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Understanding the early stages of the innovation diffusion process: awareness, influence and communication networks

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The themes of awareness and influence within the innovation diffusion process are addressed. The innovation diffusion process is typically represented as stages, yet awareness and influence are somewhat under-represented in the literature. Awareness and influence are situated within the contextual setting of individual actors but also within the broader institutional forces. Understanding how actors become aware of an innovation and then how their opinion is influenced is important for creating a more innovation-active UK construction sector. Social network analysis is proposed as one technique for mapping how awareness and influence occur and what they look like as a network. Empirical data are gathered using two modes of enquiry. This is done through a pilot study consisting of chartered professionals and then through a case study organization as it attempted to diffuse an innovation. The analysis demonstrates significant variations across actors' awareness and influence networks. It is argued that social network analysis can complement other research methods in order to present a richer picture of how actors become aware of innovations and where they draw their influences regarding adopting innovations. In summarizing the findings, a framework for understanding awareness and influence associated with innovation within the UK construction sector is presented. Finally, with the UK construction sector continually being encouraged to be innovative, understanding and managing an actor's awareness and influence network will be beneficial. The overarching conclusion thus describes the need not only to build research capacity in this area but also to push the boundaries related to the research methods employed.

Keywords: Communication, critical perspective, diffusion, innovation, social network analysis.

Introduction

This research seeks to add to the innovation diffusion literature, with a particular focus on the UK construction sector. The aim of the research is to better understand how actors become aware of an innovation and then how their opinion regarding the innovation is influenced. It is acknowledged that the innovation diffusion literature draws upon a broad range of themes, embedded in numerous theoretical schools while also being methodologically fragmented. The innovation diffusion themes central to this research relate to the early stages of the diffusion process (cf. Rogers, 2003) and are *awareness* and *influence*. The research seeks to understand how these themes manifest themselves within actors' contextual settings and the broader institutional forces. The importance of contextual settings have long been championed in literature relating to broad management (Pettigrew, 1997), innovation diffusion (Schot and Rip, 1996) and more specifically construction management innovation (Bresnen and Marshall, 2001; Lu and Sexton, 2006) as impacting on how actors influence and interpret the world around them. This is significant, as understanding how actors become aware of an innovation and then how their opinion is influenced is important when seeking to create a more innovation-active UK construction sector. A research design using two alternative modes is developed around a pilot population of chartered

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construction professionals and then within a case study organization seeking to adopt an innovation. Questions for respondents focus upon key themes, all of which literature claims will shape awareness and influence. Social network analysis (SNA) is used to map the awareness and influence networks of actors. The analysis and discussion point towards unique networks for actors, which may not be particularly surprising to some. However, it is the extent to which such networks differ that is interesting, illustrating that actors have very different *capabilities* in association with awareness and influence within the innovation diffusion process. A more fine-grained observation reveals evidence of a number of influence networks with an egocentric structure, which are thus very inward looking. The implications of these findings are discussed and the research culminates with an explanatory framework to make sense of these awareness and influence networks while remaining mindful of associated themes within these embryonic stages of the innovation diffusion process.

Calls for improved innovation diffusion

Like many business sectors, UK construction has been the focus of a number of studies from policy-makers and business commentators related to innovation. The current doctrine sees UK businesses encouraged to be competitive through innovation (cf. Reid and Peter, 2008; Mason *et al.*, 2009). In the UK the Department for Business, Innovation & Skills (BIS) seeks to promote and steer innovation within businesses. It offers an assessment demonstrating where practitioners are 'innovation active' related to different industries and highlights the UK construction sector as needing support to encourage innovation and the diffusion of said innovations (cf. Hauser, 2009). The UK Innovation Survey 2010 (Robinson and Kenchartt, 2010) describes the UK construction sector as 'less innovation active' compared to other sectors. Of course numerous reports have been commissioned over recent years aimed at improving the UK construction sector through the adoption and diffusion of innovations, typically from other sectors such as manufacturing (e.g. Latham, 1994; OST, 1995; DETR, 1998). While such recommendations are debated in the academic literature (cf. Koskela *et al.*, 2002; Green and May, 2003) what remains clear is that the UK construction sector needs to understand how to be more innovation active, how to become aware of innovations and how opinions regarding innovations are influenced. This research contributes to tackling this challenge.

Innovation diffusion within a construction sector context

In order to respond to the demands outlined above it is important to outline the academic literature surrounding innovation diffusion. While the antecedents of innovation research can be traced back to the work of Tarde (1903) and the early work of Rogers (1963), interest from the construction management literature is still in its infancy (Sexton *et al.*, 2001). Historically construction management literature has focused on innovation as a technology while drawing upon a positivist perspective (cf. Tatum, 1986; Pries and Janszen, 1995; Slaughter, 1998, 2000; Mitropolous and Tatum, 2000; Koskela and Vrijhoef, 2001). While such research has offered significant advancement and understanding, more recent developments have further stimulated the academic debate by drawing on the interpretivist perspective (Bresnen and Marshall, 2001), the critical perspective (Fernie *et al.*, 2006) and the socio-technical systems perspective (Whyte, 2003). Indeed, recent studies concerning innovation diffusion have focused on a number of aspects of the process including awareness (Larsen, 2005a, 2005b), influence (Harkola, 1995) and communication (Emmitt, 1997). Despite developments in literature the connection and importance of the contextual settings and institutional forces across projects, departments, companies and the construction sector with innovation diffusion are over-simplified. Green *et al.* (2005) note that such contextual considerations are rarely viewed as an active part of the analysis. Of course, steps to address this are being taken and a number of scholars have championed the significance of context (cf. Fernie *et al.*, 2003; Green and May, 2003; Green *et al.*, 2008, 2010). Such examples draw on the broader management literature and its explanatory concepts including capabilities, embeddedness and localized learning to name but a few. Here innovation is viewed as something new to the observer, with elements of both risk and uncertainty (cf. Larsen, 2005a).

