Knowledge sharing in the organizational context: using Social Network Analysis as a coaching tool

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Abstract

Knowledge sharing between employees is a critical success factor in knowledge intensive organisations and depends on the quality of an employee's relationships with co-workers. Relatively little research has been done on how to incorporate relationship aspects into a coaching intervention. This paper describes an organisational coaching intervention that used Social Network Analysis to analyse relationship patterns between individuals in a team following an action research approach. Social Network Analysis artefacts were used to help identify coachees, set coaching goals, create self-awareness, identify behavioural changes, and to provide some measure of the coaching efficacy in improving knowledge sharing in a team.

Keywords: Social Network Analysis (SNA), coaching, frequency of communication, trust level, energy dynamics, knowledge-sharing.

Introduction

The effect of coaching on individuals has received research attention in the past (Evers, Brouwers & Tomic, 2006; Gyllensten & Palmer, 2005; Spence & Grant, 2007). Coaching in the larger systemic context such as teams and organisations has, however, not been well researched (Grant, Passmore, Cavanagh & Parker, 2010). In an attempt to include the larger organisational context, the focus of the research reported here was to use the relationship patterns (via SNA) between coached individuals and their team to guide the coaching intervention. The aim was also to use SNA and participant perception to provide an indication of the possible benefits of individual coaching on improved knowledge sharing within the team. Knowledge sharing was specifically chosen as it is an important element in the success of knowledge intensive organisations (Cross, Parker & Borgatti, 2002).

In business coaching the coaching of individuals typically departs from the purely person-centred approach (Flaherty, 2006; Whitworth, Whitworth, Kimsey-House, Kimsey-House & Sandahl, 2007) to also address the interests of the sponsoring organisation (Worldwide Association of Business Coaches, 2007). The aim is to coach the individual and the organisation to achieve a positive outcome for both, by taking into account and addressing the needs of both (Cavanagh, 2006; Kahn, 2011; O'Neil, 2007; Passmore 2007). The individual forms part of the organisation via their network of relationships with others in the organisation, and according to this view, the structure of these relationships directly impacts the organisation (Kilduff, Crossland, Tsai & Krackhardt, 2009; Stacey, 2011).

Academic research is very important for coaching to establish itself as a profession in the future (de Haan & Duckworth, 2013; Linley, 2006). One of the research themes identified by Grant, Passmore, Cavanagh and Parker (2010) looks at the link between individual coaching and the larger organisational context and it is this suggestion that inspired this research.

Objectives

The objective of this research was to explore the use of SNA as a tool during a coaching intervention as well as to use SNA to investigate the possible benefits of individual coaching, beyond the individual, on improved knowledge sharing within the team.

Secondary objectives include:

1. To ascertain the way SNA results can be used to identify potential coachees.

2. To investigate how SNA can be used during a coaching intervention to help create awareness, set goals and create new strategies.

3. To investigate whether SNA techniques are useful to assess the capacity of individual coaching to improve knowledge sharing in a team.

Contribution to field

Using SNA in coaching is a novelty. This study may benefit researchers by providing insights into the application of SNA to coaching. The use of SNA methods illustrated in this research, if applied, may benefit coaching practitioners looking for novel assessment tools to identify coaching clients, to create self-awareness in clients and to help guide the coaching intervention. SNA methods can also be used to collect data when researching practice for contribution to the academic field of coaching. This study could also benefit managers of teams in knowledge intensive organisations who may question the benefit of coaching beyond the individual in that SNA provides insight into the capacity of coaching to improve knowledge sharing in the entire team.

Literature review

Social Network Analysis (SNA) methods and techniques were applied during this research. Complexity Adaptive Systems Theory forms the theoretical basis for understanding the importance of relationships in the group context. These fields are reviewed in this section.

Social Network Analysis

SNA is a specialisation of Network Theory concerned with the dynamics that shape connectivity in complex natural networks such as cells, organs, ecosystems, and social networks such as organisations, professional networks, the Internet, and even terrorist groups (Kilduff, Crossland, Tsai & Krackhardt, 2009). SNA examines the structure of social relationships in a group to uncover the informal connections between people (Ehrlich & Carboni, 2005). It is a mature academic field that uses a precise language, definitions, mathematics and graph theory to measure and explain relationships between entities (Freeman, 2004; Wasserman & Faust, 1994).

A network consists of a set of actors or nodes along with a set of ties of a specified type (such as friendship) that links them (Borgatti & Halgin, 2011). The ties form paths through their interconnection with other nodes, in the process linking nodes indirectly in a web of connections. The web of ties translates into structures where the nodes occupy specific positions in the structure. The power of SNA is in the ability to characterise these structures and node positions (Borgatti & Halden, 2011). There are studies that show that the consequences of misperceptions of social networks can be catastrophic (Burt & Ronchi, 1990).

