Routledge
Taylor & Francis Group

Construction Management and Economics

ISSN: 0144-6193 (Print) 1466-433X (Online) Journal homepage: https://www.tandfonline.com/loi/rcme20

Towards a social network theory of project governance

Stephen D. Pryke

To cite this article: Stephen D. Pryke (2005) Towards a social network theory of project governance, Construction Management and Economics, 23:9, 927-939, DOI: 10.1080/01446190500184196

To link to this article: https://doi.org/10.1080/01446190500184196

Construction Management and Economics (November 2005) **23**, 927–939

Towards a social network theory of project governance

STEPHEN D. PRYKE*

Bartlett School of Graduate Studies, University College London, Torrington Place Site, Gower Street, London WC1E 6BT, UK

Received 9 June 2004; accepted 21 March 2005

The findings of a study are presented using social network analysis in an innovative application involving the analysis of construction project governance. The rationale supporting the application of social network analysis (SNA) within the construction project coalition context was published by this author in a previous paper in this journal. The rationale is summarised in order to explore a very specific framework for the examination of the governance of construction coalitions. The significance of the analytical approach proposed relates to the weakness in existing analytical methods, particularly in relation to changes in approach to procurement following the publication of the Latham and Egan reports.

The research framework relates to the key functions of the coalitions to SNA. Within the framework of these key functions, network density and actor point centrality data are gathered using a form of linear responsibility analysis chart adapted to assemble network data in node list form for input in UCINET 6, SNA analysis and visualisation software. Analysis of the directional, non-trivial, valued and multivariate network data reveals that the study of comparative network density and project actor related point centrality is effective in providing an understanding of a number of characteristics of *new procurement*. Specifically, we can study and evaluate quantitatively, possibly for the first time: use and relevance of financial incentives in the governance of projects; emergent and redundant project actor roles; movement away from traditional independent financial management roles within projects adopting a supply chain management (SCM) approach; alternative candidates for the role of manager of the supply chain and their relative levels of engagement and effectiveness; the effects that the use of clusters and SCM have upon post-contract production activities; the effects that partnering arrangements and standardisation of design have upon transaction costs during the production phase; the effects on project governance of a reduced reliance on contract for project governance; and characteristics of the relatively new role of cluster leader. The results of the research are presented here principally in tabulated form and involve network density values for contractual, performance incentive and information exchange networks. Centrality values relate to the prominence of the key project actors within the three main types of network identified above.

Keywords: Governance, procurement, project management, social network analysis (SNA), intra-coalition networks

Introduction

Pryke (2004a) established the importance of the use of social network analysis (SNA) as a methodology in the analysis of the relationships that comprise the construction project coalition. This importance is partly related to Nohria and Eccles' (1992, p. 4) five reasons for taking a network perspective, which (in summary) comprise:

- All organisations are social networks and therefore need to be analysed in terms of networks of relationships.
- Organisations operate in environments comprising networks of other organisations.
- Difficulty in seeing overall patterns of relationships by looking at one organisation due to 'multiple, complex, overlapping webs of relationships'.
- Actions of actors in organisations can best be explained in terms of their position within networks of relationships.

* E-mail: s.pryke@ucl.ac.uk

Construction Management and Economics
ISSN 0144-6193 print/ISSN 1466-433X online © 2005 Taylor & Francis
http://www.tandf.co.uk/journals
DOI: 10.1080/01446190500184196

- The comparative analysis of organisations must take into account their network characteristics.

Specifically, it was posited (Pryke, 2004a) that SNA point centrality values for project actors within the project principal function networks, provide quantitative data, as well as accessible graphical representations of the changes in roles and relationships arising out of the implementation of *new procurement*[1] in the UK construction industry. The principal functions of design and specification, management of progress and financial management are dealt with in more detail below.

Pryke (2004a,b) identifies a number of shortfalls within existing analytical methods applied to construction project activity. In summary, task dependency, structural analysis and process mapping approaches currently in use have the following limitations:

- *Interdependence*—although existing methodologies can accommodate interdependent activities, none of them provide any information about the nature of these interdependencies. These interdependencies are regarded as fundamentally important in the understanding of transitions in intra-coalition behaviour.
- *Level of detail*—existing methodology is frequently focused upon individual site tasks or decisions. This level of detail is inappropriate when studying changes in governance trends for major construction projects.
- *Quantification of data*—this is not possible using traditional forms of analysis.
- *Iterative and interactive nature of coalition functions*—these aspects of intra–coalition activity are not readily represented by traditional analytical methods.
- *Assumptions about hierarchy*—traditional structural analysis reflects assumptions about status within coalition relationships that are increasingly redundant.
- *Complex relationships*—traditionally, construction relationships have been portrayed as dyadic, particularly those relating to contract or formal authority relationships. Creative and problem-solving exchange networks are more complex and hence non-dyadic.
- *Volumes and routes of information flow*—Winch (2003) conceptualised the project as an information flow system. Understanding the configurations and effectiveness of these flows is fundamental to understanding the effectiveness of project management systems. Yet current methodologies are ineffective in analysing this type of data.

An alternative analytical approach

Pryke (2004a) proposed that the construction project coalition be conceptualised as a network of relationships, classified according to the principal project coalition functions. These principal functions were identified as:

- Design and specification
- Management of progress
- Management of cost

The methodology was applied to four UK construction projects, details being given below. The activity within each of these intra-coalition networks was modelled using information exchange network characteristics and the governance of these networks was observed by gathering data relating to contractual relationships and performance incentive arrangements between coalition members.

