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Network gaps and project success

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Project success and client satisfaction are results of collaborative actions by project actors throughout the entire project life cycle. One principal factor in project success is the application of effective management tools. Gap analysis helps to achieve client satisfaction. However, gap analysis is unable to deal with the organic nature of information exchange between project actors. Social network analysis (SNA) enables the identification and analysis of information exchange and communication patterns in synergy with projects. Two case studies were carried out to identify gaps in the current linear project management approach. Gap analysis and SNA were used to analyse each project and to examine the research hypothesis on the use of SNA to identify network management gaps in projects. The gap analysis showed gaps of execution and conformance, which were confirmed by SNA. There was little evidence of project governance outside the project contractual arrangements during project execution. The current application approach of different management tools is limited in providing a whole-project view. The combined application of gap analysis and SNA can help practitioners to exceed client expectations.

Keywords: Client satisfaction, gap analysis, project management, social network analysis.

Introduction

The UK construction industry gradually evolved into a trade-based industry over a period of 200 years (Winch, 2002). As a result, the UK construction industry operates in a highly fragmented way which has impacted upon communication patterns in projects. Primacy was given to the process of 'contract administration' and project actors carried out their duties in an adversarial manner within various forms of standard contractual framework. The publications of the Latham Report in 1994 and the Egan Report in 1998 were calls for collaboration and reform within the construction industry. A number of studies on the nature of the UK construction industry developed and new procurement systems were introduced (Latham, 1994; Pryke, 2004b). As client needs became increasingly central, the post-Egan agenda questioned the continued fragmentation in projects. There was a call for closer relationships between the client, the design team and the constructors. This required new management tools to create and maintain collaborative working relationships between project actors through effective information exchange and communication patterns.

The examination of information exchange relationships provides an alternative approach to the traditional emphasis on time, cost and quality. None of the existing linear management tools capture how project actors interact (as a coalition) in pursuit of the achievement of project goals. This is due to the following factors:

- the level of complexity and fragmentation in the UK construction industry;
- the increased focus on contract administration in construction and Real Estate (RE) sectors; and
- the emphasis given to scientific management tools.

Furthermore, client satisfaction is found to be fundamental to the perception of project success. Winch *et al.* (1998) used gap analysis in the analysis of factors associated with the achievement of client satisfaction. However, gap analysis followed a linear communication model throughout the project life cycle and

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showed limitations in addressing the organic nature of projects, outside the contractual links.

This paper deals with two case studies in which gap analysis and social network analysis (SNA) are combined in the study of project network gaps and project success. The combined use of both tools enabled the successful analysis of the systems associated with the delivery of project objectives and client satisfaction through effective project governance (Pryke, 2005), towards project success. But what do we mean by project success?

What do we mean by project success?

The study of project success was introduced in 1969 by Rubin and Seeling (Belassi and Tukel, 1996), who considered technical performance as a success measure and related success to the project manager's experience, while modern project management focused on the *iron triangle* of time, cost and quality as the combined criteria for project success (Cooke-Davis, 2004). Once projects required a higher level of interaction and technical support, it became difficult to consider time, budget and quality as the only criteria for success (Winch, 2002; Cooke-Davis, 2004). On the other hand, Baker *et al.* (1983) adopted the concept of perceived performance to measure project success.

One approach to studying project success is to focus on factors leading to project success and success measures. Pinto and Slevin (1988) reviewed over 400 projects and concluded that factors affecting project success included:

- coordination and relations;
- adequacy of project structure and control;
- project uniqueness, importance and public exposure;
- success criteria salience and consensus;
- competitive budgetary pressure;
- initial over-optimism, conceptual difficulty;
- internal capabilities build up.

Furthermore, they developed a similar approach to studying success measures dealing with project success factors at strategic and tactical level (ibid.). The strategic measures included project mission, top management support, project scheduling and client satisfaction, while tactical measures included client consultation, personnel selection, technical tasks, troubleshooting and communication. As it depends on pre-agreed strategic and technical criteria (which are difficult to establish in current multi-layered project networks and complex environments) project success needs to be studied at three levels over the project life cycle in order to answer the following questions (Cooke-Davis, 2004):

- How do we ensure that the project is done right?
- How do we ensure that the right project is done?
- How do we ensure that the right projects are done right, time after time?

However, while there is a clear understanding about measuring project financial performance, there is no consensus on how to monitor intangible assets and therefore Cooke-Davis (2004) refers to project success being measured against the overall objectives of the project. In 'A retrospective look at our evolving understanding of project success', Jugdev and Müller (2005) concluded that developing and maintaining good relationships and effective communication with project stakeholders may contribute to effective management of projects. There is a need to ensure continuous review of project objectives and adequacy of management tools.

In conclusion, the increased emphasis on the client's role in the post-Egan agenda places a renewed focus on addressing the link between project success and client satisfaction, and more emphasis is needed (among practitioners) on the analysis of interactive communication networks between project actors.

Project success and client satisfaction

Belassi and Tukel (1996) concluded that client consultation and client satisfaction scored the highest rankings as critical success factor and success key performance indicator (KPI), respectively, in the construction industry. They also established that client coordination was repeatedly shown as a significant contribution to project success in a number of studies. Cooke-Davis (2004) highlighted the need to evaluate the 'benefits' of projects in relation to project success and addressed the need for effective benefit delivery and client satisfaction framework.

The growth in the UK construction industry, prior to 2009 at least, brought continuous pressure upon consultants to demonstrate an increasing level of added value for clients. Winch (2002) argues that projects are carried out to add value at strategic and operational management levels, and therefore the concept of benefit delivery should be adopted in research on project success to bridge the gap between the client and the project coalition. The clients for their part are increasingly engaged with their supply chain in order to facilitate the added value. As projects are segmented at their strategic levels and are increasingly viewed as linear chains of activities, project quality and client needs are overlooked and project objectives are considered within the 'iso-mentality' of project functional activities and

life cycle stages, which leads to even greater need to address the communication gaps in projects.