Context can of course be interpreted in a number of ways, ranging from a fairly static landscape upon which actors are free to direct change, with some viewing context as a connecting mechanism between concepts in order to make sense of the reality experienced (Ormiston and Schrift, 1990). Others argue that academics analyse data with a point of reference, and that point of reference is the context (Dilley, 1999). Thus, different theoretical perspectives yield different conceptualizations of context. However, some consensus can be found in that understanding context is a fundamental challenge associated with social science research (Dilley, 1999). In this research

the contextual setting is viewed as fluid, constantly changing, shaped by yet also shaping the actions of actors, thus it has a number of attributes including rules, social norms, group dynamics, communication and institutional forces. As such, the contextual setting should be considered as an active part of any research analysis (cf. Green *et al.*, 2010). Rogers and Shoemaker (1971) highlighted communication networks as an attribute of contextual settings when seeking to understand the innovation diffusion process. More specifically, the influences within an actor's unique and usually highly informal communication network (based upon trust and friendship) have been championed as critical to understanding innovation diffusion within its contextual setting (Tichy *et al.*, 1979). It is through understanding such networks that we can gain an insight into *part* of an actor's contextual setting, how actors become aware of an innovation and then how their opinion is influenced. Finally, although not the focus of the research *per se*, these networks are significant as they will have a direct impact on responses to questions asked in an interview situation between a researcher and the practitioner. The practitioner's contextual setting in part shapes how they experience and discuss the innovation diffusion process. Certainly this type of fine-grained contextual consideration (why practitioners hold certain views) and its influence upon the innovation diffusion process generally is somewhat under-represented in the construction management innovation literature.

Awareness, influence and communication networks

With communication networks accepted as an active part of any contextual setting, it is now possible to consider the themes of awareness and influence which run through such networks. Significant early work includes the Tavistock Institute's *Communications in the Building Industry*, the report of a 'pilot study' (Higgin and Jessop, 1965) and *Interdependence and Uncertainty* (Crichton, 1966). The work of Mackinder and Marvin (1982) still commands attention, as this brought to the fore how communication networks and the awareness and influence which flow through them were employed in solving design problems. Somewhat more recently Emmitt (1997) used Rogers's (1995) innovation diffusion framework to understand the communication between the architect and the specifier during the design process. Luck and McDonnell (2006) continued the architectural theme in seeking to understand how innovative design occurs through communication between stakeholders with a specific focus on conversations. Similarly, others (e.g. Loosemore, 1998; Swan *et al.*, 2001; Emmitt and Gorse, 2007) continue to champion the significance of communication and networks, yet all readily acknowledge the challenges of empirically accessing this type of data. This issue of empirical access will be returned to later.

It is well established that communication networks hold valuable understanding about awareness and influence (cf. Aldrich and Zimmer, 1986); however, it is important to position these themes in a broader discussion. It is argued that both awareness and influence mainly manifest themselves through communication and networks of communication. Literature of course outlines other influences for consideration at these early stages such as *needs* (Hassinger, 1959), *selective exposure* (Rogers, 1995) and *contextual thresholds* (Valente, 1995) and while not the primarily focus of this research these will also be discussed in forthcoming sections. Communication takes different forms: actors observe, hear, and speak which all constitute a form of communication. Other forms include body language and physical actions. With the themes of the research determined, it is important to acknowledge other related concepts, such as *peer pressure* (Zenger and Lazzarini, 2004), *groupthink* (Janis and Mann, 1977) and *power* (Ibarra, 1993) which all play a role in understanding awareness and influence regarding the innovation diffusion process. While these may help explain how awareness and influence manifest within a communication network regarding innovation diffusion, it is also important to understand the shape of the network and its interrelationship with the contextual setting it occurs in and the broader institutional forces.

Attention is therefore turned to where such communication networks are enacted, the projects, firms and construction sector generally. The UK construction sector is often described as being fragmented which in turn acts as a barrier to communication, change and innovation (cf. Akintoye *et al.*, 2000). This fragmentation certainly offers challenges and these are well documented, for example Wallace (1987) argued that as actors entered and left a particular construction context (a project or firm) the effectiveness of the communication in that network would be adversely affected. Wallace claimed that group communication would actually regress to lower levels, reminiscent of those experienced in the early development of the communication network. Gameson (1992) fuelled such concerns describing communication within a construction project context as *socio-emotional*, whereby the fluid nature of the communication network (with actors entering and leaving) meant the high levels of trust essential for diffusing innovation would never be reached. Such arguments appear to contrast the theory of weak

communication ties promoted by Granovetter (1973, 1978). As such, the potential positive impact a transient workforce, and its weak communication ties could have on awareness and influence regarding innovations remains a research requirement within a construction sector.

It is not possible to discuss the importance of contextual settings on awareness and influence regarding innovation diffusion without considering how construction firms structure themselves. Emmitt and Gorse (2007), while focusing on construction and design teams, highlighted the importance firm structure can have on communication. Noteworthy are the challenges and complexities Emmitt and Gorse faced in trying to understand in detail a small network consisting of eight actors within a project meeting. This demonstrates the difficulty facing research into communication networks associated with innovation diffusion. A significant part of that challenge is that the contextual settings, including the networks, are not static but in a constant state of flux and thus require a suitable theoretical perspective (cf. Larsen *et al*., 2008). Clearly, the broader institutional forces play a role, setting the rules by which firms and the sector operate (Currie and Suhomlinova, 2006).

Associated innovation diffusion themes

Literature offers a number of explanatory themes associated within innovation diffusion such as *needs* (Hassinger, 1959), *selective exposure* (Rogers, 1995), *institutional/structural thresholds* (Valente, 1995) and *personal thresholds* (Larsen, 2005a). These themes go some way to demonstrating the fundamental fragmentation within the literature. Hassinger (1959) argued that actors must feel the need for an innovation before seeking information about it and thus beginning the first stages of awareness. This empowers the actor regarding awareness, as if actors don't feel the need for an innovation they won't engage in awareness and influence. Similarly, Rogers (1995) used the term 'selective exposure' related to awareness, and argued that actors would consciously or subconsciously avoid messages that are in conflict with their personal inclination. Again, this empowers the actor, giving a degree of choice regarding awareness and influence, in that they can choose not to become aware of an innovation. Placing actors at the centre of the process in this fashion aligns more with an interpretive perspective (Sarantakos, 1993). However, it is argued that actors' perceptions of what they *need* and their *personal inclinations* are influenced by their contextual setting, their communication network and the broader institutional forces. Therefore, it might be more difficult for actors to avoid innovations than Hassinger and Rogers initially suggest. As ever the literature offers an alternative argument, this time leaning towards a positivist perspective (Sarantakos, 1993) whereby actors are governed by laws of behaviour and have limited choice. Today actors are bombarded with messages through various forms of media and advertising as well as their own ever-expanding communication networks. Such arguments align with the notions of 'system thresholds' (Valente, 1995) 'structural equivalence' (Burt, 1982) and even 'groupthink' (Janis, 1972) when considering the innovation diffusion process.

It is argued that dichotomizing our understanding in such a manner is counter-productive and unrepresentative of the process. It is more useful to view actors as influenced by yet also influencing contextual settings and broader institutional forces (cf. Pettigrew, 1997). This notion is of course embedded in the agency-structure perspective and championed by giants within social science such as Archer (1988), Giddens (1979), and Ritzer (1996) and associated critical literatures which seek to move beyond traditionally polar opposites of positivism and interpretivism. Thus, what is required is a better understanding of the interplay between the various themes discussed, how they impact on actors, projects, firms and even the construction sector and the complementary research methods needed to understand them.