The data were gathered using the framework outlined above and employing social network analysis for the purpose of analysis. Social network analysis (SNA) is based upon Graph Theory (Scott, 1992, p. 7) and represents organisational groupings as systems of nodes linked to each other by a specified relationships type. These relational ties can take a number of forms (see Wasserman and Faust, 1994; Pryke, 2002, 2004a); critically, the SNA approach to the analysis of construction coalitions enables a number of different types of relationship within a given network (in our case project coalition) to be analysed using a single, common analytical method. The various data are presented in a form which makes comparison between different types of network possible. In this way we may gather data about contractual relationships and design information exchange and compare the networks, for example, in relation to the prominence of key actors within those networks. This enables changes in roles and relationships with the project coalition to be effectively quantified and represented mathematically and graphically.

Why social network analysis?

Nohria and Eccles (1992, p. 4) provide five basic reasons for taking a network perspective. Those applicable to our project coalitions are summarised as follows:

- All organisations are social networks and therefore need to be addressed and analysed in terms of a set of nodes linked by social relationships.
- The environment in which an organisation operates might be viewed as a network of other organisations.

- Organisations are suspended in multiple, complex, overlapping webs of relationships and we are unlikely to see the overall pattern from the point of view of one organisation.
- Actions, as well as attitudes and behaviour of actors in organisations, can best be explained in terms of their position within networks of relationships.
- The comparative analysis of organisations must take into account their network characteristics.

Pryke (2004a) dealt with some of the key terms used within SNA and dealt with the choice of point centrality as the focus for the analysis of the project coalition networks. Point centrality provides a measure of the prominence of a given actor within a network. Prominence is similar, as a concept, to power and can be associated with negative as well as positive influences upon the network of actors with which a central actor is associated. Since the research sought to make useful comparisons between contractual relationships and a range of other intra–coalition relationships, the actors were identified as firms, rather than individuals.

Major reviews of the construction industry led by Latham (1994) and Egan (DETR, 1998) have precipitated a process of radical change in the management of building production. It has been argued that traditional methodologies for organisational analysis are ineffective, particularly where changes in project management and governance strategies have been changed fundamentally. SNA has been proposed as an alternative methodology. The following proposition is provided as a link to the formulation of a social network theory of project governance.

Proposition

Intra-coalition relationships in construction projects can be represented as a multi-layer of interdependent networks. These networks can be categorised as:

- networks of contractual relationships
- networks of performance incentives
- networks of information exchange, subclassified into:
  - client requirements
  - design activities
  - progress management
  - financial management

Point centrality values for project actors within the principal function networks provide quantitative prominence data, as well as accessible graphical representations of the changes in project actor roles and relationships.

Furthermore, the comparison of information exchange point centrality data for a given actor, with point centrality data for that actor's position within both contract and performance incentives networks, will enable classification of construction project governance, as well as providing quantitative data about the effectiveness of the procurement approach in changing actor roles and relationships.

Network case studies

The case studies comprised four UK construction projects. Two of the case studies, the Essex project and the Uxbridge project, involved traditional approaches to procurement. Both projects involved separate design and production actors; both projects had an absence of partnering, supply chain management or technology clusters within the procurement and project management strategies. These two projects involve both public and private sectors. They comprise the 'controls' for the two case studies involving *new procurement*. Space permits only a very brief outline of the four case studies. For further details refer to Pryke (2002).

The two *new procurement* projects were selected on the basis that they both involved innovation in procurement and project management and there was evidence[2] to support this.

The Aldershot project was one of two Prime Contracting demonstration projects under the terms of the Department of the Environment Building Down Barriers initiative; the Prime Contracting project team had employed partnering, supply chain management and technology clusters principles. Details of the project and the approach to project procurement and management are dealt with in Holti *et al.* (2000).

The final case study in Slough was put forward by one of the UK's largest property development companies; an organisation whose staff and management board have contributed to both the Latham (1994) and Egan (DETR, 1998) reports. This project provided the second *new procurement* related project; evidence of partnering, supply chain management and technology clusters were established prior to the commencement of data gathering.

Tables 1 and 2 provide an outline of some key performance characteristics of the four case study projects. The average team size per role (or the average number of staff involved in the project per firm or organisation involved) is calculated as follows:

$$\text{Average team size}(A_V TS) = \frac{\text{No. nodes structural}}{\text{No. nodes interpersonal}}$$

The data contained in the Tables 1 and 2 provide

Table 1 Case study project characteristics

	Approx. project value at April 2004 index	Gross floor area	Cost £/m^2 at April 2004 index	Programme	£/week prog. at April 2004	No. storey
Essex project (public/ traditional)	£11.11M	5500	£2020	110 weeks	£101K	3
Uxbridge project (private/traditional)	£13.13M	6500	£2020	85 weeks	£155K	3
Slough project (private/ innovative)	£7.07M	6200	£1140	52 weeks	£136K	2
Aldershot project (public/innovative)	£13.13M	6200	£2120	75 weeks	£175K	2

context for the network data which follows and provides evidence that the four projects were broadly[3] similar. Full details of the projects are contained within Pryke (2002).

Data gathering

Boundary specification

The natural boundary for this research is the construction project coalition. As Scott (1992, p. 56) observed, however, the determination of boundaries of networks in a research project is the outcome of a theoretically informed decision about what is *significant* in the situation under investigation.