Contextually from the above, client satisfaction, based on pre-agreed project success criteria, and coordination and relationships in the form of efficient and effective communication between project actors is the primary focus in the assessment and development of project networks.

Gap analysis and project life cycle

The need to understand the systems associated with complex projects is increasingly becoming essential. Efficient project governance is pursued through the adoption of a holistic approach to management of projects.

Two approaches were developed to realize this holistic view namely:

- process-based management, which focuses on how things are done; and
- interface management to manage transfer in project activities during the project life cycle.

Morris (1988) introduced the concept of interface management as a means to address coordination problems. While the generic model of project life cycle reflected the transient nature of projects and the need by practitioners to change their management emphasis as projects progress, the focus on the project life cycle led to a more function-based fragmented approach to the management of projects and adherence to the traditional view of managing time, cost and quality (Turner, 1993, p. 24).

However, project activities can be linked together to reduce project surprises and to enable efficient management of client expectations through the application of gap analysis (Winch *et al.*, 1998) with an attention to the overlap between project stages. Winch *et al.* (1998) also addressed the need to keep the client in focus and maintain the 'line of visibility' throughout the project life cycle in order to maintain project added values. Figure 1 schematically links the linear approach of gap analysis to the Royal Institute of British Architect (RIBA, 2008a) Plan of Work. Further analysis to understand the impact of the RIBA Plan of Work on current management practices is the subject of future research in the UK.

Gap analysis and client satisfaction

Prior to Latham (1994) and Egan (1998), little research has put the client as the focus of interest at integrative and strategic levels. In their 'Towards total project quality: a gap analysis approach', Winch *et al.*

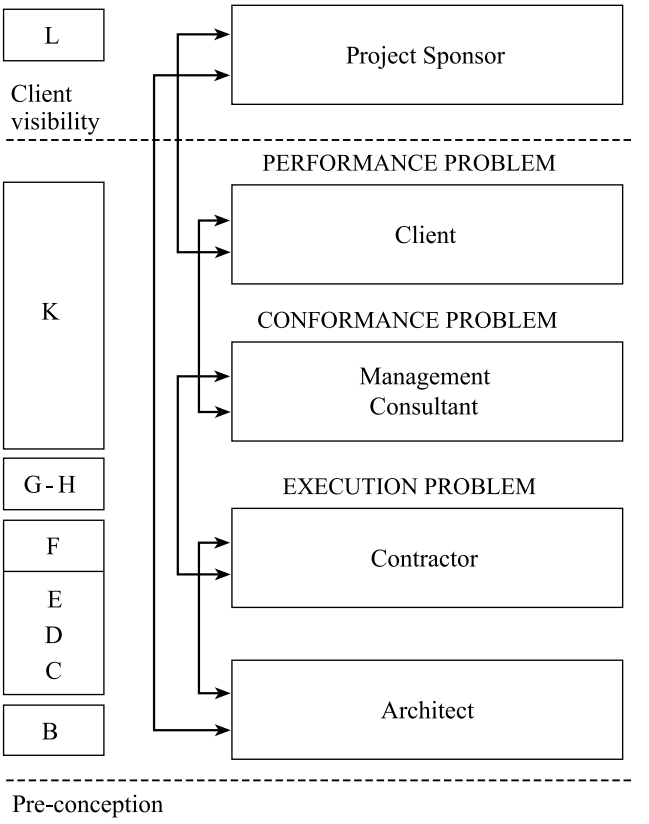


Figure 1 Generic gap analysis and RIBA plan of work

(1998) focused on the client's needs and based their model on the service quality model developed by Zeithaml *et al.* (1990) which identified four factors that might affect the client's expectations and 10 dimensions of service quality, with an emphasis on communication between project actors (Zeithaml *et al.*, 1990 in Winch *et al.*, 1998). Winch *et al.* (1998) identified five gaps throughout the life cycle of projects. Successful control of these gaps will minimize client surprises and help gain client satisfaction.

Table 1 Principal gaps in management model (developed from Winch *et al.*, 1998)

Principal gaps in management model	
Gap 1	Between consumer expectations and management's perceptions of consumer expectations.
Gap 2	Between management's perceptions of consumer expectations and management's translation of those perceptions into service quality specifications.
Gap 3	Between service quality specifications and actual service delivery.
Gap 4	Between actual service delivery and external communications to the consumer about service.
Gap 5	Between actual service delivery and the consumer's perception of the service.

In the context of project management, gap analysis is a successful linear management tool aimed at capturing gaps between management perception and the client's expectations at early project stages and in identifying design and planning problems during design stages. In addition, practitioners can benefit from using gap analysis in identifying execution and performance issues during 'construction' and 'use' stages. However, successful delivery of projects is linked to the dynamic nature of information exchange outside the conventional linear model between project actors. Gap analysis is unable to capture the organic nature of projects. Social network analysis was introduced as a non-linear tool to study the information exchange and communication typology in projects.

Social network analysis

Social network analysis has gained increasing importance in recent research dealing with the multi-faceted nature of the construction industry. Otte and Rousseau (2002) defined SNA as a broad strategy for investigating social structure rather than formal theory. Other definitions of SNA are provided by Wassermann and Faust (1997), Loosemore (1998), Tennenhouse *et al.* (2002) and Pryke (2004b). For the purpose of this paper, the definitions illustrated below are adopted.

> Most broadly, social network analysis (1) conceptualises social structure as a network with ties connecting members and channelling resources, (2) focuses on the characteristics of ties rather than on characteristics of individual members, and (3) views communities as 'personal communities', that is, as networks of individual relations that people foster, maintain, and use in the course of their daily lives (Tennenhouse *et al.*, 2002).

> SNA is a body of theory and methodology for the analysis of systems based on the conceptualisation of systems as networks of relationships. The network comprises actors or nodes linked by some form or relationship (ties). SNA enables the observer to systematically specify the relationships between actors within a group. The output of the analysis can be expressed mathematically and graphically (Pryke, 2004b).