With the above points in mind, it becomes clear that individuals experience awareness and influence very differently. Chance exposure to innovations, highly structured and powerful marketing campaigns, and the persuasive powers of an actor's communication network within their contextual setting are all relevant yet unique. Additionally, the actor's age, education, geographical location or financial position have a role to play (Rogers, 2003). Certain actors may be in a position allowing high levels of awareness of innovations, while others find themselves somewhat under-exposed to innovations. This directly affects an actor's opportunity to even enter the innovation adoption and diffusion process. Actors may be better equipped personally as well, having better social skills for engaging in the awareness and influence process. Through considering the polarized positions and explanatory themes above it becomes increasingly clear that actors actually have less control than some might suggest (cf. Hassinger, 1959; Rogers, 2003). Yet, it is also clear that actors are not passive and directly controlled by externalities as others allude to (cf. Burt, 1982). Actors form their awareness and are influenced through an iterative interaction with their

contextual setting (part of which is their unique communication network) and broader institutional forces.

From the literature reviewed and arguments mobilized it is important to restate the key aim of the research before outlining the methodological justification and empirical research design. The aim of the research is to better understand how actors become aware of an innovation and then how their opinion might be influenced related to that innovation. In addressing this aim, the research offers insights into the importance of unique communication networks within given contextual settings while influenced by and influencing the broader institutional/structural forces. A by-product of this is improvement of our understanding of suitable research methods for achieving this as well as the extent to which suitable data are empirically accessible.

Methodological justification

With the complexity of the research subject discussed attention is turned to the methodological challenges raised by the research aim. In order to address the ontological assumptions made within the research the critical perspective (cf. Sarantakos, 1993) is used as a touchstone thus recognizing the strengths of both positivistism (structure) and interpretivism (actors). While positivism emphasizes structure and interpretivism champions the actor, the critical perspective recognizes both as important and insists they be considered as interconnected and not separate at all (Whittington, 1988). From such a perspective the themes of awareness, influence and communication networks align with what Fairclough *et al.* (2002) describe as ideally real. Awareness and influence are psychological states experienced by an actor which represent something real. Fleetwood (2005) describes themes such as awareness and influence as having causal efficacy meaning they have the ability to produce effects and change. This is certainly true of awareness and influence as they will affect the innovation diffusion process. Therefore, the research places high importance on structure and on actors. Communication networks can be seen as providing the temporal space where awareness and influence may reside, are socially negotiated by actors, while still interdependent with an actors' interpretation and also the broader structural forces. This allows innovations to be ascribed meaning, value, and even to manifest themselves to suit particular contexts. Aldrich and Zimmer (1986) demonstrate that communication networks and thus the relational ties which form them provide a key unit of understanding.

Method

The arguments mobilized thus far enable us to appreciate the role of both actors and their contextual setting as interconnected, where actors both shape yet are shaped by their contextual setting (cf. Pettigrew, 1997). Similarly, the argument enables the research to insist on recognizing both structure (typically championed by positivists) and actors (typically championed by interpretivists) in any understanding offered (cf. Whittington, 1988). The unit of analysis thus begins to consider actors as having an iterative relationship with the structure (network and broader institutional forces) through which awareness and influence are shaped, changed and contested over time. One method for mapping out such networks is social network analysis (SNA). This branch of sociometry claims to reveal unseen structures that shape groups through the position of actors within them: alliances, subgroups, beliefs and personal agendas (Moreno, 1951). The historical development, methods and application of SNA are well documented (cf. Wasserman and Faust, 1994; Scott, 2000). Briefly, Bavelas (1950) and Bavelas and Barrett (1951) laid the foundation for what would become SNA. Their work adopted a structuralist perspective, whereby the relational communication ties were viewed as part of a closed system, and the constraints of the system essentially governed the choices available to the actors. Katz's (1955, 1957) seminal work was embedded in a more pluralistic perspective linking innovation diffusion and informal communication networks, thereby reinstating the actors and their choice as an inseparable part of a social system and the analysis process. As such sociometry, like many fields, has theoretical fractures often resulting in the early pioneers' work being subjected to reanalysis (cf. Burt, 1982). The complementary relationship between innovation diffusion and SNA is well established (cf. Burt, 1982; Valente, 1995).

Advocates of SNA view a system and how it functions as a *whole*, by mapping the interrelationships between its members (termed nodes) and is thus embedded in a positivist perspective with structuralist leanings. SNA is traditionally used to map relational data in order to statistically analyse a network's constituents and is thus useful for mapping awareness and influence within a contextual setting (Scott, 2000). Certainly SNA is no panacea with Leavitt (1951), Pool (1973), McQuail (1987) and Windahl (1992) all struggling to make sense of the quantity and the quality of the data provided by the networks they produced. This can often result in more questions than answers. It is acknowledged that SNA is

still evolving—something which is demonstrated by the different ways it is used. For example, although SNA is embedded in the positivist perspective it is used here in a less deterministic yet complementary fashion. No novelty is claimed in this, as literature is increasingly populated by research drawing on a critical perspective and using SNA in a more descriptive rather than prescriptive fashion (cf. Peay, 1980; Lievrouw *et al.*, 1987; Bidart and Lavenu, 2005; Agneessens *et al.*, 2006). For example, Coviello (2005) outlines a 'bifocal' approach using SNA and content analysis while readily acknowledging the challenges of managing the dynamic nature of the network. As such, unlike traditional SNA studies, readers will not find pages of calculations or measures of betweenness or centrality, as it is argued such social constructs cannot be *measured* with any real meaning. However, what is offered is an improved understanding of awareness and influence and discussion of how SNA might be used as a complementary method.

SNA has a number of proponents in the construction management research community and has been used in a variety of ways. Loosemore (1998) used SNA to complement more qualitative techniques to offer an understanding of crisis management efficiency. Focusing upon a case study of innovation within a construction contracting firm, Harkola (1995) mapped how actors used communication at different stages of the diffusion process. The diffusion occurring through those communication networks was then subsequently explained using concepts from alternative paradigms, cohesion (Katz, 1955) and structural equivalence (Burt, 1982). Swan *et al.* (2001) and Larsen (2003, 2005a) experimented with the technique in order to understand the shape of trust networks and innovation diffusion respectively. However, it is perhaps the ongoing work of Pryke and his commitment to SNA that offers the most engaging contribution for the construction sector. Pryke has studied a range of issues using SNA, including project governance (Pryke, 2005a; Pryke and Pearson, 2006), project success factors (El-Sheikh and Pryke, 2010), and project coalitions (Pryke, 2004) while innovation has been a recurring theme in his work (cf. Page *et al.*, 2004; Pryke, 2005b).