The boundaries for the case studies analysed here were established using the following criteria:

- The individual to be an employee of one of the project actor firms comprising the project coalition and to be actively engaged upon the project at the time that the data were gathered.
- The individual not involved in the use of hand tools for any part of his/her role in the project.
- Individual to be identified by at least one other project actor.
- The link with any given actor to be significant in terms of frequency and perceived importance of input by other actors.

Table 2 Average team sizes

	Average team size per role (A_VTS)
Essex project (public/traditional)	2.67
Uxbridge project (private/traditional)	2.48
Slough project (private/new procurement)	2.18
Aldershot (public/new procurement)	3.33

Data were triangulated by confirming the existence of linkages between project actors. Both actors identified in a linkage had to confirm the existence and type of linkage before the linkage was regarded as valid. The type of network data associated with the four case studies here involves relatively low levels of subjectivity when compared with a network involving judgements of human emotion, for example; in practice all network linkages were validated by the actors identified. All data were gathered by one individual to avoid variations in classification of relationship activity.

Individuals employed by the project actors were interviewed to establish their information exchange networks, separate networks being identified for each of the main functions of the project coalition, detailed above. Inspection of documents and interviews established the networks for contractual relationships and performance incentives. All data sets were converted into node lists and the node lists imported into the SNA software package, UCINET 6 (Borgatti *et al.*, 2002).

The SNA software provides the possibility of carrying out a very large number of routines once the node list data has been imported. Analysis was based upon the point centrality of key project actors within the main project function (information exchange) networks.

Changing governance patterns were mapped using point centrality measures for key actors within contractual and performance incentive networks. These data were not qualitative, other than to record the particular standard form of contract employed. The performance incentive networks were identified through interview with project actor representatives and the value and direction of these incentives were noted. Directional data relating to information exchanges were gathered through the use of a highly structured interview employing a questionnaire in a linear responsibility analysis format (Pryke, 2002). Information exchange data were triangulated through

the use of send and receive enquiries. Data relating to the importance and frequency of communications were also gathered. All modes of communication were aggregated.

Density of networks was computed to provide context for the range of point centrality values. SNA generates a large volume of data for a given data set. Each type of communication—instruction, advice, mutual exchange of ideas and so on—generates a separate data set and comprises a separate network. Each project has a number of network types relating to the main project coalition functions, as well as the data relating to contract and incentives.

Data analysis

Data were analysed using UCINET 6 (Borgatti *et al.*, 2002), which has since been replaced by UCINET 6.64 (Borgatti and Freeman, 2004). The programs are designed to analyse social networks and other proximity data and include measures of centrality and connectivity, methods of detecting sub-groups and positions and a number of other more complex measures. The software is also able to express the analysis of data in numerical matrix, as well as sociogram[4] format.

Initial analysis of the data sets for the four construction projects produced substantial and therefore easily detectable variations in values, which were observable through inspection of density and centrality values, as well as comparison of sociogram diagrams, produced through the 'Draw' feature within UCINET. The data are presented in tabulated form initially; some interpretation of these data is provided and some of the conclusions illustrated using sociograms.

The data identified essentially comprised directional, non-trivial, valued and multivariate networks. This means that something flowed in one or more direction between nodes (money, information, liability or service provision, etc.), there were (with one exception) more than two nodes in each network, some relationships were weighted for importance and, finally, there were a number of relationships between the nodes (respectively in relation to the previous sentence). In view of the large volume of data produced, the data relating to frequency and perceived importance of communications are not presented here.

The structure of the following analysis is based upon the classification of networks around which the conceptual framework was developed. More specifically, the analysis follows the sequence used in the proposition statement above. We commence with a review of the network data for contractual and performance incentive networks. This is followed by the information exchange networks relating to the principal project functions—cost and progress management; design and specification. The analysis deals with the issues of network density and actor centrality which form the focus of the proposition.

Network densities

Density is a measure of connectivity; the extent to which the actors are connected to each other. At a value of 1.00, all actors are connected to each other, the network having total connectivity. At a value of 0, none of the actors are connected, a network being absent and all actors therefore classified as isolates. It follows that all network density values fall within the range of 0–1. Table 3 below shows the absolute values for density in the contract, performance incentives and three key information exchange networks.

The formula for network density adopted is as follows (Wasserman and Faust, 1994, p. 129):

$$\text{Density}(\Delta) = \frac{l}{n(n-1)}$$

Relative density values are also of interest; the comparative values for a given network type, such as contract, between case studies; also the relative values for different network types within a given case study. To facilitate this comparison, the density values were normalised, all values being expressed as a factor of the lowest density value across all data sets. These data are shown in Table 4.

Table 3 Densities for all networks

	Contract	Performance incentive	Cost management	Progress management	Design and specification
Essex project	0.136	0.091	0.212	0.129	0.182
Uxbridge project	0.095	0.058	0.133	0.090	0.133
Slough project	0.061	0.002	0.020	0.020	0.066
Aldershot project	0.050	0.091	0.080	0.127	0.214

Table 4 Densities for all networks (normalised)

	Contract	Performance incentive	Cost management	Progress management	Design and specification
Essex project	68	46	106	65	91
Uxbridge project	48	29	67	45	67
Slough project	31	1	10	10	33
Aldershot project	25	46	40	64	107

What do we learn about project governance from an examination of network densities?

Contractual networks

From Tables 3 and 4 we see that the values of densities in contractual networks are lower for new procurement than traditional procurement. New procurement strategies, represented by the Slough and Aldershot projects, appear to beget project coalitions that are less well connected, that is, fewer contractual relationships overall.