Pryke's definition shows that SNA is a tool to investigate the information exchange and contextually address the social structure in projects providing a framework to enable the spontaneous study of communication typologies and language for the study of project organizations. Since projects are seen as a continuous exchange of information (Winch *et al.*, 1998), Otte and Rousseau (2002) focused on the type and quality of links between project actors and the importance of SNA to emphasize individualistic acts of network members. Projects are seen as a continuous exchange of information (Winch *et al.*, 1998), between stakeholders (project actors). The facility within SNA to capture information exchange patterns in projects is therefore useful to study precise classified relationships associated with specific project systems with the view that improvement in project communication will contribute to clients being informed of project surprises.

Social network analysis and client satisfaction

The application of SNA is relatively new in the construction industry. Nevertheless, it is strongly linked to recent research in new procurement, collaboration, integration and communication in projects. The application of SNA in the construction industry, therefore, provides the means to analyse the systems associated with delivering project added value and meeting client requirements efficiently (although indirectly) through:

- addressing problems at early stages and thus minimizing any client surprises;
- identifying and improving information exchange networks (Pryke, 2004b) and reducing any possible discontiguity in financial incentives; and
- achieving a balance between social and scientific aspects in management of projects.

All of these help practitioners achieve client satisfaction through efficient and effective management of project information. But how can practitioners benefit from two distinctive management tools to minimize client surprises?

Research hypothesis

In order to deal with the theoretical and analytical issues related to project networks, it was important to identify the gaps in project networks and, in doing so, to establish the research hypothesis to link two primary research areas: gap analysis and SNA and their relationships to client satisfaction. As noted above, this paper accepts Winch's argument that the fewer client surprises, the more client satisfaction is achieved, and the more a project is perceived as successful. In addition, we can view projects as continuous exchanges of information networks. However, the information exchange in this context covers non-contractual and informal communication in addition to the conventional management view of project communication under formal project contractual arrangements. Consequently, this paper addresses the need to identify the network gaps in projects through the examination

of network typology in projects against the linear approach of gap analysis; and suggests the following hypothesis:

> Does social network analysis, as a non-linear management tool, allow practitioners to identify network management gaps in projects in opposition to gap analysis as a linear management tool?

The research methodology

The authors understand and appreciate the epistemological challenges in generalization, which negate the nature of projects and application of associated management tools. Therefore, the research methodology and subsequent section of case study analysis should be considered as a pilot study of the argument addressed in this paper, and the findings and discussion herein should be elevated from the 'specific' to the 'general' argument which forms part of much wider research to identify network gaps in construction projects in general. In this context, SNA is used as a research methodology and a tool to enable an independent and non-hierarchical analysis of project systems.

About the case studies

The Department for Education and Skills (DfES) in the UK launched the Academy Programme in 2001 to develop 200 publicly funded Specialist Schools by 2010 at a capital cost of £5bn. While most academy buildings are of good quality, and a major factor in their quality is the time and effort spent, the programme suffered cost overruns as a result of poor project management (National Audit Office, 2007). Two under-construction projects were selected from the Academy Programme for the analysis on the basis that projects provide mature communication networks during the implementation stage. It is also expected that, at this stage, project objectives are fully established and communicated between project actors. See Table 2 for the project characteristics.

The primary project issues were identified in an initial project interview with the project leaders. This formed the basis for the subsequent project gap and network analysis through a structured questionnaire to examine the communication patterns vis-à-vis project delivery against time, cost and scope creep as a critical project issue during the execution stage with reference to conformance gaps (see Winch *et al.*, 1998 for further information on project gaps). Table 3 shows the communication matrix used to measure the frequency and significance of formal and informal information exchange between project actors related to project cost, schedule and scope of work with reference to conformance gaps during the execution stage. In order to capture the different aspects of information exchange, the project actors were asked to independently identify the frequency and perceived importance of the information sent and received. See Table 3.

Table 2 Project characteristics

Project	Total budget	Programme	Gross floor area
Academy A	£34.2m	78 weeks	10 000 m^2
Academy B	£31m	117 weeks	11 300 m^2

Table 3 Communication measurement matrix

	Time	Cost	Scope
Type of communication	Formal communication include written instructions, RfI, non-conformance letters and instructions for actions		
Frequency of communication	(1) Communication occurs once a month or less (3) Communication takes place on weekly basis (5) High frequency communication on daily basis		
Perceived importance	Perceived importance is measured by both sender and receiver of information and scored as: (1) Least important (3) Moderate level of significance (5) High importance—high impact		

The concept of a limited project life span was also adopted and project network boundaries were defined on a nominal basis (see Borgatti *et al.*, 1992 for more information on network boundaries) for small project networks and included project lead designer, project management consultant, and contractor (see Table 4). The resultant high level project network was limited to fewer than 10 actors for each project which allowed for a new perspective on network typology in small group formation. Also, this was found useful in terms of data gathering with a 100% feedback.

Table 4 Key to roles of project actors

Project A	Key project role	Project B
RHA	Architect	ASW
HSW	Construction project manager	AWH
KRO	Employer's agent	FTO
TWA	Quantity surveyor	GAT
CTH	Contractor	RSH
HMA	Service engineer	RTH
RBA	Structural engineer	NIQ

Information exchange was subject to analysis with reference to three areas: time, cost and scope creep. The project actors were asked to identify the type of information exchange as formal or informal, the frequency of communication, and the perceived importance of sent and received information. However, the data on received information were used to avoid perception gaps and personal bias associated with informal communication.

One of the key challenges in using SNA as a management tool is its diversity in application. With such limited number of project actors, 196 different communication networks were identified. For the purpose of this paper, 'formal information exchange' and 'informal discussion' were analysed to examine the nature of contractual relationships and non-hierarchical communication patterns in construction projects during project implementation stage. The data were used to produce a project node list per actor, subsequently presented graphically using UCINET 6 for Windows©.

