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THE EMERGENCE OF SUPPLY CHAIN ECO-SYSTEMS A SOCIAL NETWORK ANALYSIS (SNA) PERSPECTIVE

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INTRODUCTION

So-called Developed Economies are characterised, if not defined by, specialisation. Indeed the principle of specialisation is evident from the moment one moves from subsistence activity and begins to specialise in an area of comparative advantage. Thus specialisation is fundamental to the evolution of supply chains. We consider the supply chain as a network of specialist actors that interact to deliver goods and services to end-consumers.

The 'eco-system' analogy has become increasingly popular over recent years as scholars have studied the impact of specialisation and in particular various interdependencies that emerge (Dervitsiotis, 2008; Simichi-Levi, *et al.* 2008). Social Network Analysis (SNA) is a dynamic approach that focuses attention on network interdependencies and emphasises the impact of network design on firm competitiveness. However, little attention has been given to the use of SNA in supply chain analysis, with some exceptions such as Lazzarini, *et al.* (2001). The aim of this paper is to investigate the usefulness of SNA in supply chain analysis. The paper is set out as follows: firstly, given that SNA is a new approach for many of us in the SCM field, we provide a brief introduction to SNA; secondly, we present the SNA research design that informed our study; building on this we outline our methodology in the next section; this is followed by a section on findings, these are illustrative of the use of SNA in providing insight into the rather intangible nature of supply chain network relations; and, finally we put forward some conclusions and highlight limitations of our study.

SOCIAL NETWORK ANALYSIS

Social Network Analysis (SNA) is a relatively new, but rapidly growing, field in sociological and economic research. Although its precursors may be traced to Simmel's studies of dyads and triads (Simmel, 1908), it has come to prominence and wide utility only since the 1980's with the advent of powerful computational and computer visualization techniques. This software enables us to develop, analyse and compare quantitative descriptors and visual depictions of the network structures created by social and economic interaction. Most significantly Social Network Analysis provides a "fundamentally different perspective" (Marin and Wellman, 2010) on socio-economic activity, because it is concerned both with a different type of data – relational data – and because it considers the resulting structures and sub-structures (what Simmel called "forms") as the "primary building blocks of the social world" (Marin and Wellman 2010).

Excellent field surveys, together with detailed accounts of techniques and applications, can be found for example in the books by Scott (Scott, 2000) and Wasserman and Faust (Wasserman and Faust, 1994), the collections edited by Carrington *et al.* (Carrington, Scott, and Wasserman 2005; Carrington and Scott 2010), and the journal edition edited by Van Duijn and Vermunt (2006).

Lazzarini, *et al.* (2001) suggest that one way to integrate Supply Chain Analysis (SCA) and SNA is to consider simultaneously all type of interdependencies that occur in a given inter-organisational setting. They identify three categories of interdependencies: (a) pooled interdependencies involve discrete or autonomous contributions by loosely

coupled actors; (b) sequential interdependencies such as supply chain vertical linkages and associated buyer-seller interdependencies; and (c) reciprocal interdependencies meaning that one actor's input is another actor's output, these actors generally are tightly coupled in that the knowledge of one strongly depends on the knowledge of another.

RESEARCH DESIGN FOR SOCIAL NETWORK ANALYSIS

Five key elements are evident in research design for Social Network Analysis: the choice of sampling units; the form of relations; the relational content; the level of data analysis; and the network boundary (Knoke and Kuklinski 1996:14).

The sampling unit refers both to the "higher-level system whose network is to be investigated" and also "one or more lower-level units" that constitute the nodes or actors in the network. In our case we selected one business networks within a particular rural area, with firms (including: first tier suppliers, manufacturers, retailers and service providers) as nodes.

Knoke & Kuklinski (1996) distinguish between "relational content" and "relational form". Content is the nature of the relationship, e.g. supplier, customer, advisor; and form captures properties of the relations between pairs of actors e.g. frequency, value, reciprocation. They note that the relational content that the researcher chooses to study is usually based on theoretical considerations, and also that each relational content can be viewed as determining a separate network, although some studies may consider multiple types of relations (a "multiplex network"). Within their "typology of relational content" we are interested primarily in "transaction relations" and "communication relations", while acknowledging that there may also be "embedding" in, for example, "sentiment" or "kinship" relations.