Research design

Two alternative modes of enquiry were pursued (pilot and case study), using alternative populations and administration techniques. Importantly, both approaches asked the same questions established from the seminal literature. Questions focused upon whom actors went to for advice, communicated with, who they felt drove innovation, which people they saw as friends, innovators, socialized with, trusted and most importantly sought opinions from—all of which shape the awareness and influence stage of the innovation diffusion process (cf. Tichy *et al.*, 1979; Albrecht and Ropp, 1984; Krackhardt, 2003). Thus, the questions sought to map the awareness and influence, nothing more. In both modes of enquiry the questionnaire structure followed that of Krackhardt (2003), seen within the literature as the template for accessing SNA data.

Pilot study

The pilot study had no specific innovation focus and no bounded context such as a project or company. The only boundary was membership of a professional body related to the construction sector, the Chartered Institute of Building (CIOB), the Royal Institute of British Architects (RIBA) and Royal Institution of Chartered Surveyors (RICS). Contact details of members were gained from the publicly available records published by each institution. The Dillman Total Design Method (Dillman, 2000) was employed to administer a questionnaire survey targeting professional members of said institutes. Members were sent a prior notice letter informing them of the research and that a survey would be sent in a few days' time, asking them with whom they communicated about innovation. The survey was sent a few days after the letter. If no response had been received after one week a reminder letter, along with another copy of the questionnaire was sent. If after two weeks a respondent had not returned the questionnaire, a final reminder was sent, again with a copy of the questionnaire. Of the 75 questionnaires distributed, only 15 were completed and returned, many of which included additional comments.

Case study

These data are derived from a division of a national civil engineering firm. The division was located in the South East of the UK and in the process of implementing an innovation (a new integrated management system) at the time of data collection. Employing this approach allowed data to be captured during the diffusion process. Thus, the findings were bound within the contextual setting of a specific innovation, a specific firm, and one constituent of the UK construction sector. A list of employees within the firm was used to develop a roster survey as advocated by Krackhardt (2003). A more interactive explanation of the study was possible than in the pilot study, as each of the

166 staff members within the division had the study explained to them either on a one-to-one basis or in small groups of four or five. This process ensured respondents understood the reasoning behind the questions while establishing a degree of trust between the researchers and the respondents. It was clarified that the 'integrated management system' was the innovation, rather than any developing structural changes within the firm. Once again, Krackhardt's questionnaire template was used. This resulted in 154 responses, thus producing 154 separate awareness and influence networks.

Producing networks

The responses from both data gathering modes were uploaded into a SNA computer software package called UCINET 6 (Borgatti *et al.*, 2002). Using the relational data provided a binary matrix is constructed whereby 1 represents the existence of a relationship and 0 represents no relationship. The matrix is made up of two axes using the relationship attributes established within the literature and previously discussed (cf. Tichy *et al.*, 1979; Albrecht and Ropp, 1984) and the nominations from the respondents. The software transforms the matrix, using statistical calculations into a map (known as a sociogram), based upon the data forming a *closed network* with no exogenous influences or potential connections (an acknowledged weakness in the SNA method).

Analysis of the networks

In order to initiate a discussion associated with the arguments made in the first half of the paper one example sociogram from each mode of enquiry is presented. Space clearly prohibits the presentation of all 169 sociograms (the total of both the pilot and case studies), although it is argued that this would offer little to the overarching discussion that follows and key points made. Each sociogram presented graphically represents the participants' responses to the questions and thus their perception (it is acknowledged that these might be 'politically correct' responses in some cases) of their own awareness and influence network. For the purposes of publication nominees have been assigned hypothetical names in order to ensure anonymity.

Initial observations and impact of the research design

The difference between the two networks shown is initially striking, with the case study network offering a far greater number of nominations and connections. It is therefore useful, in the first instance, to discuss the networks from a research design perspective. One of the starkest differences between the research modes adopted is that respondents to the pilot study approach refused to provide names of individuals, although there clearly was an interest in, and a willingness to contribute to, the research. As such, respondents provided not names, but descriptions of their contacts either by profession or by job title. The reasoning for this is reflected in the additional comments offered by the respondents, whereby respondents described feeling 'uncomfortable' divulging personal information and that they felt 'the questions were intrusive'. Such statements are understandable due to the lack of trust associated with a survey questionnaire administered via e-mail. Conversely, having a case study environment, where the context was bounded and senior management endorsed the research, together with a roster list of respondents helped in constructing a fuller network. The trust built up through the face-to-face explanations of the research helped overcome many of the concerns raised in the pilot study. Furthermore, the clarity of the explanation available through the case study approach, again face-to-face, allowed greater depth whereby respondents could air their concerns. All of these factors contributed to a much richer dataset using the case study population. Notwithstanding these positive issues, problems were encountered in the case study particularly the use of the roster survey with respondents making the following observations: 'The format is onerous and one of the most difficult surveys I have ever had to complete'; 'I have not been here long enough to really know anyone in this way'.

In addition, a number of respondents offered adverse comments about the potential value of the actual 'integrated management system'. A final comment regarding research design relates to the honesty of the answers offered, which is of course not unique to SNA research. It is worth mentioning that actors may feel compelled to answer questions in a manner they feel is politically correct associated with their contextual setting rather than how they actually behave or feel. This concern is more relevant to the case study enquiry, as the results were shared with senior management of the firm.

Overarching evidence of awareness and influence

With some of the research design issues discussed, attention now moves towards how the networks resonate with the arguments made in the first half of the paper. In the first instance it is useful to comment

broadly upon the shape of the networks and their significance. Neither of the networks presented is symmetrical. This demonstrates the idiosyncratic nature of such networks and the various actors involved. It would be difficult to describe the networks as being constructed through a rational or logical process. This is precisely the point the research is intended to highlight: actors experience awareness and influence differently and researchers need to understand this, access it and understand its impact. The differences in the networks clearly illustrate this. The shapes of these networks immediately demonstrate the infinite number of possible permutations associated with nomination, strength of relationships and connectivity, all of which impact on awareness and influence. The networks provide support for the arguments made, in that they can provide a picture of these themes.

Understanding the pilot study data

Turning to the pilot study data, office colleagues and particularly partners have considerable impact on how the respondent becomes aware of an innovation and then how their opinion of said innovation is influenced (see Figure 1).