But most firms are connected to one actor: the developer or Prime Contractor. This is reflected in higher levels of centrality for developer and Prime Contractor. New procurement produces fewer contractual links, and by inference, fewer contractual links may provide less opportunity for contractual disputes. But these contractual links are focussed upon a relatively small number of prominent actors.

Performance incentives

The Slough project coalition employed strategic partnering and relatively intensive intervention from senior management within the developer organisation to achieve effective project governance. There was a very weak reliance on performance incentives and contracts (see values of 1 and 31, respectively, in Table 4). The Prime Contracting pilot project employed a Guaranteed Maximum Price (GMP) supplement to the contract conditions and shared savings, these performance incentives acting as substitutes for the more traditional liquidated damages, retention and performance bonds used in traditional procurement. The densities of performance incentive networks (Table 4) were identical (at 46) for Prime Contracting and the Essex scheme which employed traditional public sector procurement.

Both projects, although employing different forms of procurement, used relatively well connected networks of performance incentives. The nature and operation of the incentives was quite different in each case, however.

Cost management

Densities are lower in new procurement than traditional procurement. It is suggested (and this is supported by anecdotal evidence) that the lower levels of activity implied by lower network densities reflect a requirement for lower levels of financial management activity with new procurement. Neither the Slough nor the Aldershot project had separate client or contractor's quantity surveyor (QS) functions. Cost management was demonstrably more effective under new procurement, it being dealt with in two very different ways:

- Slough project—costs were prevented from escalating by close management of small firms that worked frequently for the same client—partnering in its most literal sense. Also, repetition, standardisation and familiarity in relation to building specification provided some certainty and a reduction in risk.
- Aldershot project—whereas the client on the Slough project internalised the design development and other construction risks, under Prime Contracting these risk were transferred to the Prime Contractor. The use of GMP and shared savings agreements provided financial certainty for the client.

Both the Slough and Aldershot projects were completed within the budgets set at contract stage. This was established through post completion surveys (Pryke, 2002).

Progress

Analysis of progress management data was slightly less conclusive than for other measures, in that very similar values are seen in Tables 3 and 4 for progress monitoring information exchange network densities, in relation to the Essex, Slough and Aldershot projects. Only the Slough project exhibits much lower density when compared to all other projects. It is suggested that partnering and supply chain management (SCM) substantially reduce the need for monitoring and control here. If we refer to Table 1, we see that the Slough coalition achieved by far the shortest

programme time at 52 weeks; the production of 119 M^2 of gross floor area per week indicates a 55% higher rate of construction than its development competitor on the Uxbridge project. Repetition is an important factor here.

The developer on the Slough project operates from the location of a very large development site, which is subject to ongoing redevelopment, providing the opportunity to continually refine the buildings constructed. In contrast to this, the Prime Contracting model uses an intensive process of progress management reflected in a dense network. Despite this the project was not built very quickly (see Table 1). The highest density of progress management information exchange on the Aldershot project produced the second lowest rate of production.

Design and specification

Once again, the Slough project had relatively low densities—low levels of connectivity generally. It is posited that partnering and standardisation remove the need to have high levels of information exchange relating to design during the production phase.

Other projects had a surprisingly high level of information exchange relating to design issues during production; this is perhaps the effect of the prototype problem in construction. It certainly underlines the problem of contractual incompleteness, given that the data were all gathered during the post-contract period of the development process. Given the similarity in values between the Essex and Aldershot projects (91 and 107, respectively, in Table 4), we might conclude that intense supply chain management activity in relation to prototype projects will not compensate for a lack of familiarity for the design solutions, hence the similar values for Essex and Aldershot projects. Partnering and long-term relationships, with their associated familiarity and standardisation issues, seem to have reduced the activity needed to achieve a coordinated design in the case of the Slough project.

A well connected design development network on the Prime Contracting (Aldershot) project reflected the contractor having control of a complex design process requiring extensive information exchanges. The use of clusters tended to cause higher density in this information exchange network because broader communications across the whole network tends to arise. The use of clusters does not, arguably, deliver better information exchange, that is, more density in information exchange networks, merely different configurations of network with a shift in influence within the networks (see discussion of centrality below).

The move from traditional procurement and project management to supply chain management *requires one prominent actor to manage the production phase*. In the case of the Slough project, the prominent actor was the developer; in the case of the Aldershot project, it was the Prime Contractor.

Actor centrality

Degree centrality (one of three types of centrality, see below) refers to the extent to which a given actor is connected to all other actors. A high level of centrality for a given actor within an information exchange network might, for example, indicate an actor with a high level of power. This power might be associated with specialist knowledge or status conferred under the terms and conditions of a form of contract. It is also possible in the context of design and specification information exchange networks that actors with high levels of centrality originate information with a high level of ambiguity; the prominence within the network therefore reflects the high volume of exchange necessary to finalise project information (Pryke, 2002, 2004c).

The extent to which centrality is a measure of power is one that attracts much debate amongst SNA aficionados (see e.g. Brass and Burkhardt, 1992, p. 191; Mizruchi and Potts, 1998, p. 354); this point is summarised in Pryke (2002). Degree centrality provides a measure of communication activity (Freeman, 1979, p. 236) and was adopted in favour of the other two types of centrality identified by Freeman (Betweenness and Closeness).

In order to create some comparative data, and to limit the overall volume of data that was to be analysed, one definition of centrality needed to be selected. Inspection of the networks presented in Freeman's paper and comparison with the size and configuration of networks likely to be produced by our study of construction project coalitions indicated the following:

- All three measures of centrality provided the same values for the best example of centrality (the star).
- All three measures of centrality provide the same values for the least central scenario (an actor placed in a circle).
- Degree-based measures provided the smallest range of variations in centrality values.