Formal information exchange and discussion patterns were studied primarily to examine the level of centrality and connectivity between project actors. The results from SNA were reviewed against project independent gap analysis and were subsequently integrated to help in the understanding of network typology and project network gaps.

Research findings

At the time of data gathering, projects actors (including the employer's agents) identified the management of project schedule, cost and scope creep as key project management functions during the construction phase. Delivery against time was perceived as the more important measure for Academy A, against cost performance for Academy B.

The project managers for each of the two projects were independently asked to apply gap analysis of their projects following the model developed by Winch *et al.* (1998). Since both projects were under construction at the time of data gathering, the projects gaps were identified primarily as gaps between what was initially designed and what was constructed on site and classified under 'gap of conformance'. See Table 5.

With reference to time, cost and scope, both projects recorded unauthorized spending and schedule delay of 49 and 12 weeks for Academy A and Academy B, respectively. The cost overrun and project delay were met by formal client adversarial communication and issuance of non-conformance letters by the employer's agents. Value management was not initiated at the time of data gathering and the project actors focused primarily on the project parameters rather than the added value or enhanced functionality as means of cost reduction.

Table 5 Example of project gaps

Examples of project gaps
Unauthorized project spend
Re-design of ME packages
Electrical and IT design do not meet the scope
Client request to modify the design for computer labs in Academy A and sport facilities in Academy B
Contractor commission re-design of roof insulation
Changes in renewable energy requirements
Re-design of external work to reduce project cost

Both projects were procured as design and build. However, the gap analysis showed that the two projects were seen as chains of sequential events following the RIBA Plan of Work (2008a) despite the nature of design and build projects. This linear management view impacted on the communication pattern and network formation between project actors as discussed later in this paper.

The National Audit Office (2007) noted that some academies established collaborations to help share and reduce costs, either with the support of sponsors involved with more than one academy or by cooperating with local authorities. However, the DfES neither undertook nor commissioned post-project review.

In addition, a number of project gaps were identified during pre-design and design stages with impact on project delivery during construction. These included:

- no evidence of stage gate review or use of RIBA stage checklist;
- no evidence of reassessing project objectives (scope) or cost; and
- project schedule was reviewed in a reactive manner to scope creep.

These gaps can be categorized under gaps of definition, execution and conformance following the gap analysis model by Winch *et al.* (1998).

As a result, there was a tendency to re-agree the scope of work during construction on site. The respondents for the two projects agreed that, due to the nature of design and build, it was difficult to obtain clear stage definition or effective stage reviews and apply structured and consistent gap analysis.

The gap analysis of both projects confirmed the dominance of contractual arrangements between project parties, which dictated the communication channels. The communication was limited to parties linked through contractual agreement and there was little incentive for project members to communicate outside their contractual framework. The project actors considered gap analysis a useful tool for holistic project

control, but not necessarily at current project stage with a high level of design gaps.

The application of SNA enabled the examination of the communication patterns through 48 different communication networks. These were identified using the network parameters identified above. The consolidated networks used for the purpose of this paper are categorized as formal information exchange and informal discussion. Six different network configurations were represented for each project as shown in the network socio-grams in the following section. See Table 6 for reference of project networks.

With regard to Academy A, the formal information exchange network (01SWC) shows a relatively high density with regard to scope of work as the architect is a central receiver in this network and information is contained at that point. On the other hand, the high centrality of the contractor suggests a change in project governance under design and build with active information exchange between the contractor and the employer's adviser. The contractor showed less interest in lower priority information exchange. This reflects the contractor's lack of interest in information exchange in the absence of contractual reward as a form of performance incentive. Furthermore, the dominance of contractual relationship is once again confirmed by the quantity surveyor given relatively high centrality as shown in Figure 2.

