Mapping networks: Exploring the utility of social network analysis in management research and practice

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ABSTRACT

Although social network analysis (SNA) offers an increasingly insightful perspective on the relational and structural properties of organizational activity, discourse on how to manage and coordinate its application is relatively scarce. Aimed largely at an applied network analyst, this paper presents a greater understanding of *how* SNA has been previously discussed in management studies, *what* the main points are and *where* these issues can be addressed prior to and during the research process to ensure network data are efficiently managed, analyzed and interpreted. Engaging with several practical concerns associated with SNA – including network boundary specification, data reliability, context of inquiry and network visualizations – a viable framework is developed that is accessible to managers, consultants or researchers in facilitating the structuring, collection, handling and analysis of network data. The discussion illustrates the relevance of this perspective for both a practitioner and a theoretical audience.

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1. Introduction

Reflecting on the evolving nature of a network perspective on individual, group, organization and industry interaction, Parkhe, Wasserman, and Ralston (2006, p. 560) highlight that "networks are reshaping the global business architecture". This is particularly evident within management research and practice where networks and relational capabilities offer a fundamental and inherent mechanism for organizations to engage and interact within and across the global marketplace (Gulati, Lavie, & Madhavan, 2011). For example, theoretical developments on business networks have significantly enlightened the network dimensions of market-based transactions (Anderson, Håkansson, & Johanson, 1994; Hägg & Johanson, 1982; Håkansson & Ford, 2002; Johanson & Vahlne, 2009; Monaghan, Gunnigle, & Lavelle, 2014; Wilkinson & Young, 2002). Increasingly, social network analysis (SNA) is applied as a methodological tool and convenient heuristic to map relationships and quantify engagement between interdependent actors, resulting in an array of research endorsing the theoretical and mathematical components within management specific literature (Borgatti & Foster, 2003). Despite this "progressive phase" of network analysis (Kilduff & Brass, 2010, p. 344), the complexity of research

streams in which this technique has been developed – including economics, mathematics, sociology and industrial psychology – has produced an abundance of perspectives and approaches to network analysis. Thus, the learning associated with utilizing SNA is highly dependent on the capacity, competence and enthusiasm of researchers to engage with the existing variety of technical and theoretical reviews available. Consequently, herein lies the current gap in the literature.

The specialization of contemporary research within SNA has resulted in limited general material for a network analyst to develop a more inclusive understanding of *how* SNA has previously been used within management studies, *what* the main points are that must be considered before engaging in such a research project and *where* they can be addressed within the network study. Rather than engage in a technical, mechanical or theoretical analysis of network data, the purpose of this paper is to explore some of the fundamental practical aspects of network analysis, aimed at familiarizing researchers and practitioners with some decisions surrounding the structure, collection, handling and analysis of network data prior to embarking on some of the more detailed dimensions of the tool. First, this paper seeks *to profile the practical complexities associated with utilizing network analysis within management research*. Drawing upon established network research, we consider some of the core decisions required prior to engaging with or performing SNA. Our second research objective centers on *the creation of a guiding framework for network analysts of any tenure to assist with implementation of this methodological approach*. This framework

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presents some suggestions and probing questions for analysts to consider prior to initiating SNA research and during the process.[1] The article is directed towards readers who seek to apply, analyze or interpret social network data yet are limited in their knowledge of the broader methodological implications and decisions inherent to SNA.

As the schism between technical reviews and theoretical meta-analysis represents a significant concern when first engaging with SNA (Cross, Kase, Kilduff, & King, 2013; Halinen & Törnroos, 2005), the importance of this paper rests first in providing a more feasible and tangible tool for researchers embarking on SNA. As such, the paper offers a navigating template for the significant body of material available on this technique and presents an initial framework by which researchers and practitioners can traverse the complex practical decisions associated with this methodology. As businesses increasingly seek efficient forms of identifying and understanding interactive patterns and phenomena both within and outside of the organization (Krackhardt & Hanson, 1993; Parise, Whelan, & Todd, 2015), in addition to exploring and capitalizing on business networks (Håkansson & Ford, 2002; Johanson & Vahlne, 2009; Monaghan et al., 2014; Wilkinson & Young, 2002), this research illustrates the utility of SNA in providing an accessible and nuanced heuristic for managers, businesses and researchers to explore formal and informal relational engagement between actors within a well-constructed research design. By nuanced heuristic, we refer to the capacity for SNA to offer an engaged mechanism and tool for analysts to gather insights on the relationships, interactions and connections within their team, organization or community (Anklam, 2007; Baker, 2000). Among others, information of this nature has been used in organizational and management studies to further understand elements of job performance, team dynamics, employee turnover, innovation and creativity, organizational structures and customer relationships (Borgatti & Foster, 2003; Borgatti & Halgin, 2011). A second contribution rests in advancing the discourse beyond earlier technical studies, such as those offered by Conway (2014), Carpenter, Li, and Jiang (2012), Halinen and Törnroos (2005) and Håkansson and Ford (2002). This paper certainly does not seek to negate seminal and specific SNA papers, but rather to supplement them by synthesizing some of the key decisions available to network analysts prior to engaging with theoretical constructs or technical data. Thus, following an introductory review on the discussion of SNA within management research, four key practical concerns are identified, which in turn facilitates a customized framework for social network analysts as they engage with this methodology.

