small firms struggle with process improvement through ICT adoption (Nousala et al 2008).

The literature is not clear as to what exact processes SMEs should follow to successfully adopt process improvement within their business processes (Nousala et al 2008). This lack of clarity regarding processes is also true for SMEs in the steel frame industry. Issues such as a reactive or proactive approach by the owner/manager to technology changes and management commitment and perception of benefits are cited as key issues for SMEs (Nousala et al 2008; Martin and Matlay, 2001). However, deciding upon which of the many and rapidly changing technologies available to adopt, given the lack of resources, represents a significant problem for small business. As Martin and Matlay (2001) suggested small firms require clear external guidelines for evaluating ICT possibilities.

Lee and Chuah (2001, p 688) stated that, "*In order to ensure selection of the appropriate improvement strategy or approach, much time and effort is needed to understand the underlying concept, methodology and impact of each approach*". Furthermore, they argued that the literature failed to provide adequate guidance on how to effectively follow these steps (Nousala et al 2008). Crowe et al (2002) posited that there exists a need to have a quantitative risk assessment tool to aid in BPR projects to compensate for the high failure rate. The development and testing of an industry specific methodology and available toolbox would represent a step towards providing SMEs in the steel housing industry with the necessary information, methodological approaches and the available industry specific tools to successfully prioritise and implement their sustainable business processes.

4 The significant problem of successful industry clustering

Understanding the development, movement and impact of these supply chains as industry clusters within complex systems, facilitates the tracking of activities and their impact through the lens of scalability. There is a lack of critical understanding regarding the significant practical impact for creating effective industry based sustainable systems which impact regional SMEs, mid to large organizations, cities, regions and countries. The development of successful industry clustering combines local, regional and national elements.

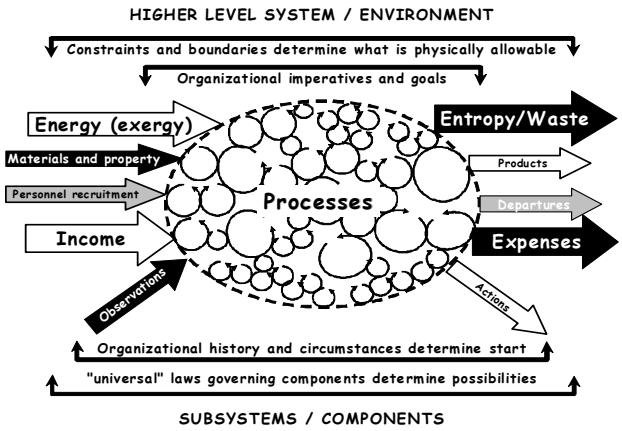
The organizations involved in this research were a very diversified collective from the steel industry. The research focused on two different aspects;

a. short term investigation into common issues and possible solutions.

b. long term, how this diverse group can form the basis of an industry platform for continuous improvement on all levels.

By focusing on the traditionally difficult target group "the SMEs" it was possible to initiate the beginnings of an emergent process from a grass roots approach, to facilitate identification and development of an industry wide collective methodology. Investigation and documentation of this methodology could yield new methods and applications, i.e a socio-technical approach.

Conducting an industry wide comparative analysis via socio-technical means (using ICT tools and applying social/biological methodologies) determines sustainable approaches for individual organizations, industries and their regions. Improvements via long term bottom up approaches (requires longitudinal thinking for implementation time lines) create efficiencies that support and under pin sustainability for organizations and their immediate urban environments.



Structure of an autopoietic organization. (Hall, Dalmaris and Nousala 2005).

This illustration shows some of the major functional subsystems that would be found in a medium sized autopoietic organization. The processes evolving and emerging at differing rates need to be viewed holistically through a longitudinal approach.

5 The significant problem of successful industry clustering

Since many industries and their supply chains in Australia have been built upon a SME base, reliance on traditional top down approaches for investigation into strategies for innovative insights, transformation and the like have been

less than successful. This is mainly due to the difficulty for SMEs to find resources to be noted on an individual level, so many resort to seeking (within their supply chains) access for collaborative approaches to tackle industry wide issues (ICIP, Industry Cooperative Innovation Program 2006). The Australian Review of the National Innovation System Report, Recommendation 3.3 of the Review (Cutler & Company, 2008), highlighted the crucial importance of new connections and clusters for the competitive advantage of firms in knowledge based economies. The report emphasised the importance of collaboration amongst SMEs and with research providers; in fact, the term "collaboration" appears repeatedly in the report.

Collaborative approaches have now been recognized (Innovation policy 2008; Productivity commission 2007) as desirable the development of methodology and SME collaboration through industry clustering is widely attempted and understood. However, the development of successful clusters remains some what elusive (Hall and Nousala 2007). The possibility of enhancing industry capacity and capability through collaborative clustering via SME the level is innovative. This break from the traditional top down approach enhances the capability of the entire supply chain simultaneously and begins with the SME as an individual entity.

Developing the foundations of sustainability on all levels is vital. Within the steel housing industry sector, the ground level fundamentals in the current fiercely competitive environment are to qualify and win more contracts (increasing revenue), perform better on contracts won (improve rate of investment, ROI), continue to satisfy customers, manage and mitigate risks, comply with regulations, respond to community and environmental standards, and in some cases, increase shareholder value.

Until recently skills shortage and training were significant considerations, both for the individual organizations and the industry as a whole. The current economic landscape is now contributing to fluctuating employment, add to this the normal project cycles and the difficulty to build and/or retain specific skill sets within any organization (regardless of size), the impact collectively is serious. Without collaborative networks to help transfer and retain skills and project know-how, competing successfully becomes increasingly difficult.