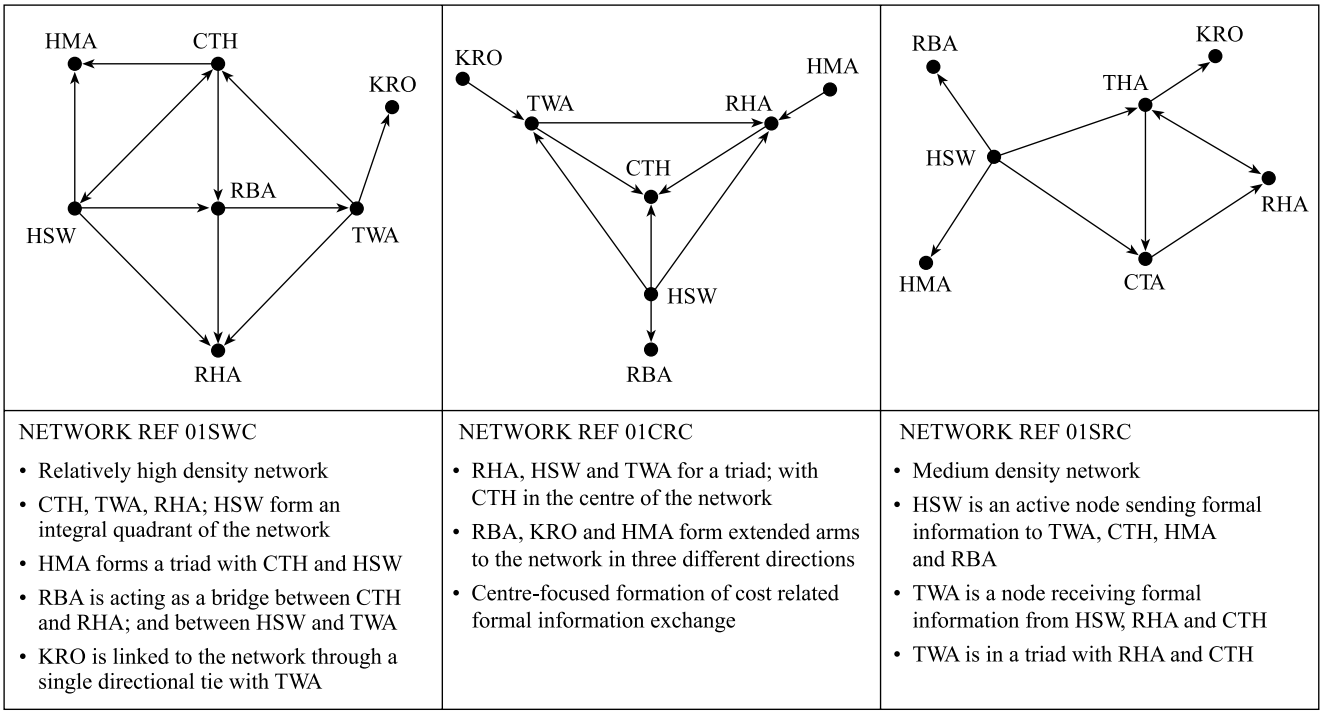
Table 6 Key to network diagrams

Network reference	Area of communication	Communication type
01SWC	Scope of work	Academy A Formal information exchange
01CRC	Cost related	Academy A Formal information exchange
01SRC	Schedule related	Academy A Formal information exchange
01SWD	Scope of work	Academy A Informal discussion
01CRD	Cost related	Academy A Informal discussion
01SRD	Schedule related	Academy A Informal discussion
02SWC	Scope of work	Academy B Formal information exchange
02CRC	Cost related	Academy B Formal information exchange
02SRC	Schedule related	Academy B Formal information exchange
02SWD	Scope of work	Academy B Informal discussion
02CRD	Cost related	Academy B Informal discussion
02SRD	Schedule related	Academy B Informal discussion

Notes: The first two digits (01) refer to (Academy A) and (02) to (Academy B). SW: scope of work, CR: cost related, SR: schedule related, C: formal communication, D: informal discussion.

The cost related information exchange network (01CRC) shows high centrality and the active role of the project quantity surveyor, reflecting the dominant

Academy A Information Exchange Networks



NETWORK REF 01SWC	NETWORK REF 01CRC	NETWORK REF 01SRC
• Relatively high density network • CTH, TWA, RHA; HSW form an integral quadrant of the network • HMA forms a triad with CTH and HSW • RBA is acting as a bridge between CTH and RHA; and between HSW and TWA • KRO is linked to the network through a single directional tie with TWA	• RHA, HSW and TWA for a triad; with CTH in the centre of the network • RBA, KRO and HMA form extended arms to the network in three different directions • Centre-focused formation of cost related formal information exchange	• Medium density network • HSW is an active node sending formal information to TWA, CTH, HMA and RBA • TWA is a node receiving formal information from HSW, RHA and CTH • TWA is in a triad with RHA and CTH

Figure 2 Information exchange network—Academy A

culture of contract administration in the UK construction industry. In addition, the sole link between the quantity surveyor and the employer's agent confirms the increase in cost management as the main interest of the project team operating within a strict budget approval mechanism and limited risk allowance.

The analysis of schedule related network (01SRC) shows the quantity surveyor, project architect, contractor, the employer's adviser and the employer's agent have a similar level of centrality and exactly the same number of ties. This tends to show the dominance of a rather traditional project management approach based on contract administration.

The scope of work informal discussion network (01SWD) is a representation of discussion networks as sub-groups with no links across. This socio-graph reflects the dominance of the contractual relationship and a lack of informal discussion between the project actors. Although contractually linked to the contractor, the architect forms a discussion link with the employer's agent, with the contractor and the client's agent being isolated in this network, which suggests absence of team spirit.

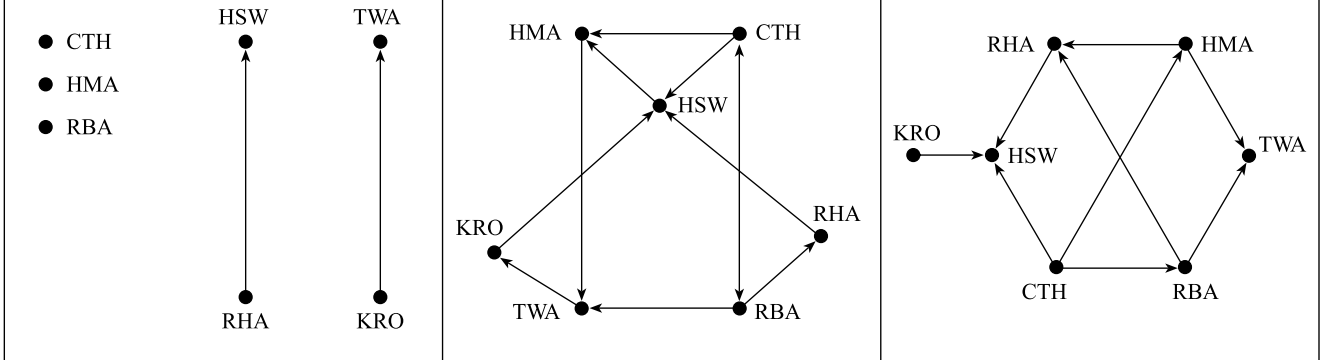
The cost related discussion network (01CRD) shows a very low level of interest among the project team to engage in non-directional cost related communication. The comparative analysis of cost related formal information exchange and informal discussion networks shows a communication gap between the project actors and significant separation between formal and informal network typology. This can be explained by the project culture of primacy given to the contractual relationship. There was a general perception among the project team that formal information exchange supersedes the need for non-directional communication.

The schedule related (01SRD) discussion is very limited to single directional ties between actors in an identical manner to the cost related discussion network. The dominance of single directional communication networks was seen to hinder efficient project coordination and is perceived as a sign of high risk where project opportunities are overlooked.

On the other hand, Academy B scope of work formal information exchange network (02SWC) shows an active network with relative high density, and high centrality for the architect and the contractor, which reflects the contractual link under design and build during the project execution stage, and the interest in reviewing the scope of work. The high centrality of the M&E engineer and the project quantity surveyor shows that the M&E scope of work is a major concern of the project team.