The "level of analysis" describes the type of network study: egocentric, dyadic; triadic or complete. We use both "ego" and "complete" network analyses. We note that visual depictions of such networks have long been used in geographic studies to show the spatial structure of trade networks (e.g. Braudel 1982) and, more recently, GIS-based representations of the spatial dimension of these networks have become almost a commonplace.

The nature of such position or patterns of relations can be summarised by analytic measures that range from simple measures of overall network density, to measures of an actor's centrality (or conversely, peripherality) and on to structural measures of subgroups ("cliques"), and comparative measures of structural equivalence in sub-networks or between networks.

Boundary specification is a defining issue for any empirical network research. An influential paper on this topic by Laumann et al (1983) distinguished between a *realist* specification in which the researcher accepts the network boundaries experienced by the actors in the network, and a *nominalist* specification in which the closure of the network is imposed by the researcher's theoretical framework.

In our research we take a position that is something of a hybrid between these two. In general, because at the highest level of our study we are interested in phenomena at the "area" and "sectoral" level, we adopt *nominalist* boundary specifications, i.e. we confine our networks to a geographic area and to a business sector. We do not, however, seek to identify all or a "representative sample" of businesses in that sector or geographic area and to then uncover their network ties. Rather we select an initial set of actors, using qualitative "purposive sampling". We then use Doreian and Woodward's (1992)

"expanding-selection" method of data-collection - which results in a "realist" boundary-specification. Thus we terminate our traversal of the emerging network when we encounter an actor who is located outside the geographic area or an economic sector on which we have not focussed, but our network comprises a set of actors who are reachable from that initially chosen set. Thus our "network" will most likely be a subset of all the actors that would meet the nominalist criteria. Consequently we have aspects of an "outside view" through the "nominalist" boundary specification, and something of an "inside view" through the expanding-selection method of data-collection. In addition, we have incorporated the notion of the network as a socially-constructed, rather than objectively-specified, entity.

METHODOLOGY

Social Network Analysis has been perceived generally as a quantitative methodology - although not necessarily "positivist" in approach (Hollstein 2008; Hollstein & Straus 2006; Heath et al. 2009). But there is also a long-standing empirical tradition of combining both qualitative and quantitative methods in network research (Scott 2000; Crossley et al. 2009), sufficiently marked in fact that it could be argued that the combination of methodologies is in fact the dominant tradition in most practical applications of Social Network Analysis. The development of a theoretical orientation towards mixing qualitative and quantitative approaches to Social Network Analysis has happened however only in very recent years (Crossley et al. 2009; Edwards & Crossley 2009; Edwards 2010).

Adopting the sampling procedure as outlined above, we applied SNA techniques to investigate the emergence and behaviour of SME (Small & Medium-scale Enterprise) dominated supply chain networks within a defined geography. Hence we focused on the impact of local embeddedness of such networks. In designing survey instruments for interviews, we follow Johnson & Turner's (2002) description for what they call "inter-method mixing" using an Interview Guide combined with a "Quantitative Interview". We use the Quantitative Interview primarily to gather quantitative network and relational information for SNA. We follow that with a traditional semi-structured interview in which we collect (network-oriented) qualitative data. We use two SNA software packages, Ucinet (Borgatti, *et al.*, 2002) and Pajek (de Nooy and Vladimir, 2005).

FINDINGS

The study area, West Cork, Ireland, is characterised by a high density of food SMEs. Given this density we were interested in the role played, if any, by locally embedded networks, vertically, horizontally and 'diagonally' along the supply chain. We conducted interviews with 14 enterprises following the sampling procedure as outlined under methodology above. This provided a rich dataset organised around 'network relations' as the themes we were interested in were 'network centric'. Thus, for example, we were not interested in why a respondent was an entrepreneur but we were interested in why a respondent took actions to position his/her business better, to make a wider circle of connections or to seek new sources of knowledge. In particular, we were interested in network connections that were 'of importance to the business'. A number of interesting findings emerged that support the notion of eco-systems, these include: local network knowledge, role of customers in establishing reputation and extended supply chains.

Vertical Linkages

When investigating the importance of vertical supply chain linkages from the enterprise's perspective we find that 'importance' is often not associated with level of sales or even profitability. Rather it is the nature of the relations in terms of reputation, referrals and even association with the region. For example, one enterprise rated a local retail outlet among her top three customers, however further investigation revealed that sales through this outlet were very small compared to most other customers. This is particularly striking when compared with the other two 'important customers' identified, one of which is a leading speciality food retail outlet in London and the other of similar standing in Dublin.