Network orientation

Networks are often discussed in terms of their degree of direction, i.e. being inward or outward looking. This network is inward or egocentric looking which generates trust, an important issue for diffusing innovations. However, a network that is overtly egocentric can adversely affect awareness and even influence through ignoring messages from outside the network while potentially incubating elements of groupthink (cf. Veshosky, 1998). Adopting similar views as the colleagues nominated and failing to look further afield for ideas or question decisions is centrally important to understanding awareness and influence (cf. Janis and Mann, 1977). Owing to the egocentric shape of this network (and thus the high influence levels this brings), awareness of innovations from other contextual settings would appear to be restricted.

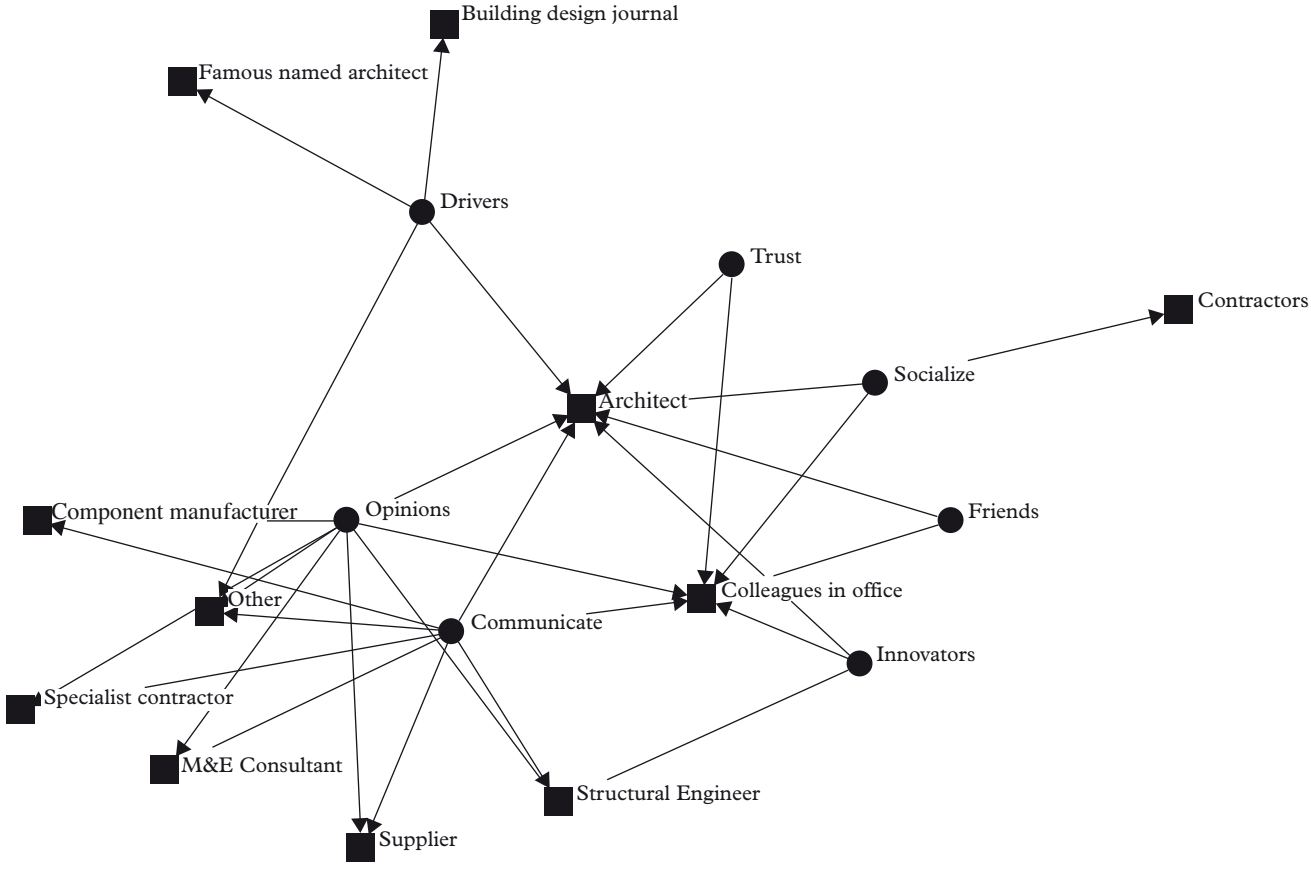

Figure 1 Example of pilot study data

Number and type of nominations

Actors with a greater number of nominations are often credited with being opinion leaders or innovators (Rogers, 2003). Opinion leaders would be those actors used to gain awareness and to help influence opinion regarding an innovation. The respondent views business partners as key in their awareness and opinions. Literature also associates a high level of nominations with the idea of actually being innovative (Valente, 1995). It is argued that the business partners identified are themselves innovators. However, when this is considered against the inward-looking nature of the network it raises more questions. For example, if these apparent innovative nominees (business partners) are isolated and don't posses bridging connections there is a risk their innovativeness could stagnate. The actors nominated as opinion leaders and thus seen as innovators need stimulation from outside their own contextual setting (cf. Granovetter, 1978). The data demonstrate that awareness and influence come predominately from the architect and business partners (colleagues in the office), though of course the other nominees play a role. Contractors appear to play a limited role regarding awareness and influence, a result that contradicts findings from other studies which have argued that contractors are a key source of innovation (cf. Slaughter, 1993). Regarding the type of nominations within the network, the data illustrate the absence of a number of key construction professionals, such as surveyors. This suggests that for this respondent, surveyors do not play a role in becoming aware of innovations, and also have little influence when forming an opinion regarding adoption. Other key stakeholders often associated with innovation such as the client (cf. Hartmann *et al.*, 2008) also fail to be nominated, thus further contributing to the academic debate. The networks produced from other respondents showed that various construction professionals fail to be nominated, thus further illustrating the importance of actors' networks and their contextual setting. It is proposed that business partners occupy such a position in the network in part because they are the formal decision makers within the respondent's company and will certainly have a degree of power.

Broader institutional forces influencing the network

It is important to recognize that the actor's network illustrated does not exist in a vacuum. It is assumed that the key nominees such as the partners (who are seen as opinion leaders and innovators) will have connections with others outside the network shown. The research design did not seek to access a second round of networks from key nominees (e.g. partners). However, it is accepted that it would be naïve to assume that the network illustrated is not interconnected with other networks and institutional forces (cf. Granovetter, 1985). Such considerations return to the research orientation, whereby actors are shaped by yet also shape their contextual setting (cf. Pettigrew, 1997). Other factors are of course relevant, such as education, literature accessed on a regular basis or relevant events attended, to name but a few.

Understanding the case study data

The network produced from the case study population is complex (Figures 2 and 3), primarily due to the improved research design discussed earlier. This affords a more in-depth descriptive analysis, which culminates with particular attention given to the left side of the network where most of the connections reside (Figure 3).