2. Social network analysis (SNA) in management research: How has it been used previously?

Social network theory, which considers the connections (ties) among individuals, units or organizations (actors), is increasingly employed within management research as a means of understanding the complex and interactive relationships and patterns between and within organizations (Borgatti & Halgin, 2011; Gulati et al., 2011; Kilduff & Brass, 2010; Wasserman & Faust, 1994). Given its objective and systematic analysis of relations between actors, SNA enables interactions to be explored, quantified and evaluated (Brass, Galaskiewicz, Greve, & Tsai, 2004). For example, the Hawthorne studies of the 1930s, which mapped interaction among workers and demonstrated the role of group affiliation in enhancing worker efficiency, prompted the human relations movement and reflect an initial attempt to capture social networks within organizations (Roethlisberger & Dickson, 1939). Tichy, Tushman, and Fombrun (1979) formally introduced and advocated the use of SNA in management studies, and since then SNA has featured heavily in a range of intra-organizational and inter-

organizational processes. Network perspectives have been used to explain organizational phenomena at a number of interpersonal, inter-organizational and intra-organizational levels of analysis, such as trust, inter-organizational relationships, business networks and embeddedness (Borgatti & Foster, 2003; Coviello, 2006; Granovetter, 1985; Gulati, 1999; Håkansson & Ford, 2002; Johanson & Vahlne, 2009; Uzzi, 1996) as well as organizational and industrial structures (Lorenzen & Täube, 2008; Rocha, 2012), subsidiary strategy (Andersson, Forsgren, & Holm, 2002), brand communities and customer relationships (Shen, Chiou, Hsiao, Wang, & Li, 2016; Zaglia, 2013). Furthermore, interest in the dynamic influence of social ties on organizational networks across and within different locations has been explored in the context of multinational companies (Awate, Larsen, & Mudambi, 2015; Monaghan et al., 2014).

Extensive reviews are available with greater detail on the development, contribution and prospects of network analysis for management; these methodologically substantiate conceptual frameworks such as social capital, organizational structure, power relations and trust, performance, innovation and knowledge activities, among others, at different levels of analysis (Balkundi & Kilduff, 2006; Borgatti & Foster, 2003; Brass et al., 2004; Kilduff & Brass, 2010). A simple search for "social network analysis" in *Academic Search Premier* and *Business Source Premier*, two leading management research databases, results in over 400,000 references (282,829 and 163,694 academic references, respectively). Similarly, Borgatti and Halgin (2011) trace the exponential growth of academic publications referring to social networks since the 1970s, demonstrating the increased popularity of this approach. Focusing primarily on recent studies from leading management journals, Table 1 presents a summary of contributions from network-based papers published in the previous two decades,[2] which we categorize into the following four different literature streams: (1) theoretical, (2) technical, (3) practical or (4) applied research.

The nature of SNA traverses both academic interests and practitioners' needs, as reflected in the breath of its dissemination. However, evidence of how to engage with and utilize social network research is relatively sparse within the literature. In Table 1, references to practical and applied concerns with SNA have largely emerged from meta-analytic theoretical reviews of empirical network research or scientific and mathematical exploration of SNA. A recent exception is the work of Peter Marsden, which accentuates the need for greater work on data reliability and measurement issues within network analysis. However, Marsden (1990, 2003, 2005) does not focus on the actions required to enhance or attend to network measurement. Equally, while authors such as Conway (2014) and Carpenter et al. (2012) provide a more detailed review of methodological issues in the application of SNA to management issues, there is limited interactive, applicable counsel on handling and analyzing network data. Håkansson and Ford (2002) provide valuable advice and tools on the use of case studies within network-based research, but this perspective is limited to a case study research design. General textbooks on network analysis, such as Scott (1999), Wasserman and Faust (1994) or Borgatti, Everett, and Johnson (2013), provide a brief and introductory overview of the initial stages in collecting SNA concentrating more on the process of analysis and testing. Nonetheless, there tends to be less capacity for researchers, practitioners and novice network analysts to decipher the preliminary steps necessary to undertake network analysis. Greater contemporary research is needed on aspects of structuring and collecting network data, such as how and why data is collected on a particular network (network boundary specification), how the researcher ensures that it is the correct data (data reliability), when to compile

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[1] Given the rich alternatives available within the field of network research, in addition to the multitude of options available to an empirical researcher, this framework is not exclusive but merely offers a compendium of suggestions.

[2] This list is indicative, rather than exhaustive, insofar as it presents an illustrative outline of the variety of leading scholarly articles and practitioner guides on social network analysis within top tier journals. Equally, the categorization of these papers is premised on the identified schism between technical and mathematical advances and theoretical and meta-analytic reviews.

Table 1
Example of extant literature on social network analysis in management.