The choice of centrality measure was based upon an analysis of the characteristics of these three measures (using Freeman's paper of 1979) and their relevance to the research context and type of data produced.[5] A more detailed discussion of the rationale for the choice of centrality measure is contained in Pryke (2002).

The formulae adopted for centrality is given below to avoid any ambiguity in terms and its definition.

For centrality $(C^1_D(x))$,

$$\frac{\text{in–degree}(x)+\text{out–degree}(x)}{2(n-1)}$$

where $C^1_D(x)$ represents the centrality value for network D (this might be an information exchange network relating to progress monitoring, for example); and where x is a given actor within that network (for example, the architect); n represents the total number of nodes in the data set; in-degree refers to incoming relations (information) and out-degree, outgoing relations.

Centrality issues and changing actor roles in relation to changes in procurement strategies

The analysis below refers to Tables 5, 6, 7 and 8, which give normalised centrality values across a sample of the networks analysed. We have looked at three types of ties identified by Wasserman and Faust (1994, p. 18), in the context of the construction project. These were resource transfers, interaction and formal relations. Specifically, data were gathered relating to inter-firm networks of performance incentives, information exchanges and contractual relations. Changes in centrality within a type of network and for a given

Table 5 Comparable centralities for all networks—values expressed as factors (centrality × 100): client actors

	Contract	Performance incentives	Progress management	Design and specification
Essex (traditional)	25	0	9	14
Uxbridge (traditional)	25	8	10	0
Slough (new)	50	2	18	3
Aldershot (new)	3	6	5	3

Note: This table does not deal with the centrality of the client in cost management and instruction, communication networks.

Table 6 Comparable centralities for all networks—values expressed as factors (centrality × 100): consultant actors

	Contract	Performance incentives	Cost	Progress management	Design and specification
Essex	6	0	41	41	55
Uxbridge	3	0	23	15	45
Slough	2	0	12	2	5
Aldershot	3	6	9	8	38

Table 7 Comparable centralities for all networks—values expressed as factors (centrality × 100): constructor actors

	Contract	Performance incentives	Cost	Progress management	Design and specification
Essex	27	27	23	32	36
Uxbridge	20	20	35	63	40
Slough	50	2	12	18	41
Aldershot	40	56	64	71	65

Table 8 Comparable centralities for all networks—values expressed as factors (centrality × 100): cluster leader actors

	Contract	Performance incentives	Cost	Progress management	Design and specification
Essex	5	8	17	36	54
Uxbridge	3	4	3	6	33
Slough	16	isolate*	11	18	20
Aldershot	3	5	18	21	35

actor type provide a means of evaluating changes in the structure and governance of construction coalitions.

In particular, we shall show the shifting relationship between performance incentives, information exchange and contractual relationships that comprise the governance of the construction project.

Client roles

Client roles are dealt with in Table 5. In terms of project coalition governance, the approaches of the Slough and Essex projects approach were predominantly contractually orientated; the Uxbridge project placed more emphasis upon performance incentives than the Slough and Essex projects.

Reference to Table 5 shows the contractual prominence of the construction client/developer on the Slough project; it also shows the low level of involvement of the Uxbridge client in design matters. There was a relative lack of prominence in performance incentive networks in the case of both public sector clients.

Contract networks

The client is prominent in contract networks under traditional procurement, as shown in the Essex and Uxbridge projects. The client is also very prominent in Slough model. For SCM to work effectively, the client must have a very prominent position or employ a contractor who will fulfil this function in design and build mode. The client has few links with the coalition members in the Prime Contracting (Aldershot) contract networks and the contractor leads the process completely (cf. Tables 5 and 7).

Performance incentives networks

A very powerful client managing the supply chain hands-on does not need performance incentives to operate successfully. The use of GMP on the Uxbridge and Aldershot projects provides an alternative formula for project governance. Prime Contracting seems to operate well for 'arms length' clients where performance incentives deal well with the risk transferred to the Prime Contractor

Information exchange patterns

Prominence of the client in progress monitoring networks is broadly reflected in the contractual networks. Design development information exchanges did not correspond with the contract network positions for the clients.

The prominence of the client, or otherwise, in design development networks is a function of experience, knowledge and inclination. Hence, whereas the client for the Uxbridge project adopted a completely hands-off approach, the client for the Essex project was very much involved in the management of the post-contract phase of the project.[6]

Consultants' roles

The consultant's roles are dealt with in Table 6 above.

Contractual networks

The consultant's role is relatively weak in all procurement routes except for public sector traditional procurement (Essex project).

Performance incentives

Performance incentives are not an important feature of procurement routes, in relation to the role of consultants, except for Prime Contracting (public sector new procurement). Under Prime Contracting consultants are incentivised through a shared savings scheme.

Information exchanges

These are very powerful in public sector traditional procurement (Essex) and have only slightly less prominence in private sector traditional (Uxbridge) and private sector new procurement (Slough). Consultants are managed rather than tied into complex contractual arrangements or performance incentive deals in all procurement routes except Prime Contracting. The Prime Contracting procurement approach might be regarded as an innovation in the use of performance incentives in relation to consultants.