This network consists of 47 nominations, which represent only 25% of the possible nominees available from the roster survey provided. This response rate is in itself fascinating, as it reflects that this respondent is not fully engaged with actors in their company. Despite this, it is also clear that networks easily become very complex and difficult to understand, a problem that has plagued SNA throughout its history (cf. Leavitt, 1951; Pool, 1973). The respondent's network appears to be made up of two different levels of awareness and influence. Of particular interest is the large, yet somewhat isolated, advice attribute on the right hand side of the network. In SNA terms, this represents the advice sought by the respondent from fellow colleagues within the division of the case study firm. This advice attribute appears somewhat generic, with few connecting linkages. Thus while the respondent may be able to influence a number of other actors within the firm it is not clear how or to what degree, and also whether those nominations would be reciprocated. As such, the left side of the network, as illustrated below becomes the focus for the remaining discussion (refer to Figure 3).

The analysis offers a contribution beyond the construction management literature. Valente (1995) claims that the number of nominations an actor receives by others in the network has a positive correlation with the innovativeness of said actor. The findings offered here are not analysed to assess the number of nominations for each actor but do present supportive findings to a degree. Figure 3 illustrates that the theme *innovators* was ascribed to only five fellow employees (Neil White, Bob Com, Sam Bing, Bruce Marton and Donny Gordon). These actors also receive nominations associated with most of the other

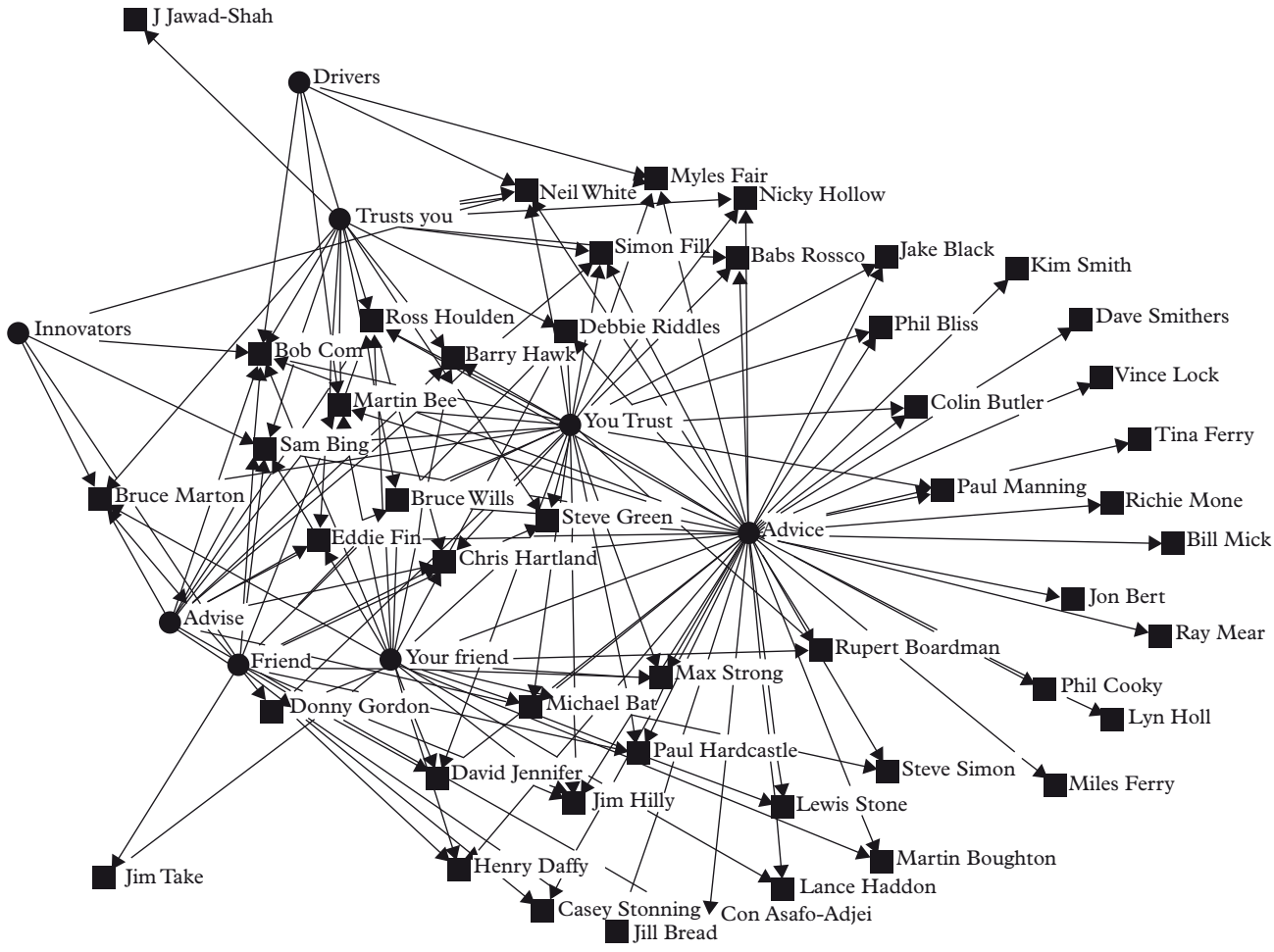

Figure 2 Example of case study data

attributes. However, a number of the other actors, such as Ross Houlden, Steve Green, Barry Hawk, Chris Hartland, Martin Bee and Bruce Wills, also have a similar number of attributes assigned to them although they are not nominated as innovators.

Breaking these themes and nominees down further, it becomes clear that the *innovators* and the *drivers* are mainly different people. The only actors that occupy both positions are Bob Com and Neil White. As these two actors are also viewed as *friends*, *trusted* and *advice* is sought from them they become the most important actors to the respondent regarding awareness and influence of innovations. Clearly, Bob Com and Neil White are central actors for understanding innovation diffusion within this contextual setting. Using more traditional research approaches the relevance of such actors might remain hidden. It is argued that all contextual settings potentially have actors playing similar roles to those of Bob Com and Neil White and understanding awareness, influence and innovation from such a position would be advantageous.