The cost related network (02CRC) is linear single directional information exchange which reflects the rigid project structure and the primacy of the project

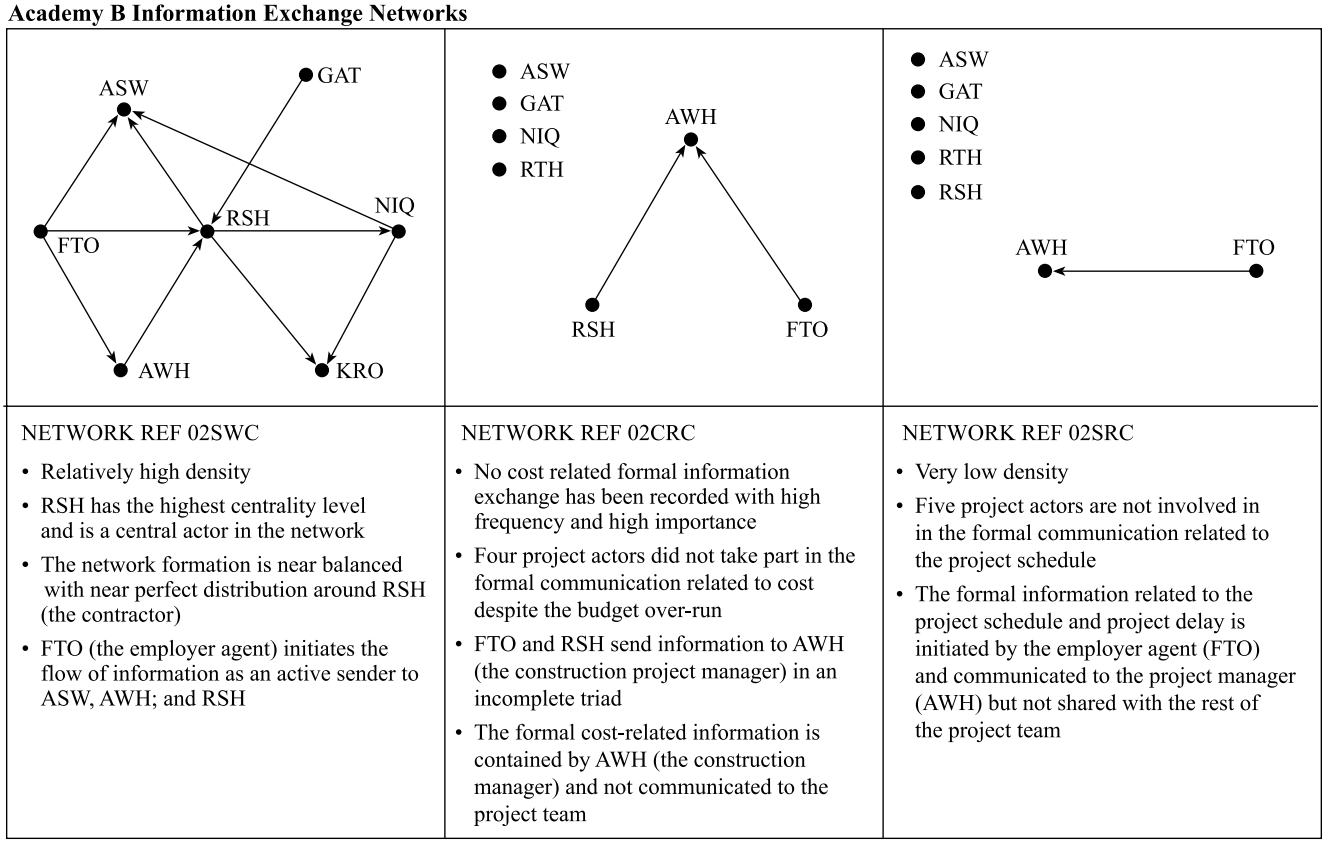
Academy A Discussion Networks



NETWORK REF 01SWD	NETWORK REF 01CRD	NETWORK REF 01SRD
• Very low centrality density network • Three actors of the project forms isolates and are not involved in the shedule-related informal discussion • Two separate sub-groups in dyadic relationships	• Medium density network • HSW is a central actor in this network • CTH, RBA, TWA, and HMA form the central quadrant of the network • RHA is acting as a bridge between RBA and HSW • KRO is a bridge between TWA and HSW	• A very balanced network formation • All actors have the same centrality level except for TWA • KRO acts as an initiator in this network

Figure 3 Discussion network—Academy A

Academy B Information Exchange Networks



NETWORK REF 02SWC	NETWORK REF 02CRC	NETWORK REF 02SRC
• Relatively high density • RSH has the highest centrality level and is a central actor in the network • The network formation is near balanced with near perfect distribution around RSH (the contractor) • FTO (the employer agent) initiates the flow of information as an active sender to ASW, AWH; and RSH	• No cost related formal information exchange has been recorded with high frequency and high importance • Four project actors did not take part in the formal communication related to cost despite the budget over-run • FTO and RSH send information to AWH (the construction project manager) in an incomplete triad • The formal cost-related information is contained by AWH (the construction manager) and not communicated to the project team	• Very low density • Five project actors are not involved in in the formal communication related to the project schedule • The formal information related to the project schedule and project delay is initiated by the employer agent (FTO) and communicated to the project manager (AWH) but not shared with the rest of the project team