Focus	Author	Year	Journal	Outcome
Theoretical	Borgatti and Halgin	2011	*Organization Science*	Analysis of the core concepts within the field of network analysis
Theoretical	Kilduff and Brass	2010	*Academy of Management Annuals*	Review of the key concepts and development of future research agenda
Theoretical	Galaskiewicz	2007	*Management and Organization Review*	Micro and macro review of organizational networks
Theoretical	Parkhe, Wasserman, and Ralston	2006	*Academy of Management Review*	Developing and advancing organizational network analysis
Theoretical	Brass, Galaskiewicz, Greve, and Tsai	2004	*Academy of Management Journal*	Multi-level review of network analysis and development of future research agenda
Theoretical	Borgatti and Foster	2003	*Journal of Management*	Framework of research streams, antecedents and explanatory mechanisms of SNA
Theoretical	Håkansson and Ford	2002	*Journal of Business Research*	Complexities of business network relationships
Theoretical	Wilkinson and Young	2001	*Journal of Business Research*	Elements of cooperation among firms within a network-based system
Technical	Conway	2014	*British Journal of Management*	Review of network visualization software
Technical	Huisman	2014	*Encyclopedia of Social Network Analysis and Mining*	Exploration of the management of missing data
Technical	Burt, Kilduff and Tasselli	2013	*Annual Review of Psychology*	Focus on the technical dimensions of network advantage
Technical	Carpenter, Li and Jiang	2012	*Journal of Management*	Framework on organizational network-level concepts
Technical	Gile and Handcock	2010	*Sociological Methodology*	Network sampling and data collection
Technical	Handcock and Gile	2010	*The Annals of Applied Statistics*	Testing of SNA modelling
Technical	Lorenzen and Täube	2008	*Journal of International Management*	Advancing evolutionary social networks
Technical	Burt	2007	*Academy of Management Journal*	Development of the concept of brokerage
Technical	Provan, Fish and Sydow	2007	*Journal of Management*	Inter-organizational networks: a technical review and theoretical development
Technical	Kilduff and Oh	2006	*Organizational Research Methods*	*Re*-analysis of seminar network research to emphasis the importance of context within SNA
Applied	Shen, Chiou, Hsiao, Wang & Li	2016	*Journal of Business Research*	Utility of social networks in enhancing marketing communication
Applied	Lin and Lin	2016	*Journal of Business Research*	Exploration of network relationships for SME performance, growth and innovation
Applied	McDermott, Corredoira, and Kruse	2009	*Academy of Management Journal*	Knowledge transfer between public-private institutions
Applied	Borgatti and Li	2009	*Journal of Supply Chain Management*	Technical application to supply chain management
Applied	Kilduff, Crossland, Tsai, and Krackhardt	2008	*Organization Behavior and Human Decision Processes*	Complexity of small friendship networks and the perception of their structure
Applied	Balkundi and Kilduff	2006	*The Leadership Quarterly*	Theoretical development of leader effectiveness
Applied	Coviello	2006	*Journal of International Business Studies*	Network relationships in international new ventures
Applied	Holmen, Pedersen & Torvatn	2005	*Journal of Business Research*	Applying network approach to technological innovation
Applied	Borgatti and Cross	2003	*Management Science*	Develop a formal model of information seeking within a network
Practical	Parise, Whelan and Todd	2015	*MIT Sloan Management Review*	Innovation within diverse network ties
Practical	Cross, Gray, Cunningham, Showers and Thomas	2010	*MIT Sloan Management Review*	Effective employment networks
Practical	Cross, Liedtka, and Weiss	2005	*Harvard Business Review*	Managerial guidebook for SNA
Practical	Cross and Prusak	2002	*Harvard Business Review*	Personal and informal relationships among managers
Practical	Krackhardt and Hanson	1993	*Harvard Business Review*	Importance of within-firm social ties for firm performance and success

network data (context of inquiry) and ways in which a researcher can improve data representation (network visualization).

3. Utilizing social network analysis: What are the main points to consider?

This paper first responds to the schism between either theoretical reviews and meta-analysis or mathematical inquiry and technical reviews on the analytic process of relational data. In line with the study by Halinen and Törnroos (2005) on case study research within business networks, we contend that there remains a fundamental lack of guidelines in terms of structuring, collecting, handling and interpreting network data. In their study of network dynamics, Ahuja, Soda, and Zaheer (2012) refer to these as 'hygiene principles', stating "In the interest of developing a more solid empirical foundation… we believe that a variety of hygiene precautions need to be considered carefully by future work. Failure to consider some of these issues has led to some degree of skepticism about the significance of extant network findings" (p. 444). Below, we outline four activities that relate to inherent decisions within network analysis, namely, network boundary specification, data reliability, intervening context of inquiry and the increasing use of network visualizations, which have been independently considered in the literature or noted as potential limiting criteria of relational data. We discuss each of these elements in order to enhance understanding of the necessary considerations before engaging in a social network based research project and highlight the alternative options for analysts, both practitioners and those who are theoretically oriented, within each domain.

3.1. Network boundary specification — structuring of SNA

Network boundary specification relates to the identification and definition of network parameters prior to and during analysis (Doreian & Woodard, 1992; Gile & Handcock, 2010; Kilduff & Brass, 2010; Laumann, Marsden, & Prensky, 1989; Marsden, 2005). Indeed, Borgatti and Halgin (2011) stipulate this as the most important choice an analyst must make. First illustrated by Fombrun (1982), the specification of network boundaries – by its very nature – fundamentally shapes the structure, composition and participation within a network and therefore is a crucial aspect of constructing network research. Moreover, a particularly important ramification of network boundary selection pertains to the role of indirect ties (actors not directly connected to focal actors within a network structure), weak ties (actors not strongly connected) and non-redundant ties (relationships that impede new information) in the transfer of information and resources (Burt, 1992; Granovetter, 1973). For example, brokerage, a mechanism whereby actors connect different components of the network and span structural holes, is more likely to produce fresh ideas and therefore, a network should include relevant and appropriate members to account for the possibility of uncharacteristic linkages (Burt, 2007).