The reason for the high rating was due to the impact that this local outlet had on the 'spatially extended short supply chain'. West Cork is popular with tourists who frequent the retail outlet and purchase the product. On return to their home county/country they continue to buy the product on-line. In the respondent's (R15) words: "*So that's been incredibly important - and that was very important from the beginning - the fact that there were so many people with holiday homes who would come here on holiday and you'd just bump into them, you know, you'd bump into them in [the local shop or they'd buy your products and ring and say "Do you ship?"*" The concept of the 'spatially extended short supply chain' was popularised by Marsden et al (2000; 2002) and Renting et al (2003).

They considered these chains short in that the product although transported over some distance is "embedded with value-laden information when it reaches the consumer ... [and] this enables the consumer to make connections with the place/space of production and, potentially, with the values of the people involved and production methods employed" (Renting et al 2003:400).

They confined their definition to customer who had never visited the region and illustrate with examples such as well-known regional specialities like Champagne wine or Parmigiano Reggiano cheese and also 'fair trade' food and beverage products. We find similar examples within our network, but these customers in many cases have visited the region and found the products in local retail and food service outlets (proximate supply chains). In this way we find an interesting interplay between 'spatially proximate short supply chains' and 'spatially extended supply chains'.

Thus the use of SNA mapping and associated qualitative data provides a useful insight into vertical linkages along the chain. This reasoning for identifying 'important customer linkages' (i.e. reasons other than sales, such as new product development/introduction, market feedback, retail reputation) is borne out by most enterprises that identify at least one of two local stores as among their top three customers. Figure 1 illustrates a segment of the SNA map with these two local retailers circled on the right-hand side.