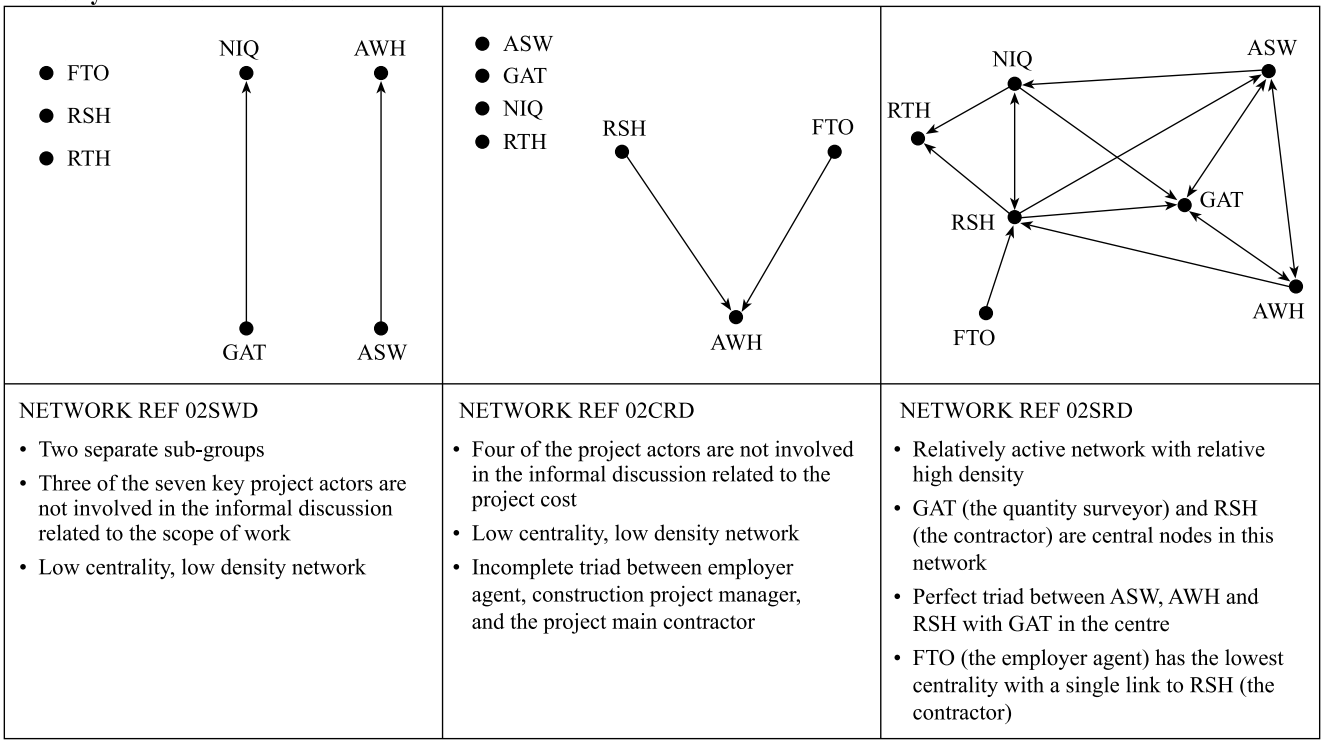
Figure 4 Information exchange network—Academy B

contractual relationship. The isolation of the rest of the project team reflects a poor level of formal information exchange on cost related issues. At the time of the analysis, Academy B recorded 7% unauthorized spending during the construction stage. As a result, the project experienced a higher level of client involvement as seen in the socio-gram. However, there are no indications that the project benefited from the high centrality and connectivity of the employer's agent in this case. The schedule related information exchange network (02SRC) comprises an isolated dyad (a link between two actors) involving the client and the employer's agent.

The programme delay and budget overrun were frequently highlighted as critical project issues in the monthly project progress reports. However, the associated network diagram indicates avoidance of formal cost and schedule related information exchange between the project actors, but rather informal attempts to restructure the scope of work as an alternative corrective action. With regard to the informal discussion networks for Academy B, no high priority discussion network has been recorded with regard to scope of work. The fact that such a network is missing and that the project is behind schedule and over authorized budget tends to confirm the observations of formal and adversarial relationships between project actors. In addition, the low frequency, low significance network (02SWD) is a linear network with very low centrality with minimum discussion links confirming the same. The employer's agent has the highest centrality in this network which shows an attempt to address the problem.

The unauthorized spending impacted on the low priority cost related informal discussion network which shows the project team's awareness of project issues. However, the project coalition did not show constructive actions towards the problem; and no formal or informal information exchange has been recorded with high density and/or connectivity (see socio-gram 02CRD). On the other hand, the schedule related discussion network (02SRD) shows high density and active discussion on project schedule which tends to confirm the nature of the project implementation stage and the interest of the DfES in meeting project practical completion and timely opening of the academy.

Academy B Discussion Networks



NETWORK REF 02SWD	NETWORK REF 02CRD	NETWORK REF 02SRD
• Two separate sub-groups • Three of the seven key project actors are not involved in the informal discussion related to the scope of work • Low centrality, low density network	• Four of the project actors are not involved in the informal discussion related to the project cost • Low centrality, low density network • Incomplete triad between employer agent, construction project manager, and the project main contractor	• Relatively active network with relative high density • GAT (the quantity surveyor) and RSH (the contractor) are central nodes in this network • Perfect triad between ASW, AWH and RSH with GAT in the centre • FTO (the employer agent) has the lowest centrality with a single link to RSH (the contractor)

Figure 5 Discussion network—Academy B

Discussion

The two case studies demonstrated importance of time and cost as primary measures of project success during project execution, with an emphasis on the contractual arrangement as a means of effective project control. It has been widely accepted to portray project contractual relationships in different forms of organizational charts. However, such representation is nothing but simplification of project networks with no reference to information exchange between project actors. 01CRC and 02CRC socio-grams are examples of SNA application to capture communication networks that accurately reflect the contractual relationships between the quantity surveyor and the employer's agent. Wider application of SNA can assist practitioners in addressing project reporting requirements, for instance, as a means to reform project contractual relationships in an iterative process to ensure continuous adjustment of contracts under new procurement. The current interest in the traditional approach towards 'contract administration' was reinforced by two factors: the position of the profession of quantity surveying in the UK construction industry and the dominant adoption of the RIBA Plan of Work (2008a). However, in the current economic downturn, financial institutes, project sponsors and practitioners can benefit from developing a collaborative environment under new procurements (Pryke, 2004a) to facilitate prompt decision making and ultimately time saving and cost reduction in projects.