The respondent advises a number of key actors in the network, including those attributed as *innovators*. However, it is perhaps the theme of advice that commands the most attention in this network, as it splits the network almost in half. The respondent seeks advice from many other actors; however, this is strongly skewed toward actors they *trust*, *view as a friend*, and see as both *innovators* and *drivers of innovation*. It is thus argued that these actors on the left side of the network strongly influence the respondent's awareness regarding innovations and also influence their opinion of said innovation. It is this type of observation that is traditionally overlooked by innovation diffusion research in the construction management literature, yet potentially contains rich data to improve our understanding through follow-up interviews. In addition, it helps set the offering from this respondent (either through this SNA data collection or through

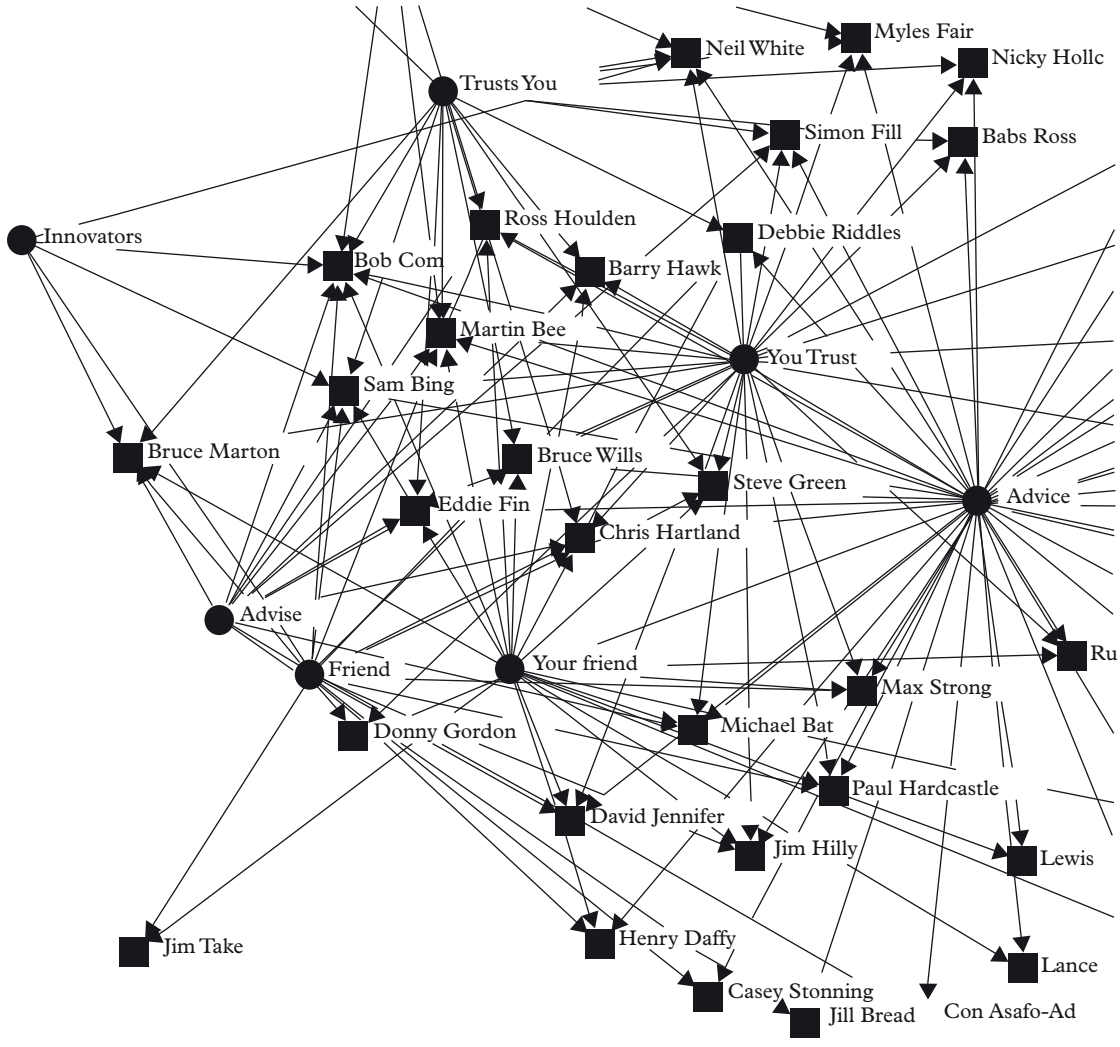

Figure 3 Case study key influences

additional follow-up interviews) into a clearer contextual setting.

More questions than answers

As noted in the literature, SNA data is difficult to make sense of and often raises more questions than it answers (cf. Windahl *et al.*, 1992). The significance of the actors mentioned above should be taken in the manner intended, i.e. explanatory rather than predictive. The explanatory powers of these network data require further investigation, potentially through interviews with key nominees. Returning to the arguments mobilized in the first half of the paper, the network tells a story resonating with the themes of awareness, influence, communication networks and the type of discourse potentially mobilized by the respondent. It is contended that using this type of network together with a respondent's qualitative interview data would give a better understanding than traditional interview data alone. Certainly, such network questions could be asked during an interview situation (potentially avoiding concerns raised by respondents during the pilot study approach). That is the purpose of the research, to understand whether SNA can offer a complementary method to help understand awareness and influence and thus the overall innovation diffusion process, and clearly it does. A final point relates to the assertions made from the data and the sample size used. From adopting a critical perspective the research was never attempting to offer any statistically generalizable findings to suit every situation. However, with 15 pilot study sociograms and 154 case study sociograms it is argued that the research offers suitable rigour regarding sample size.