We might also conclude that the use of long-term partnering relationships on the Slough project obviates the need for separate performance incentives for consultants. Traditional procurement is characterised by a consultant's role that relies heavily on a managerial approach to governance which is not fully supported by either contract terms or performance incentives—the Slough scheme exhibiting slightly more effective project governance than the Essex or Uxbridge projects, yet the Prime Contracting route showing the best governance mix. Under new procurement, consultants are less prominent in networks dealing with cost management, progress and design development. The high level of prominence of the Essex consultants in cost

management networks illustrates a key difference in approach between traditional and new procurement—good financial certainty on the Slough and Uxbridge projects being achieved *without a prominent traditional QS role*. A minimal involvement of consultants in progress and design development networks reflects the partnering environment. The Aldershot project is the only project to link its consultants into the performance incentive networks.

Main contractor's role

The contractor's role is dealt with in Tables 6 and 7 above. Under both traditional and new procurement, the contractor's role is represented by a balanced form of governance based upon centrality figures in Tables 6 and 7. It is proposed that these (constructor's) roles are *mature* in that the contract conditions and performance incentives correlate with information exchange figures.

Prime contracting alone produces a little more prominence for contractors than the proactive developer might have in a new procurement environment. But new procurement (the SCM aspect of it, at least) leads to, and demands, one central actor to control the production process.

The use of a Guaranteed Maximum Price (GMP) supplement to the contractual conditions leads the contractor to be more proactive in client, budget related cost control[7] (see Uxbridge and Aldershot project values in Table 7). It appears that this effect is independent of the procurement route selected.

Cost monitoring, instruction and progress networks are managed most effectively by Prime Contracting. The Slough coalition, however, achieved very effective project governance, through the innovative application of SCM techniques. The client actor, unusually, in performing a management contractor role was the least prominent when compared to the other three projects.

If Prime Contracting is to be regarded as successful, it is because of the prominent role of the contractor, the management activities being supported by appropriate contractual conditions and performance incentives. The use of clusters is not necessarily essential to success in this type of procurement.

The approach adopted on the Slough project relied far less on governance of the production process through contractual requirements and performance incentives.[8] The supply chain was leveraged (Cox and Townsend, 1998) through placing workload on a very long-term basis and promoting efficiency through simplicity of design, intensively (and internally) managed buildability. Repetition of design, standardisation of specification and familiarity through local contacts and non-hierarchical information exchanges were all important factors. See Table 7 and Figure 1 for illustration of this point. The contractor's role has high levels of centrality in both traditional and new procurement routes. Traditional forms of contract are strongly biased towards the production function and the role is familiar and *mature*,[9] even in relation to design and build. Based upon relative centrality values in Table 6, it is the other functions within the construction project that are dealt with less satisfactorily.

The Slough project client, in its role as client/developer/constructor, has a more prominent role contractually than the Prime Contractor on the Defence Estates project. The client actor on the Slough project has a higher level of contractual centrality than the Prime Contractor on the Aldershot project. This implies shorter network linkage distances and a more logical privity of contract structure.

We can see that projects that use Guaranteed Maximum Price exhibit a prominence by the contractor in cost, progress and design development networks (refer to Uxbridge project in Tables 5, 6 and 7). The Prime Contractor's prominence in most of the Aldershot project networks is in contrast to the low prominence approach on the Slough project. It is suggested that *standardisation and repetition make prominence of the contractor unnecessary*.

Cluster leaders and subcontractors

Cluster leaders and subcontractor roles are dealt with in Table 8. These roles show some variations in the balance between the nature of project governance, over the four projects (Table 8 refers). There is a bias in traditional forms of procurement towards communication or a managerial approach to governance. The Slough model (new private sector) shows a bias towards contract and performance incentives. The Prime Contracting (Aldershot, new procurement) model looks very similar, in terms of governance mix, to traditional procurement routes. This tends to emphasise the point that the cluster leader is a new role and this role is not dealt with by current contractual arrangements—the actors fulfilling this role on the Aldershot project doing so on what must essentially be regarded as a voluntary basis.[10] Contractually, and in terms of performance incentives, cluster leaders are no different under Prime Contracting to the subcontractor under traditional forms of procurement (centrality figures in Table 8 support this).