Given that "boundary-setting and sampling decisions can have a profound impact on the structure of the network" (Conway, 2014, p. 4), significant time and attention must be allocated to network attributes, including parameters and participants. Within this, two primary concerns exist. First, in order to specify the *network boundary*, a network with a clear and delineated configuration must be constructed. While the approach to defining the boundaries of a network varies according

to the research design, topic and objective, a more specified network structure allows for the most effective sampling strategy to be implemented (Laumann et al., 1989). Laumann et al. (1989) offered three specific approaches to select and define network boundaries and members: positional (where network membership is premised on role, title or position), event-based (participation in one or more events pertaining to the network) and relational (based on direct linkages among network members). Furthermore, Doreian and Woodard (1992) introduced expanding selection as a means of identifying network members, where snowball sampling of actors can facilitate a more inclusive and comprehensive network structure. More recently, Gile and Handcock (2010) have discussed respondent-driven sampling, in which identifying potential links and ties within subtle networks is employed as a means of defining the network boundary. Thus, in order to ensure that the network boundaries do not impede potential boundary spanners or bridging ties for non-redundant contact, network structure may be best specified by enhancing fixed sampling with an open-ended section for respondents to identify partners it connects with, thereby aligning with the ethos of expanding selection (Doreian & Woodard, 1992).

A second related concern with network boundary specification pertains to the level or type of network under study. In determining the parameters of the network, the researcher must ascertain whether a whole network, dyadic ties or ego-network will be most significant in addressing the key research question (Ahuja et al., 2012; Laumann et al., 1989; Provan, Fish, & Sydow, 2007). A whole network adopts a higher order level of analysis in which multiple nested networks are included under the research design. For example, Provan et al. (2007: 482) define their whole network as "a group of three or more organizations connected in ways that facilitate the achievement of a common goal… Examination and analysis of a whole interorganizational network includes organizations (nodes) and their relationships (ties), the absence of relationships, and the implications of both for achieving outcomes". As such, the focus is on the potential presence and absence of relationships within one delineated network structure. Dyadic ties, by contrast, relate to the specific relationship between two nodes and have been largely explored within the context of alliances and partnerships where the research focus lies on the interaction between two organizational entities or nodes (Gulati, 1999). Ego networks capture the ties and connections of one central organization or node and generate a network solely from their perspective. This level of analysis has been most central in propagating the embeddedness literature (Granovetter, 1985; Uzzi, 1996). While the type of network is not constrained to these three approaches, identification of the network along these lines can have substantial implications for the subsequent determinant of data collection, handling and visualization (Ahuja et al., 2012; Borgatti & Halgin, 2011).

In summary, close attention should be assigned to boundary parameters to ensure sufficient identification and definition of a network prior to and during analysis. Nonetheless, problems with network characterization and classification may still occur during data collection. For example, respondents may struggle to relate to the network parameters explicated by the research team, choosing to offer insights and data beyond the defined network. Moreover, depending on the sampling approach, the inclusion criteria for one respondent may be slightly different to that of another. Although this may facilitate exploration of potentially non-redundant ties or brokerage relationships, network boundary specification must be carefully considered in order to capture the structural architecture of the network (Borgatti & Halgin, 2011). While research analysis can be conducted with subcomponents, or subgroups, of a specific network structure, there is a greater risk of missing data, non-response or incomplete networks when the specific network level is not defined, which can significantly negate data robustness (Huisman, 2014). Given the various options available in generating a network, in addition to the multiple implications created by the boundaries of a network, management researchers and practitioners must be

considerably cognizant of what the bounded network encapsulates, or excludes, whether a local or whole network more appropriately suits the research question, or whether it is possible to populate the network.

3.2. Data collection — reliability of the data

Although it is not unique to SNA, reliability of network data has been a persistent issue within methodological reviews (Conway, 2014; Marsden, 1990). It is often substantially amplified due to the central role of connections and interactions, which often lead to bias from self-response and self-desirability. Like other empirical studies, reliability relates to the accuracy, consistency and repeatability of data and how data output effectively represent reality.