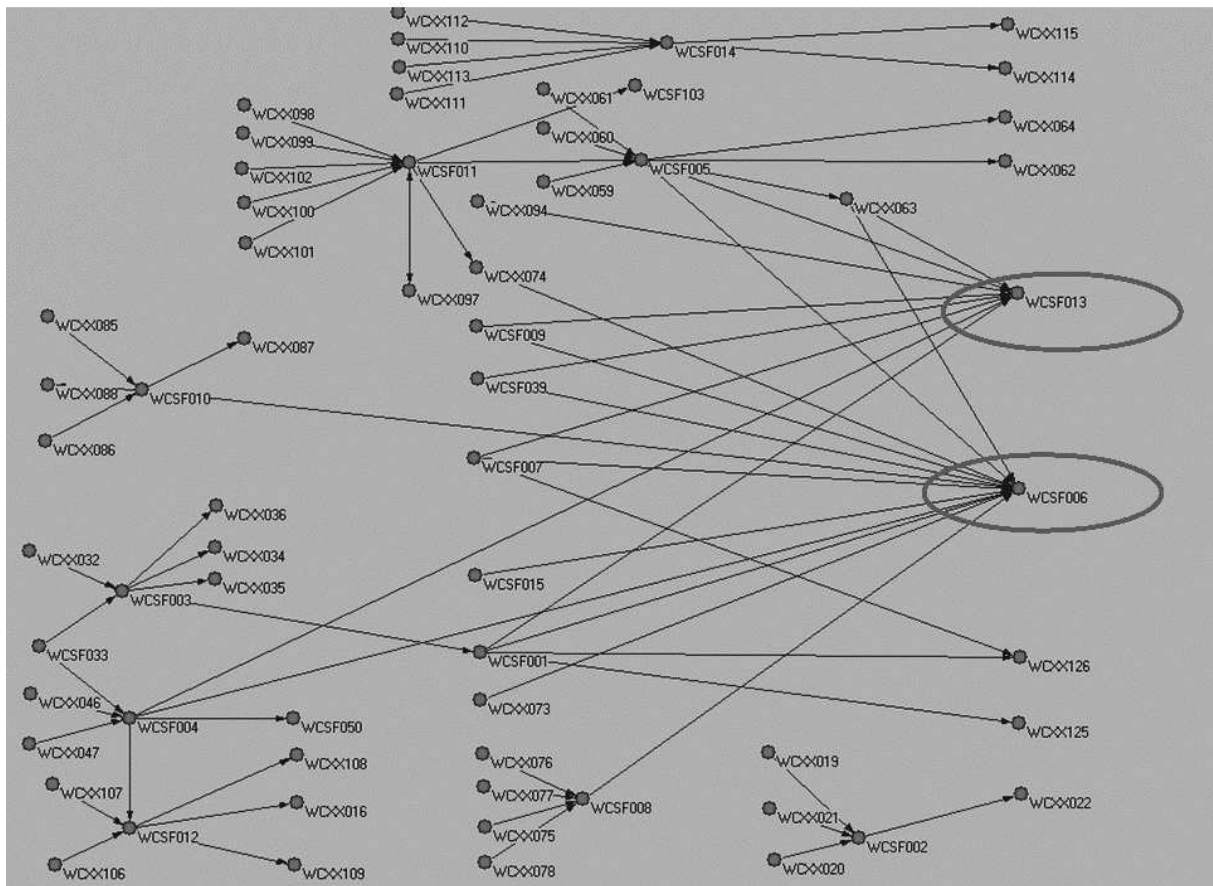


Figure 1: Importance vertical linkages

Horizontal and Diagonal Linkages

Given the findings above, it is no surprise that when measuring centrality these retailers were found to be at the centre of the map. Centrality mapping also identified other interesting linkages which support the notion of eco-systems embedded in local knowledge networks. For example, an enterprise (R10) recently established in the region had initially relied on contacts from outside the local network. However, in recent times he has established horizontal linkages with other enterprises in the area and these have become important sources of knowledge: *"Oh I would certainly ... I visit the odd market when I'm around the place, and I take a stand down at a market with other food producers. And then through the networking events organized by the Cork Chamber [of Commerce] or the West Cork Enterprise Board - I'd meet them there, and we put together an informal group last year, with two or three other food producers, and we've actually made a few group purchases for ingredients - things like that, and traded packing insight and contacts."*

In addition to vertical and horizontal links, we investigated what is commonly termed 'diagonal linkages'. These are linkages with various service providers. The interplay between the density of food SMEs in the region and the number specialist service providers is of particular interest since we hypothesised that increasing specialisation resulted in the increasing importance of 'supply chain eco-systems'. However, other than linkages with public enterprise support agencies, we find that the role of vertical and horizontal linkages of greater importance to the success of these SMEs. This may be due to the small size of the firms and hence their level of expenditure on specialist services is somewhat limited. The level of horizontal interaction resembles that of the

industrial districts and SME clusters that were first identified in the 1980s and popularised by scholars such as: Brusco (1996), Enright (1998), Kristensen (1992) and Pyke (1992). Indeed there are interesting parallels between this literature and recent interest in 'eco-systems'.

Interdependencies – pooled, sequential and reciprocal

It is interesting to find that the vertical interdependencies found among those with 'important linkages' are more pooled and reciprocal in nature than sequential. One might initially expect to find sequential type interdependencies important as these typify supply chain links, but in fact we find that reciprocal type interactions are more evident since it is these interactions that have broadened and deepened knowledge and skills, for example in areas such as: market information, customer contacts, and product development (Gulati and Singh, 1998; Lazzarini, *et al.* 2001.). We can return to our recently established business (R10) to illustrate. When this respondent's rationale for selecting his 'three top customers' was queried we discovered his largest customer was not included. When asked why this customer was not included in his 'top three' he responded: "*they are an important customer for sales revenue, but I just sell to them, it is just a transaction*". Whereas his interaction with his 'top customers' was much more reciprocal and this informed his thinking and improved business strategy and operations. Much of this information is tacit and leads to 'transformations' whereas sales and delivery processes are by nature more transactional and tend to be quickly codified.

We also found both pooled and reciprocal interdependencies along horizontal linkages. Figure 2 illustrates the emergence of a strong clique (bottom grouping) based primarily on horizontal linkages⁶. Some of the other linkages that members of this group have with other actors are shown in the top right hand corner (these are primarily first tier suppliers) and two 'enterprise outliers' are in the top left hand corner.

Thus we find that SNA coupled with qualitative data provides a good insight into the interplay of different forms of proximity: spatial, organizational and relational; and into the relative importance of codified and tacit knowledge in creating competitive advantage. In addition, we observed a clear distinction between means used to establish relationships and those used to maintain them.

⁶ It is interesting that the 'two local retailer' identified earlier are also member of this clique since they behave as co-producers.