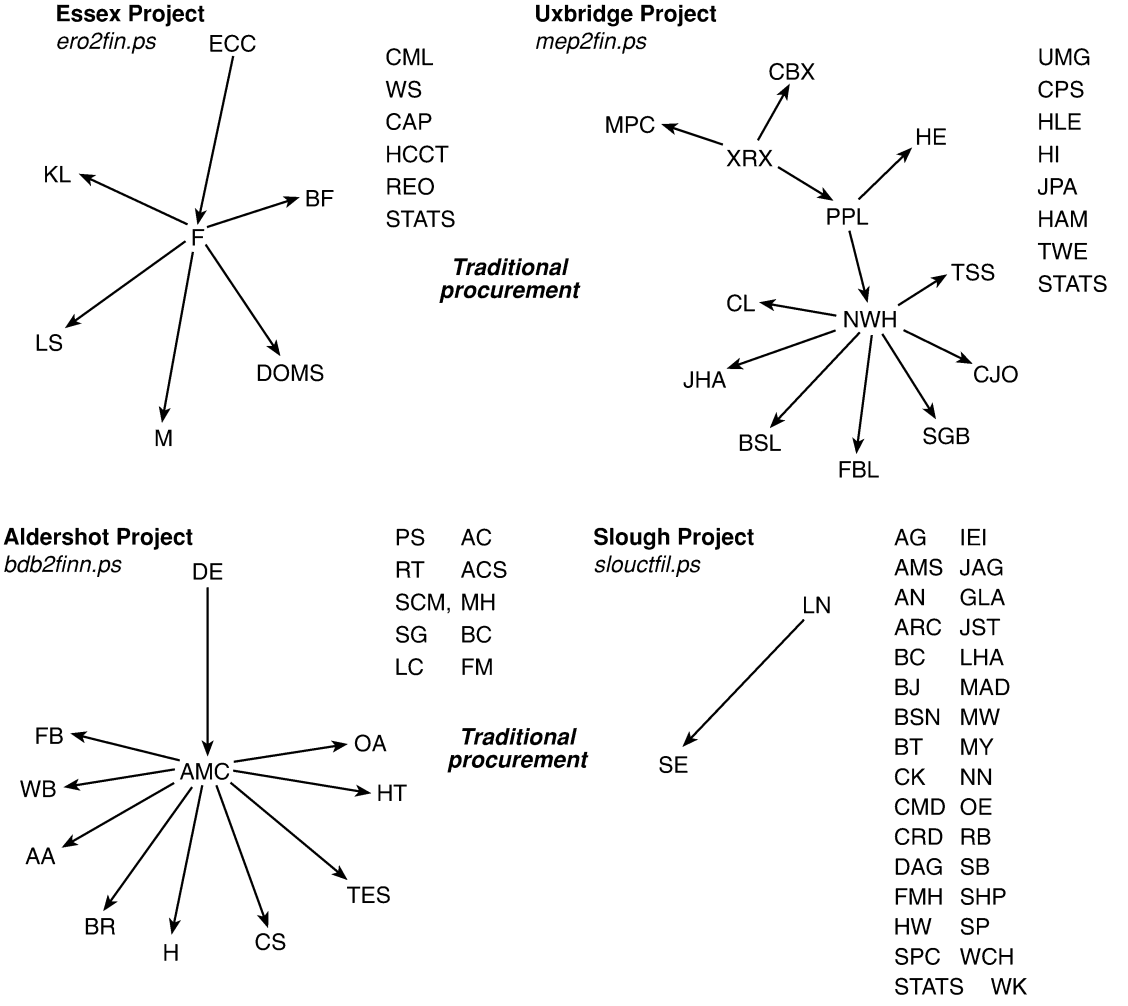

Figure 1 Performance incentive networks. *Note*: the Aldershot project sociogram shows the Prime Contractor (AMC) in a position of centrality in relation to all other project actors. Approximately 50% of the project actors are linked into the performance incentive network. Those actors listed to the right of the sociogram are isolates; they are not connected to (and not therefore associated with) the performance incentive network. By contrast, the Slough project sociogram shows two actors only linked in a performance incentive relationship (the developer and its future tenant). All other actors are isolates. This is a partnering arrangement which places reliance upon performance incentives or formal contractual arrangements.

If Prime Contracting is to develop and become widespread (and, at the time of writing, the Defence Estate Organisation appears to be proceeding cautiously and not exclusively with this initiative) the contractual conditions and compensation and liabilities of cluster leaders need to be resolved.

We can see very effective roles (reflected in similar values for centrality in contract, performance incentive and information exchange networks in Table 8) being performed by subcontractors under the traditional approach employed on the Essex project. Although good connections exist between the subcontractors and developer on the Slough scheme, the subcontractors are in a weak position in terms of cost, progress and design processes on this project.

Conclusions

We have built upon the rationale for the use of social network analysis in project coalitions and presented the findings from four case studies carried using this innovative approach. Social network analysis generates notoriously high volumes of data. The analysis of the SNA data for our four case studies makes a contribution to the analysis of project governance as follows:

1. A number of important changes in project governance and actor roles associated with the implementation of supply chain management and the use of work clusters were identified and quantified using SNA.

2. We have demonstrated the viability of using SNA in the analysis of construction project governance. We have proposed that the project coalition be conceptualised as a network of relationships. A research instrument was devised, based upon linear responsibility analysis, and it was related to key construction coalition activities. An appropriate software package from within the social science field was identified.
3. Network density and actor centrality were proposed as the appropriate SNA measures for the comparative study of the governance of construction projects. These measures were used to build a language and a database of relative values by which other projects might be analysed. The proposition provided an outline of a social network theory of construction project governance.

Acknowledgements

The financial support of the Royal Institution of Chartered Surveyors Education Trust and London South Bank University are gratefully acknowledged. A large number of very busy project team members also gave of their time willingly. Thanks also to Dr Hedley Smyth from the Bartlett School, University College London, for his comments on the draft paper.