A number of key steps must be taken to ensure data reliability. For example, it is imperative that selection of a research instrument is fundamentally driven by the theoretical underpinnings, philosophical assumptions, research objectives and quality of information a particular instrument can yield to enhance methodological fit (Edmondson & McManus, 2007). In his seminal research on social networks, Burt (1984) illustrated the importance of utilizing a key instrument to ascertain the accuracy of informant response. A name generated roster listing was suggested, where each potential actor within a specific network was named on a questionnaire by the researcher with additional space provided for respondents to highlight other actors who may not have been identified. However, questionnaires and surveys reflect a self-report method of network identification and have been significantly criticized within the extant literature (Marsden, 1990, 2003). Thus, the use of social network questionnaires requires significant and detailed composition and administration to ensure reliable data (Marsden, 1990). Moreover, aligning with the nature of network analysis, Halinen and Törnroos (2005) highlight the significance of case study research in facilitating more in-depth exploration of networks, their boundaries and drawing interpretations from this data. A key advantage of case study analysis for network research lies in the more substantial exploration and discussion of the network's temporal context in addition to accounting for the dynamic nature of interactions. Furthermore, as surveys and questionnaires fundamentally require personal response and engagement, there is the potential to conduct semi-structured interviews alongside a social network questionnaire to populate information from the network (Marsden, 2003). As Marsden (2005) outlined, semi-structured interviews provide a high degree of flexibility for the researcher, are aimed at gaining novel insights on the perspectives and opinions of the interviewee and can accurately capture additional contextual features. Moreover, semi-structured interviews can be easily aligned with a social network questionnaire, which can quantify relational engagement between actors.

While the data collection tool is fundamental for methodological fit, a number of additional aspects of data reliability are also necessary to ensure the overall reliability of the constructs and measures. *Construct validity* relates to the assumption that an instrument accurately measures the concepts intended for capture (Bernard, Killworth, Kronenfeld, & Sailer, 1984; Marsden, 1990, 2005; Mouton, Blake, & Fruchter, 1955). Research on construct validity within SNA has tested the influence of questions posed during data collection and how this shapes the overall network (Bailey & Marsden, 1999; Marsden, 2003; White & Watkins, 2000). Similar to the constraints pertaining to network parameters, the questions and topics sought from respondents must align with the nature of the network, the sampling protocol and the interactions under exploration effectively, to ensure precision in obtaining the most relevant data (Ahuja et al., 2012). Moreover, when conducting network research with large or international companies or institutions, it is also crucial to ascertain a response from the most knowledgeable individual within the organization or institution who is best positioned to be aware of the interactions and networks under study (Romney & Weller, 1984). Finally, the use of multiple data sources

can also strongly enhance construct validity by verifying and substantiating the interactions identified.

Informant accuracy, which questions the authenticity of self-reported information compared to the true reality of observed interaction, remains a prevalent and ongoing concern within network data reliability (Bernard et al., 1984; Brewer, 2000; Wasserman & Faust, 1994), as well as *informant competence*, which pertains to the respondent's knowledge and proficiency of the topic (Marsden, 1990, 2005; Romney & Weller, 1984). Informant accuracy and competence can often transpire from the inadvertent influence of personal (non-organizational) relationships and informal interactions on participant responses to organizational level research. This primarily occurs within large organizations, where many individuals can hold a range of roles, responsibilities and relationships, resulting in multi-level and multi-issue driven interactions. Although this informal interaction may capture an additional level of engagement among actors, it does cause some concern regarding the reliability of the data. In particular, multiplexity among respondents, which refers to the extent to which two actors are connected by multiple ties, could represent a potential threat to data reliability unless it is treated from the outset (Beckman & Haunschild, 2002; Carpenter et al., 2012; Kilduff & Tsai, 2003). To minimize this threat, participant selection must be significantly rigorous, as explained above.

A network can be highly subjective, from the perspective of both the researcher and the respondent, as it is premised on the relationships and connections between actors and may be more susceptible to distorted data. Thus, it is important to pursue stronger levels of reliability (Ahuja et al., 2012). While the reliability of SNA data and the collection instrument can be examined using traditional methods such as test-retest studies, reliability can also be explored during the administration of the SNA in terms of "in-practice performance of instruments" (Marsden, 2005, p.12). In-practice tests of data reliability do not interfere with the composition, form or structure of the network yet can enhance the findings' robustness. In many cases, the combination of a qualitative instrument of data collection, such as an interview, with a more quantitative method, such as a question, can facilitate the identification of inconsistencies within data (Marsden, 2003). For example, respondents may identify and quantify network relationships that were not previously mentioned during an interview, or may inflate or underplay the frequency of relationships noted. By providing a component of face-to-face engagement, a researcher can probe the respondent on a specific topic or answer if it seems conflicting or paradoxical to the earlier narrative.

As such, the issue of inaccurate or incompetent informants, in addition to vague or ambiguous construct development, can create significant concerns or issues with data unless preemptive measures are employed before and during data collection.

3.3. Context of inquiry — handling network data

In addition to the work of Halinen and Törnroos (2005), several reviews on network data also illustrate the need for greater contextual information (Marsden, 2003; White & Watkins, 2000). For example, Kilduff and Brass (2010; p. 340) argue that "social network research should be rooted in the specifics of time and place". As such, the contextual dimensions of network data are pivotal to understanding and generalizing the results. We identify three contextual issues for SNA data: research context, content and researcher effects.

The overall *research context* fundamentally pertains to the grounding of research within the broader political, social, economic and temporal context (Halinen & Törnroos, 2005). In their insightful longitudinal study, Kilduff and Oh (2006) review the multiple re-analyses of seminal research by Coleman, Katz, and Menzel (1966) on the diffusion of practices among medical practitioners in four small US towns during the early 1950s. Highlighting that all four re-analyses produced different and contradictory results, their findings demonstrate that insufficient historical, social and environmental contextualization can greatly

influence the subsequent interpretation of network data. Thus, prior to engaging in data collection, the theoretical, empirical and methodological rationale of a network research study should be clearly outlined and disseminated among potential participants to ensure alternative explanations are controlled for (Ahuja et al., 2012). For example, when collecting raw data, a brief information sheet could be circulated to minimize uncertainty surrounding the purpose of the research and the scope of the network (although this will be largely dependent on the sampling procedure). Information on the academic and practical rationale will allow participants to become familiar with the content, format and motivation of the study before they contribute.