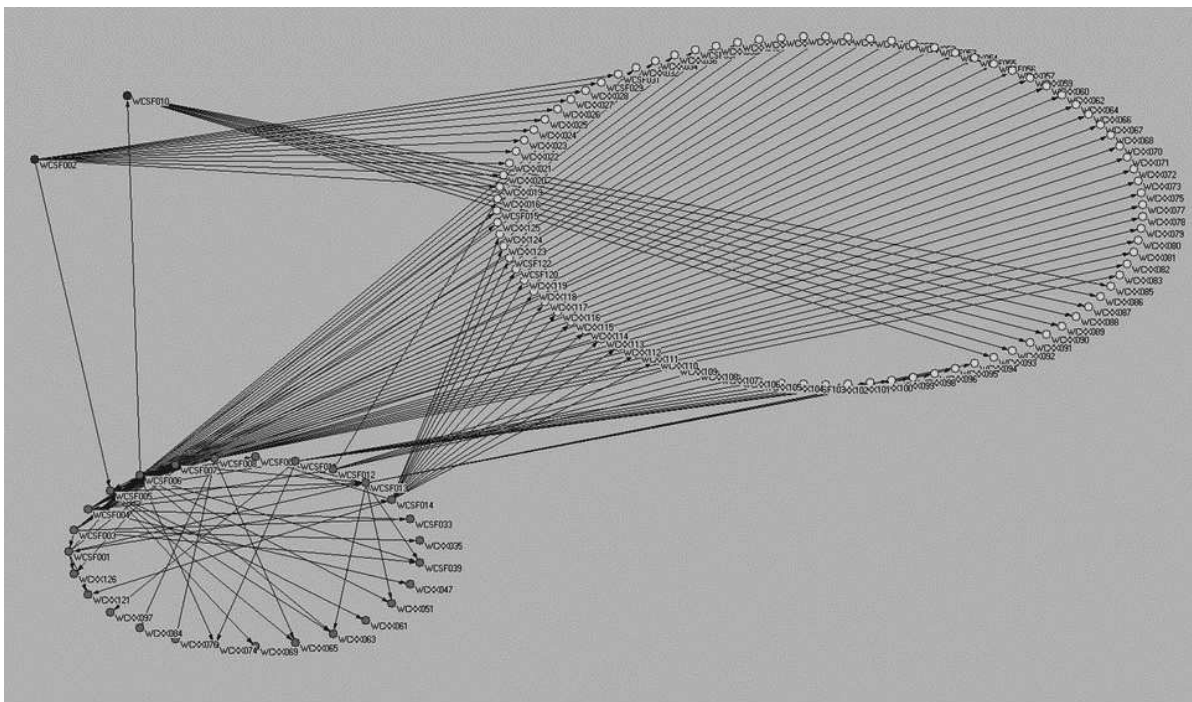


Figure 2: Horizontal linkages – An Enterprise Clique

In summary, our findings support the argument that the networks are neither exogenously determined nor static. Rather they are “snapshots” in time that are created (and modified) by the agency of the actors within the network – oftentimes guided by or constrained by the network position in which those actors find themselves at that particular point in time. Thus our networks are socially constructed.

CONCLUSIONS

Our intent was to collect complementary data and to use the results from each method in turn to guide further iterations with that and/or the alternate method. Thus a finding from SNA that a group of actors form a subgroup or “clique” would cause us to examine the qualitative data (or collect more) to determine possible explanations for this. One important reason for doing this is that SNA can be overly mechanistic, and results may be misleading or simply hard to interpret without sound theoretical and empirical understanding of the network structure being studied and also of details of the survey methods adopted. This approach provided a useful insight into network establishment and evolution. In particular, this approach allows us to incorporate social processes of both structure and agency (Kelle 2001): making clear, for example, that relations are conceptual and cognitive entities; that actors actively construct the network; that the network serves as a resource to actors; and conversely that their actions are shaped by the structure of the network.

Our application of SNA techniques is limited to a study of SME dominated supply networks. Furthermore, our focus on local embeddedness ignores the increasing importance of global interactions along supply networks. However, within the limited scope of our study we find the use of mixed methods, including SNA techniques, offers a useful analytical approach to the study of what has often been considered a rather intangible phenomenon. In particular, we find SNA techniques, such as subgroup/cliques and centrality measures, useful in studying emerging supply network ‘ecosystems’. While this initial work offers promise further application of these techniques to a wider range of supply networks, including those involving larger scale organisations and wider spatial boundaries, is required.

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