Notes

1. New procurement refers to procurement methods involving partnering, supply chain management and the use of work or technology clusters. For a more detailed discussion of the features of these procurement strategies, refer to Pryke (2002).
2. The identification and classification of control projects, and those representing what has been classified as *new procurement*, is problematic and imperfect. The control projects were selected on the basis that they appeared to exhibit none of the features or characteristics of new procurement as defined in note 1 above. The schemes representing new procurement were selected on the following basis:
   - The Slough project represented the systems used by one of the UK's largest property developers. The manager of the building division at the time was a contributor to both Latham and Egan reports, as well as a number of influential industry bodies.
   - The Aldershot project was chosen after having some difficulty in locating an example of new procurement in the public sector. The project comprised a Prime Contracting project put forward as a Demonstration Project.
3. Clearly, from a methodological point of view, we would seek four projects identical in all aspects apart from the variables forming the basis of the data analysis. This is not practicable; most construction projects are unique apart perhaps from housing projects, where repetition of design, though not overall project design parameters, is commonplace. Housing projects could not provide useful suitable projects for the studying of innovative procurement and project management techniques. The characterisation of particular procurement routes is, in itself, problematic. There is some discussion of this point in Green (1999, pp. 133–37).
4. The term 'sociogram' is used throughout since it is the most commonly used term to describe 'spider diagrams' relating to social networks. Some may feel that the term 'graph' would be more appropriate to describe diagrams relating to relationships other than those involving social relationships. Hence contractual relationships between firms might be more correctly depicted by 'graphs'.
5. At this point we have another conceptual bridge to cross; it relates to the relevance of the chosen measure of centrality (degree) to the analysis of networks relating to networks of contractual relationships. The choice of degree centrality is rationalised above in a context of human communication networks. It also suggested that the centrality values generated by the construction project case studies would provide a measure of power within the networks. This was based upon the evidence of those who have correlated influence and power in small decision-making groups with communication network centrality. It is argued here that although the concept of power may be an issue (see the work of Cox and Townsend, 1998) *it is not essential to this case study*. We are seeking to map changing patterns of influence within a given network; it is therefore proposed that the same formula for centrality be applied to all network calculations to provide a consistent and comparable measure of centrality across a number of different types of project network. It is, however, accepted that the justification of centrality measure was based upon criteria that related to communication networks alone. It is suggested that those who have referred to the importance of power in procurement routes might be persuaded that it is in fact *centrality* (as distinct from power) that is important for the reasons given above.
6. It is interesting to note that the clients for both the Essex and Uxbridge projects were located in the same buildings as their respective project managers and within a short walk of the construction site. The centrality of the client in the respective specification information exchange networks represented the minimum and maximum values compared to the other case studies. We might conclude that physical location is not a function of centrality, within this context.
7. This is because the incentivisation of the contractor, by the client, to complete the works within a given lump sum, effectively diverts responsibility for management of the *client's* budget to the *contractor*, rather than the client's quantity surveyor (PQS). The contractor's staff have higher levels of connectivity in information exchange networks than the consultant (client's) QS and are able to more effectively manage client costs.

8. For evidence relating to this assertion, see density figures for contract and performance incentives in Table 3. The figures are relatively low, being 44% of the highest value in the sample contract and 9.4% of the highest value in the sample for performance incentives. In addition, Figure 1 illustrates the point about performance incentives (or the lack of their use in this case) for the Slough project.
9. This refers to a strong correlation between the centrality values for contract, performance incentives and information exchanges, for a given actor in a given network.
10. This was in a mood of optimism about massive future workloads through Prime Contracting following the completion of this pilot study.

References

Borgatti, S.P. and Freeman, L.C. (2004) *UCINET 6.64 for Windows*, Analytic Technologies, Harvard, MA.

Borgatti, S.P., Everett, M.G. and Freeman, L.C. (1992) *UCINET IV Version 1.00 User Guide*, Analytic Technologies, Harvard, MA.

Borgatti, S.P., Everett, M.G. and Freeman, L.C. (2002) *UCINET for Windows: Software for Social Network Analysis*, Analytic Technologies, Harvard, MA.

Brass, D.J. and Burkhardt, M.E. (1992) Centrality and power in organizations, in Nohria, N. and Eccles, R.G. (eds) *Networks and Organizations*, Harvard Business School Press, Boston, MA, pp. 191–215.

Cox, A. and Townsend, M. (1998) *Strategic Procurement in Construction: Towards Better Practice in the Management of Construction Supply Chains*, Thomas Telford, London.

DETR (Egan Report) (1998) *Rethinking Construction: The Report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the Scope for Improving the Quality and Efficiencies of UK Construction*, DETR, available from: www.construction.detr.gov.uk/vis/rethink

Freeman, L.C. (1979) Centrality in social concepts: conceptual clarification. *Social Networks*, **1**, 215–39.

Green, S. (1999) The missing arguments of lean construction. *Construction Management and Economics*, **17**, 133–37.

Holti, R., Nicolini, D. and Smalley, M. (2000) *The Handbook of Supply Chain Management*, CIRIA, London.

Latham Sir, M. (1994) *Constructing the Team: Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry*, HMSO, London.

Mizruchi, M.S. and Potts, B.B. (1998) Centrality and power revisited: actors success in group decision making. *Social Networks*, **20**, 353–87.

Nohria, N. and Eccles, R.G. (eds) (1992) *Networks and Organisations*, Harvard Business School Press, Boston, MA.

Pryke, S. (2002) UK construction in transition: developing a social network approach to the evaluation of new procurement and management strategies, PhD thesis, the Bartlett, University College London.

Pryke, S.D. (2004a) Analysing construction project coalitions: exploring the application of social network analysis. *Construction Management and Economics*, **22**(8), 787-97.

Pryke, S.D. (2004b) Analytical methods in construction procurement and management: a critical review. *Journal of Construction Procurement and Management*, **10**(1), 49-67.

Pryke, S.D. (2004c) Prominence in interorganizatinal communication networks: the weakness of strong ties *Proceedings of XXIV Annual Conference of the International Network of Social Network Analysts*, Portorož, Slovenia, 12–16 May.

Scott, J. (1992) *Social Network Analysis: A Handbook*, Sage, London.

Wasserman, S. and Faust, K. (1994) *Social Network Analysis: Methods and Applications*, Cambridge University Press, Cambridge.

Winch, G.M. (2003) *Managing Construction Projects: An Information Processing Approach*, Blackwell Science, Oxford.