In addition, Bailey and Marsden (1999) illustrate the importance of *content* to contextualize network data. While this is obviously more amenable to interview data, whereby a respondent's interpretation of questions and subsequent elicitation of network connections is significantly primed by issues and topics raised prior to network data, recognizing and communicating the content of the study is also important in handling the raw data. For example, in addition to conducting a study on a specific network, a researcher can also collect information on the history of events, organizations or actors related to the network under exploration. This will enrich the network with information and data on the source, rationale and utility of the ties between actors. One approach to doing so is for the researcher to briefly introduce the study to reiterate the function and format of the data collection, thereby offering respondents greater opportunity to fully understand and engage in the process. Within this, the researcher can probe around the nature of the network, its origins and potential purpose to illuminate the network connections. The structure of the data collection instruments can also enhance – or negate – the quality and quantity of network data. For example, administering a network questionnaire following an interview may allow respondents to quantify the interactions, relationships and processes that were discussed at length during the prior interview (Marsden, 2003).

Finally, Van Tilburg (1998) and Marsden (2003) found that *researcher effects* offer an additional contextual feature in data handling. Thus, it is suggested that a principal researcher holds responsibility for data collection for the duration of the research study in order to maintain consistency and minimize researcher and interviewer effects. For example, if one researcher engages with network respondents, it can alleviate any misinterpretation across the network data as a whole. Moreover, research training, clear procedural research guidelines and controlled verbal interaction with respondents is suggested to minimize researcher contagion of network data.

3.4. Network visualizations — interpretation of network data

Despite significant review and acclaim for the integration and use of SNA within organizational research, Conway (2014; p. 113) argues that "the seductive nature of network visualizations has distracted attention away from a number of emerging and long-standing issues in SNA". Although visualizations represent an inherent feature of SNA, these particular concerns highlight the implicit conflict between the researcher's and viewer's interpretation of a network. In many respects, this aligns with the debates suggested by Kilduff and Brass (2010) on agency and cognition within social network research. Namely, this suggests that while individual and organizational respondents generate a network from their own understanding of a situation or process, the researcher is primarily focused on creating a more generalized and abstract version of this network that may not authentically represent the respondent's perceived network.

Network visualizations can be generated from raw network data within a number of computer programs such as *Netdraw*, a specialist social network mapping program (Borgatti, Everett, & Freeman, 2002). *Netdraw* employs multi-dimensional scaling (MDS), a useful method to understanding the "internal structure of the group" (Wasserman & Faust, 1994, p. 287) by physically positioning actors based on their

relational attributes so that similar actors are graphically situated closer together while dissimilar actors appear farther apart in that space. In his critique of SNA, Conway (2014; p. 8) cautions against a reliance on MDS: "as the values of a network metric changes, so too do the physical positions of individual actors… which can be confusing when attempting to compare a network at different points in time".

Nonetheless, when visually graphed and displayed, network data provides a preliminary platform on which to explore additional themes, relationships or constructs and to prompt greater computational analysis within more analytical and robust computer programs such as UCINET, R, Matlab or Stata (Borgatti et al., 2013). For example, network maps can provide a visual heuristic for a more detailed exploration of core-periphery distribution, presence and influence of subgroups or further analysis of specific dyadic ties and relationships. Synthesizing the alternative data used to construct, generate and interpret networks – including quantitative network visualizations, inter-and intra-actor density, matrix algebra analysis, concurrent qualitative insights and, in some cases, secondary data (Wasserman & Faust, 1994) – can facilitate a more holistic and multidimensional understanding of the interaction. Thus, following the development of visual maps within *Netdraw*, computation analysis of the social network data can be conducted to substantiate the initial maps. Another mechanism to ensure appropriate interpretation of network visualization is to collate all elements of the network analysis together: the contextual data and additional qualitative or secondary information. Following analysis of the computational and visual network data, emergent results can be reviewed and analyzed alongside this qualitative and contextual data to enrich the visual maps.

Moreover, in addition to using the qualitative and contextual information to buttress the visualizations, this approach can also serve as a significant means of comparing and verifying the output. For example, to further substantiate the initial visual mapping, comparative analysis against the qualitative findings may illustrate significant congruence between the network visualizations and supporting qualitative data, particularly when anecdotal insights confirm the nature and explicit delineation of the linkages. In addition, comparative analysis between the different elements of the network data can identify inconsistencies, similar to those highlighted by Conway (2014), to guide further analysis and more rigorous exploration of the data. For example, depending on the research question, comparative analysis between two ego-networks can elicit much greater understanding of the role and positioning of an individual actor within a network than simply observing the network as a whole (Provan et al., 2007). Furthermore, ego-networks can enable a more customized exploration of engagement from the perspective of one particular node or actor. Whole network visualizations assist in identifying the structural architecture of the network and showcasing the mechanisms of formal engagement that are primarily grounded in the distinctive roles of the actors involved, as discussed above. In both respects, additional interpretation of qualitative and contextual data allows for a more comprehensive understanding of the intrinsic and informal nature of these relationships, thus enabling greater exploratory analysis if and where necessary.