An organization seeking to improve its performance needs to ensure (1) people in the organization who need particular knowledge to deal with an emerging issues can quickly identify and find those who may be able to access the kind and quality of knowledge sought, and (2) that this knowledge will be readily transferred or made available by those who have it to those who need it (Hall and Nousala 2007;Nelson and Winter 1982; Nousala et al 2005).

The research was conducted on two levels (simultaneously). Firstly, there was a qualitative analysis were processes for the individual organizations were analyzed on a day to day functional /organizational (level 1). There was a need for individual systemic systems issues to be comparatively identified and analyzed to address the 'gaps' in the full range of SME organizational systemic activities. Secondly, the foundations of an industry wide platform (level 2) was developed through partner organizations involvement where the partner organizations' needs were identified and analyzed for application of a common approach to the steel housing industry and supply chain.

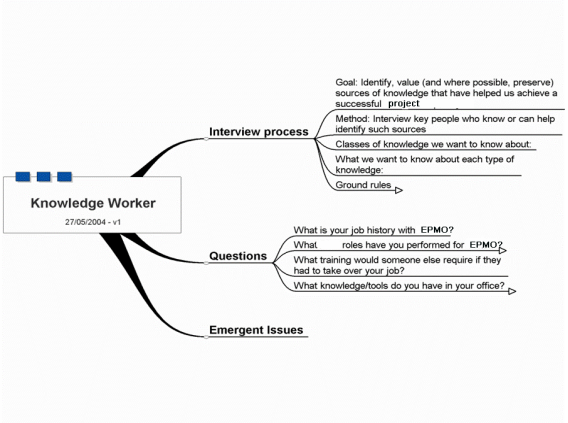
The methodological approach for this research focused on the development of the individual and collective experiences of the organizations as follows;

Level 1: Each partner organization was represented through qualitative surveys, multiple site visits and case studies approach. Initially, an extensive literature review was conducted of the systems, regulations, standards and structures both people and ICT based systems was carried out by the research team.

An embedded researcher carried out work for each case study with an organization for a set period and rotated between the partner organization, collecting data to provide in-depth (predominantly quantitative) analysis regarding explicit information systems. The organizations involved were crucial as they provided the basis for a comparative analysis/audit of the full range and depth of physical information systems for SMEs in their respective industry, as well as their placement as an entity within the supply chain.

Level 2: A series of semi-structured interviews was conducted with and between a core group of organizations within the industry (analysis and the early stage supported by a mapping tool e.g., mind manager) facilitating the different stages of data collection, analysis and presentation of the vast amounts of information gathered.

Example of interview structure;



6 Research Outcomes

Over all, there is an understanding amongst individual SMEs (through out the supply chain) that their knowledge and interactive business experience with their business systems is not only valuable, but is the foundation for the "organizational business memory". However, there is less understanding regarding what systems need to be in place or need to be developed to ensure continuous and sustainable practices for business survival and/or growth.

There was overall understanding that the development of a collective industry "platform" (the beginnings of industry clustering) provides acceptable standardized base-lines from which individual businesses could develop company differentiation and not weaken their competitive advantage as many think.

ICT was an area where improvement had not occurred in a consistent or cohesive manner between staff or "people" development and systems development, which meant that continuous improvement was more difficult to achieve. These issues were regarded as system interoperability issues within business areas causing incoherence throughout the business process.

The facilitation of a collective industry group was seen as a way to continuously investigate common issues by providing solutions through identifying common barriers for SMEs specifically. The facilitation of a collective industry group would also develop an industry platform for innovative applied solutions for future collective R & D whilst encouraging a multi-layered approach applicable to all members in a supply chain. Finally a collective approach would also facilitate capacity building and dissemination within and between SMEs working within local communities through to large industry members capable of a larger national impact.

There was an understanding that the provision of an initial self assessment in the form of an on-line tool with methodological steps would assist with the bottom up approach (in modules with descriptions of methods). The tools and methods need to be available to each organization within the industry specifically targeting SMEs.

7 Conclusions

The methodological approach for level 1 and level 2 is one that provided an in-depth analysis on multiple levels (Nousala et al 2008). The combination of the two level approach allowed for emergent findings that focused on explicit information (ICT) systems in relation to SMEs specifically, providing organizational understandings of key "people systems" and how these two systems interacted.

This research area is a significant and an emergent field of social complex adaptive systems (socio-technical) focusing on the implementation of processes involved in this multi-disciplinary field. The skill set required is considerable due to the embedded practice approach within each organization. This approach includes social science, process and management engineering and theoretical comprehension with a combination of a practical applied outcome. These are not common skills sets and no real formal training exists, yet the need for such combinations is known (Hall and Nousala 2007). This type of applied research requires a multi-disciplinary and trans-disciplinary environment to established networks and relationships.

8 Future Research

Future research will include the development of a multi-case study comparative analysis using the in-depth semi structured surveys and focus group interviews to collect individual details by focusing on commonalities in the interviews and on overt behaviours seen in the organizations day-to-day interactions and between the organizations that would help identify any emergent organizational phenomena. There maybe the possibility of tracking knowledge networks with a view to identifying common descriptors or elements suggested by the literature and thus provide the basis for an analytical approach.

Further future analysis could also include testing for a pilot for industry (and other allied industry) wide usage. SMEs would have the opportunity to improve their manufacturing processes themselves at their own pace, without engaging expensive consultants, and with the aim to also reduce the costs and risks of business and working processes by making intelligent manufacturing systems solutions accessible to most SMEs.

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(Note: all URLs valid as at 18 Dec 2008)

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