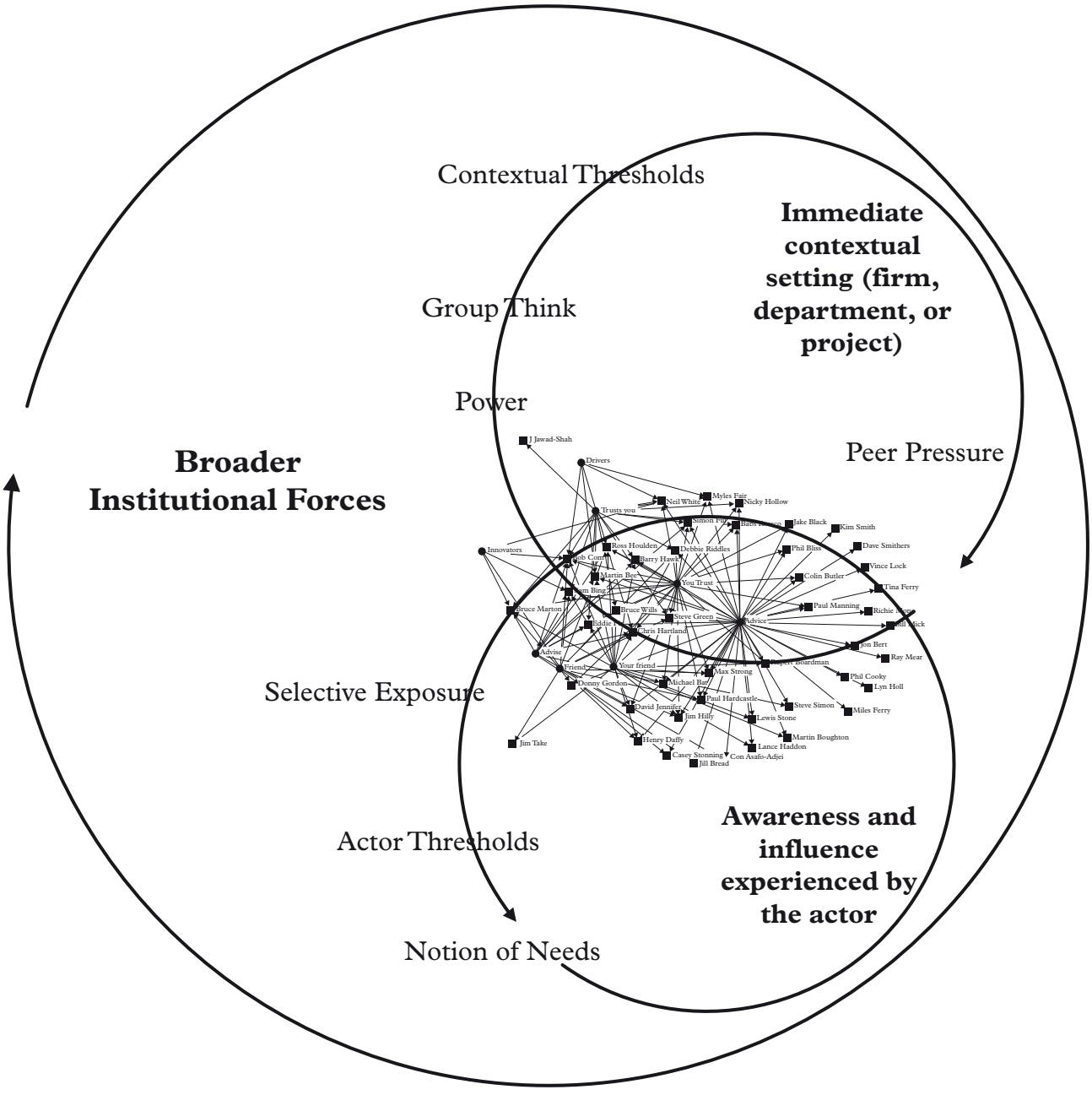

Figure 4 Awareness and influence framework

Reflection through an explanatory framework

From the arguments mobilized and data analysed it is useful to represent the inter-dependencies between the broad institutional forces, the immediate contextual setting of the firm or project and the actor. In doing so, it is important to highlight that all of these need to be viewed from a *developing* ontological position as they are not static but continuing to shape and be shaped (cf. Chia, 1995; Larsen *et al.*, 2008). For example, no sooner has a network been mapped than it will have changed in numerous ways.

The framework overleaf is used as a sense-making tool to help envisage how and also where *awareness* and *influence* occur. The awareness and influence network is both shaped and shaping the actors' experience and their immediate contextual setting (firm, department or project). However, other explanatory themes also have an impact on this process as highlighted within the literature including notions of needs, actor thresholds, selective exposure, power,

groupthink, peer pressure and contextual thresholds. All of this is of course played out across the broader institutional forces.

Conclusions

The aim was to better understand how actors become aware of an innovation and then how their opinion regarding the innovation is influenced. In order to address this communication networks were highlighted as one place where awareness and influence reside and manifest over time. These networks were mapped using SNA. An explanatory understanding was presented positioned against the agency structure literature, whereby the actor both shapes, yet is shaped by their contextual setting and broader institutional forces. It is difficult not to accept that the unique communication network of each actor offers valuable understanding. Without it research arguably takes the respondents' views out of context by not seeking to understand what has shaped their views and responses offered. Understanding the vast *capability* differences actors have regarding awareness and influence (as illustrated by their different networks) can help us begin to understand these early stages of the innovation diffusion process better. A sense-making framework is presented regarding awareness and influence concerning innovation based on these interconnections, bearing in mind also relevant themes from associated literatures (e.g. groupthink, selective exposure and notion of needs, etc.). The emphasis of the framework directs attention towards a better understanding of awareness and influence, something typically oversimplified in construction management innovation research. With the overarching policy and academic literature stating that the UK construction sector needs to be more *innovation active*, an improved understanding of awareness and influence and how they are enacted is vital. It is readily acknowledged that this research has merely scratched the surface and raised far more questions than it has offered answers. It is with this in mind that the limitations of the research and also the future themes for investigation must be outlined.

It would be foolish to champion SNA as a panacea for understanding awareness and influence as limitations abound. The research sought to assess the empirical accessibility of relational data associated with the innovation, awareness and influence. The data collection administration method clearly affected the type and amount of data provided. It is argued that such relational data should be collected through an interview-type environment thus overcoming the trust issues discussed earlier. Of particular concern is how to cope methodologically with the unbounded nature of networks enacted in practice, their dynamic nature and the complexity of the findings. Furthermore, communication is only one attribute of the situated context influencing awareness, influence and innovation diffusion.

These conclusions offer rich avenues for further research. It is hoped that, following this initial analysis, a more narrow analysis can be undertaken of the 154 case study networks focusing upon specific variables to gain greater insights. Fellow scholars may consider the numerous other attributes which contribute to the innovation diffusion process, such as impression management techniques for example. Also, further consideration needs to be given to the type of network data gathered and analysed. Broadly, this can be either egocentric or sociocentric, focusing upon one actor and all the relevant themes (as presented here), all the actors at once related to just one theme (e.g. friendship) or all the actors and all of the themes (from which it has proved almost impossible to draw meaningful arguments because of the quantity of the data). The literature offers a number of interesting and relevant themes to help explain awareness and influence within the innovation diffusion process. The notions of needs, actor thresholds, selective exposure, power, groupthink, peer pressure and contextual thresholds all potentially offer further insights into awareness and influence associated with innovation diffusion. Fellow scholars may wish to engage in understanding the explanatory roles these themes play associated with awareness and influence in more detail.

The empirical findings highlight the potential differences in actors' communication networks regarding innovation related to their contextual setting. Such networks not only include different actors, but they are also of very differing shapes, sizes and strengths all of which affect awareness and influence. This alludes to the fact that different actors have different capabilities with respect to becoming aware of innovation and even how they are influenced. Actors have different types of access to either the same or different networks, with some actors actually struggling to access their desired networks for any number of reasons. Similarly, actors might find themselves restrained by a network and find it difficult to seek broader influences. Finally, it is clear that these networks will shape the very discourse of innovation diffusion within these contextual settings and is an area requiring additional research. What is certain is that these networks are far from static, can be extremely fragile, are often centred on only a few key actors, yet they hold extremely valuable data which can potentially improve our understanding of innovation diffusion.

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