In addition to exploring the ties within the network, there is also significant merit in considering longitudinal network data to explore the evolution and development of relations between actors (Doreian, 2002; Stokman & Doreian, 1997). While this will require a substantially different research design and approach, consideration of the changes within and across a network over time can significantly enlighten understanding of the network origins, rationale and progression. In particular, the increasingly central role of network dynamics within organizational and managerial research is also an important dimension of understanding the genesis, evolution and changing nature of network structures (Ahuja et al., 2012). Empirical exploration of network dynamics and the way in which individual actions influence or are shaped by the governing network can also facilitate a more thorough network representation (Snijders, Steglich, & Schweinberger, 2007). Specific

computational tools are available for the exploration of network evolution and dynamics, which must be treated in a different manner than a static or fixed network (Snijders, 2001).

As a means of summarizing this section on the merit of network visualizations for management related research and practice, we respond to two important considerations from previous literature. First, we contest the suggestion that visualizations may distort the reality of networks demonstrating that images can be representative of different forms and mechanisms of exchange as outlined by Conway (2014). In fact, our discussion suggests a fundamental utility for SNA visualizations in graphically positioning and displaying dynamic patterns of interaction among actors within a network. Second, when network visualizations are paired with concurrent qualitative and contextual insights, this facilitates a more engaged interpretation and understanding of visual networks and relationships. Therefore, while the potential to interfere with SNA data is a real and tangible concern, the provision of accurate, reliable data gathered from key respondents within a specific context facilitates a more robust and representative SNA visualization.

4. Employing social network analysis: where can these issues be addressed?

Choosing and administering a research technique amidst the array of qualitative and quantitative options is undoubtedly an arduous task. Equally, when deciding to implement network analysis, navigating through the rich body of extant literature can also be difficult. Cognizant of a network analyst seeking to interpret and utilize a network study, the purpose of this paper is to summarize the practical concerns and challenges associated with engaging with SNA, focusing specifically on the importance of structuring, collecting, handling and interpreting network data. As a means of synthesizing these insights from the above section, Table 2 represents a viable and cohesive framework to assist researchers in conducting network analysis or to facilitate a more engaged exploration of the technical and theoretical material on SNA.

Building upon the four pillars of research design outlined above, we articulate four precursory questions as a rudimentary guideline for researchers and practitioners to navigate through their engagement with SNA. First, *network boundary specification* illustrates the importance in ascertaining the network parameters to distill and crystallize the focus of the network and generate a clear structure for the research. Important decisions are required on the inclusion and exclusion parameters for the network, and caution is warranted to ensure necessary provisions are made for non-redundant, weak and indirect relationships. Moreover, remaining cognizant of potential participants, their role within the network and the mechanisms to obtain data is also central in the early stages of engaging with SNA to guarantee *data reliability* in interpreting and discussing network elements. Careful consideration, selection and design of a research tool can enhance handling of the network data and consolidate the network structure, whereas delineated contextual information may reduce potential oversights associated with SNA during data collection. *Context of inquiry* is an important attribute to provide additional information and detail on the network, actors and ties while minimizing potential alternative explanations that may distill or discredit the findings. While multiple data sources serve as a fundamental resource in understanding and contextualizing network data, it is also important that sufficient information is attributed to the study's economic, social, political and temporal context. Finally, data interpretation can be greatly facilitated by *network visualizations* and mapping tools, but equally computational analysis such as centrality and density can also offer a more robust and significant insight. Network visualizations can both enrich interpretation and facilitate greater information on the specific relational elements of the network, particularly when additional dimensions and sources of data are included within the analysis.

Although this framework is by no means exhaustive, it seeks to serve as a macro-level, preliminary overview of the initial stages of SNA

Table 2
Framework for initial engagement with SNA in management research and practice.

Research pillar	Concept	Questions	Rationale	Options
Structure of research design	*Network Boundary Specification*: identification and definition of network parameters prior to and during analysis	What is your network focus?	→To facilitate network boundary specification	• Inclusion & exclusion parameters • Redundant vs. non-redundant ties
Data collection	*Data Reliability*: accuracy, consistency and repeatability of network data and how outputs effectively represent reality	Who are your participants?	→To ensure data reliability	• Clear focus on your participation groups • Reliable measures and data collection • Triangulated data if/where possible
Handling of data	*Context of Inquiry*: the role of research context, content and researcher effects on data	Where (and why) are you conducting this study?	→To stipulate the context of inquiry	• Justification and explanation of research questions, i.e., economic, social, political climate, temporal dimensions and academic rationale
Data interpretation	*Network Visualization*: visual representations of perceived relationships	How will the data be interpreted?	→To guarantee systematic usage of the network visualizations	• Awareness of subgroups • Core vs. periphery • Explore potential ties and different visualization options, i.e., ego networks; whole network

research. The alternative options provide suggestions on mechanisms to reduce distortion of findings and enhance the quality, accuracy and reliability of data. Engagement with these guidelines can enhance the capacity of network analysts to garner a greater understanding and command of network analysis before exploring the more theoretical or methodological guides within the discipline, such as those offered by Carpenter et al. (2012), Conway (2014), Kilduff and Brass (2010), Borgatti and Halgin (2011) and Provan et al. (2007).