Construction projects are viewed as chains of activities and are managed through continuous evaluation of their schedule and cost impact, with an absence of a holistic management view. The need for effective collaboration was introduced to the industry through the Latham (1994) and Egan (1998) Reports. However, neither of the two reports provided a model demonstrating how to initiate and maintain collaborative environments. Nevertheless, the post-Egan period focused on the creation of a collaborative working environment and reviewed the central role of the client, through collaborative communication networks in project coalitions.

The RIBA (2008a) Plan of Work has a leading role in the development of the management of projects. The RIBA (2008b) *Plan of Work: Multi Disciplinary Services* is a milestone in the recognition of the need for multidisciplinary interaction and indirectly signifies the role of cross-functional communication between project actors. It also shows a clear recognition of different procurement routes and the resultant impact on the management of projects (and communication networks) in line with the Office of Government Commerce (OGC) gateways.

Gap analysis, in the context of construction projects, is represented to conceptually promote the role of clients and focus on added value as a means to achieve client satisfaction and to assist practitioners in addressing design-led projects. However, gap analysis, in the context of construction projects, focuses on the process integrity, in a linear manner, in contrast to the organic structure of information exchange networks and the multi-faceted nature of projects.

The SNA socio-grams highlighted the role of the quantity surveyor as a bridge in the formal communication network between different project actors, conforming with the constraint imposed by the approach towards contract administration. Similarly, the contractor recorded the highest project centrality, which mirrored the nature of the project execution stage.

However, despite the project delay, the informal discussion networks recorded the least centrality. The majority of project actors acted in isolation (with no direct or indirect ties to the project actors) which limited their contribution to the formal information exchange, repetitively to emphasize the project gaps identified under gaps in conformance.

There is still a general tendency to focus on project time, cost and scope during the project execution stage in isolation from project objectives. The authors appreciate the project team focus on project parameters. The findings suggest that developing adequate project controls and project governance tools to serve the client's interest in a less adversarial management framework essential for project success can be achieved through:

- early and continuous involvement of clients;
- clear identification of project scope, objectives and parameters;
- early development of project governance including cost and design management;
- developing project management office; and
- development of real time project reporting.

Social network analysis was introduced as a complementary tool to gap analysis in a dynamic format in line with the organic nature of projects. The application of SNA is used to examine communication patterns in projects and provide detailed insight of projects (at the time of the analysis), which, in turn, allows project managers to identify problems overlooked by gap analysis and a primary focus solely on contractual relationships.

Although the application of gap analysis and SNA are found useful for understanding construction projects, they are limited individually as management and monitoring tools. While the identification of project gaps through gap analysis follows a linear pattern through the project life cycle, the current application of social network analysis is limited to retrospective analysis, being a retrospective point-in-time view of projects. The combined use of both tools allows better understanding of communication patterns in construction projects.

Conclusion

Project success is perceived differently by project actors. The change in the client's role in construction projects has led to changes in management views on project success and consequently, client satisfaction is considered a principal measure for project success. The post-Egan era gave rise to a number of management initiatives and provision of management tools geared towards project success and client satisfaction. Winch *et al.* (1998), for example, identified the significance of involving the client throughout the development cycle and concluded that higher levels of client satisfaction could be achieved through fewer client 'surprises'. They proposed gap analysis as a means to identify and manage project gaps.

In the context of design-led construction projects, gap analysis, as a linear management tool, has the tendency to focus on the process integrity and the emphasis on formal contractual links between project stakeholders, as a result of the process-based management approach. Higher levels of project controls can be achieved through the identification of project gaps throughout the life cycle or rather project processes, in line with the RIBA Plan of Work to identify briefing gaps, design, construction, execution and performance gaps. Systemic application of gap analysis and use of stage 'watch points' developed by the RIBA is an extended application of the scientific management tools with further emphasis on time, cost and quality. While useful to address process compliance issues, it does not address the underlying aspects of information exchange, the connectivity and centrality issues in project coalition or the quality of information exchange.

On the other hand, social network analysis (SNA) was introduced as a non-linear complementary management tool to help practitioners capture the spontaneous formal and informal interaction between project actors at different project levels.

This paper addressed the application of SNA in a pilot study of two under-construction projects in the Academy Programme of the DfES, and examined the potential use of SNA to identify network gaps.

The findings confirmed the dominance of the RIBA Plan of Work, a linear management approach throughout the various project stages. The project teams focused their effort on the current project stage in isolation from, and perhaps in ignorance of, clients'

expectations. This was confirmed with gap analysis to capture execution and conformance gaps in both of the case study projects due to limitations in identifying project issues outside project processes governed by the contractual framework. Project corrective actions were proposed by contractors to either reschedule or re-scope the projects as a means to deal with project delay and escalation of cost. In its annual report, the National Audit Office (National Audit Office, 2007) noted that the academy projects suffered from escalation in capital cost and the programme could have benefited from (additional) project management expertise.

The examination of project networks showed low levels of network density in general and high centrality for the quantity surveyor and project contractor, reflecting the somewhat dominant role of the quantity surveyor in UK construction coalitions and contractors in design and build projects.

While 'gap analysis' provided the platform for the concept of added value and can be utilized at project strategic levels, SNA allowed a close-up view of information exchange and communication patterns in projects. The combined use of gap analysis and SNA was found to be a powerful tool to examine project inter and intra networks for effective project governance. Early identification of project network gaps will facilitate an effective proactive management approach to minimize project surprises and effect collaborative communication between project actors, which will enable successful delivery of project objectives. In addition, close point-in-time assessment of communication patterns and network typology in projects with reference to network centrality and connectivity will help practitioners identify the required shift in focus in communication between project actors to enhance management of projects.

As further research is required to examine the evolution of project network gaps, throughout the project life cycle, these longitudinal studies would focus upon project governance mechanisms outside project contractual networks and the shift in control throughout the project life cycle.

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