Employing SNA can offer a valuable mechanism for identifying, understanding and unpacking networks, particularly if it is well executed – namely, an accurate structure, systematic data collection, rigorous handling of data and comprehensive interpretation. This paper engages with many of these fundamental components for a network analyst, presenting a number of choice parameters for consideration prior to implementation. Engaging with this material, namely the framework provided above, allows managers, businesses and researchers to quickly assess whether they have the type of data or research question to align with SNA. Moreover, the alternative questions and options provided enable managers to ensure the fundamental dimensions of their study will leverage the most accurate results. As such, this paper consists of a more practical manifesto with which managers, businesses and researchers can develop a well-constructed social network analysis as a means of exploring formal and informal relational engagement between actors.

5. Discussion and conclusions

As management researchers, consultants and practitioners increasingly utilize networks to map inter- and intra-organizational network structures and business networks, in this study, we highlight the practical considerations of SNA for analysts who are unfamiliar with this methodology or who seek greater reference on the dimensions of structuring, collecting, handling and interpreting their network research. In so doing, this paper presents a greater understanding of *how* SNA has been previously used, *what* the main points are and *where* these issues can be addressed prior to and during the research process to ensure that network data is efficiently collected, managed and interpreted. This study offers two contributions to current literature. First, the focus on structuring, collecting, handling and interpreting SNA data within the perspective of organizational and management studies counters the current dichotomy between theoretical reviews of SNA and scientific, statistical applications of the technique. Engaging specifically with four practical concerns associated with SNA – network boundary specification, data reliability, context of inquiry and network visualization – this paper provides a synthesis of information that managers, consultants or researchers can reference prior to engaging with SNA. Moreover, it contributes to SNA theory by offering a contemporary and contextualized illustration of some key issues within the field. Second, the framework extracted from this review postulates four key questions to guide and direct researchers, managers and practitioners in first engaging with SNA within their research or commercial practice. Building upon significant methodological and theoretical reviews on collecting network data (Carpenter et al., 2012; Conway, 2014; Marsden, 2005; Wasserman & Faust, 1994), this paper offers management researchers and practitioners a more delineated discussion on some of the key practical dimensions for handling and analyzing network data.

Moreover, this study provides a range of practical implications for both managers and researchers. SNA is increasingly utilized by managers as an effective tool to identify and understand the interactive patterns and networks within and across their business (Balkundi & Kilduff, 2006; Cross, Gray, Cunningham, Showers, & Thomas, 2010; Krackhardt & Hanson, 1993). Within this context, issues such as how their employees are connected, the strength of these connections and how best to leverage these connections can offer significant opportunities to motivate their staff, improve performance, enhance knowledge

sharing and learning, and reduce conflict (Anklam, 2007; Baker, 2000). However, the capacity for managers to utilize SNA may be impeded by limited understanding of the basic principles to enrich the implementation and outcome of the findings. Thus, prior to engaging with the more technically or theoretically oriented manuals, reference to the above framework can offer a more tangible introduction to SNA's utility for managers. Moreover, as the role of social ties and networks are increasingly prevalent for business transactions (Håkansson & Ford, 2002; Shen et al., 2016; Zaglia, 2013), this paper serves to unpack some of the language used in identifying, quantifying and interpreting interactive patterns.

In terms of the implications for a theoretical audience, this paper contributes to the ongoing discourse on elements of engaging with network studies, including practical difficulties with network definition (Ahuja et al., 2012; Borgatti & Halgin, 2011), complexities with data collection and handling (Halinen & Törnroos, 2005; Marsden, 2005) and presentation of network models (Carpenter et al., 2012; Conway, 2014). The framework can be utilized by academic researchers in designing and customizing their research study to ensure greater synergy between the research topic and the methodology. Researchers seeking to engage with network analysis, particularly within the context of organizational and managerial studies, can refer to the framework presented to improve methodological rigor. As such, both a practitioner- and theoretical-based audience can benefit from the framework provided and discussion of its dimensions.

Nonetheless, this study does suffer from a number of limitations. Building on the practical insights and review provided herein, there is significant potential for empirical testing of the feasibility of this framework in facilitating the process of structuring, collecting, handling and analyzing network data. Moreover, given the contemporary interest in network theory and SNA studies, the breadth and depth of theoretical, methodological and analytic issues continue to grow. Particularly with the rise of more online sources of network communication and activities, our framework, in its current form, may require adaptation to capture some of the more contemporary complexities for utilizing network analysis. In fact, a key question for future research relates to how managers and researchers remain abreast of the instantaneous changes in online network domains such as Twitter, Facebook and LinkedIn. As SNA becomes a more common and accessible heuristic within management research and practice (Anklam, 2007; Baker, 2000), greater information is required on how contemporary changes shape the practical nature of collecting and engaging with SNA research. Nonetheless, this paper represents an initial step in collating and framing the practical utility of SNA for managers, businesses and researchers, promoting greater adoption and implementation of this tool in both practical and theoretical settings.

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