An example of an SNA graph is illustrated in figure 1 where each node (square) represents a person and the ties are the arrows between the nodes indicating for example, who are friends with whom. The size of the node indicates the popularity of the person in that larger nodes have more arrows leading towards them (more friends). The different colours of nodes group friendship circles together.
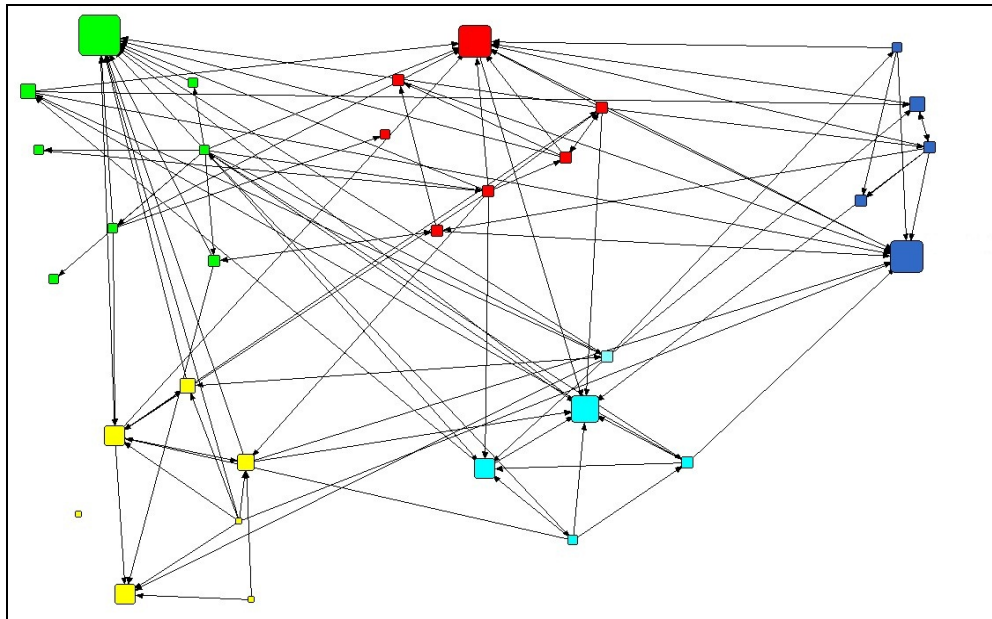
Figure 1: Example of a SNA graph indicating friendship links between different friendship circles

SNA provides a rich set of mathematical, network and graph tools to analyse network data and to determine the relative importance of nodes. Examples include centrality measures such as degree, closeness and 'betweenness'. Degree refers to the number of direct relationships that an entity has. An entity with high degree centrality is generally an active player in the network and often acts as connector or hub. It may be in an advantaged position in the network which in turn increases its power. Closeness refers to how quickly an entity can access more entities in a network, and 'betweenness' refers to an entity's position within a network in terms of its ability to make connections to other pairs or groups in a network (Wasserman & Faust, 1994). In this research the degree centrality measure was used since it represents a widely accepted standard measure of importance in a network (Brass, 1992; Hanneman & Riddle, 2005).

Another SNA concept used in this research is that of 'ego network'. This is the network that is formed by selecting a specific node and includes all actors that are connected to that node, as well as all the connections among those actors (Hanneman & Riddle, 2005). This allowed the researcher to study a focal node (one actor) and specifically the actors tied to it. In this research it was used to study the effect of coaching on the relationships between the person who was coached, and the other team members.

While SNA is traditionally mostly used in sociology research, it has recently found application in the commercial world. Examples of this include the measuring of job performance and information sharing (Ehrlich & Carboni, 2005). It has also been used in corporate mergers to identify informal leaders and using them to influence the process on a social level within the merging organisations (Borgatti & Molina, 2002).

An important consideration when doing SNA is the relationship aspect that is being measured among a group of people. The SNA graphs show relationship links between people based on a specific question that each person answers in relation to all the other people in the group. Figure 1 for example shows the network relating to the question 'who are your friends?' The SNA question is therefore important in determining what the SNA network represents and what can be analysed in the process (Wasserman & Faust, 1994).

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Complex Adaptive System Theory

When applied to organisations, Complex Adaptive System Theory provides a powerful analogy for thinking about people and their relationships within organisations (Anderson, 1999; Stacey, 2011; Wheatley, 1992).

Complex Adaptive Systems consist of a large population of agents (which in the case of this study would represent the team members) that behave in specific ways and give rise to the whole (team). In these systems order is an emergent property of individual interactions at a lower level of aggregation (Anderson, 1999). Eidelson describes Complex Adaptive System as the process whereby the individual agents continuously gather information from their neighbours and from the environment. The new information is subjected to the agent's internal rule-set and once evaluated the agent responds to the stimuli. These responses are fed back into the Complex Adaptive System and in turn may influence other agents. The stimuli and responses may also alter internal rules-sets, and therefore over time the Complex Adaptive System will evolve (Eidelson, 1997). Schneider and Somers (2006) associate the Complexity Theory notion of self-similarity with organisational identity. They quote Wheatley (1994) in saying that a system that provides its members with a strong frame of reference will support their independent activity and in the process promote self-organisation.

In this analogy therefore, people are the agents and their interactions lead to the emergence of the whole (team). Key to this are the relationships between the people (Stacey, 2011).

Methodology

Research design

In this study an action research approach was used with the aim of both taking action (applying SNA) and creating knowledge about that action (understanding how SNA is useful in coaching) (Coughlan & Coghlan, 2002). The aim of the research was not to prove that the results will hold in every circumstance, but rather to search for meaningful insights that emerged from the study at hand (Babbie & Mouton, 2001).

The classical action research steps of plan, act, observe and reflect (Kolb, 1984) was applied in the iterative spiral similar to that described by Zuber-Skerrit (2001), but in a more expanded version as described by Coughlan & Coghlan (2002). Their six-step process of data gathering, data feedback, data analysis, action planning, implementation and evaluation was applied on both a macro level (executing the entire coaching intervention) and a micro level (conducting each coaching session). The macro level mapping is shown in Table 1.

Action research step	Application to research
1. Data gathering	Collecting initial SNA data from the team
2. Data feedback	Providing SNA results to the sponsor (HR and CTO)
3. Data analysis	Using SNA data to identify potential coaching candidates
4. Action planning	Designing the coaching intervention
5. Implementation	Executing the coaching intervention
6. Evaluation	Assessing the outcome of the coaching intervention using the second, post-coaching SNA data set

Table 1: Macro level action research steps applied to this study

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The micro level mapping is shown in Table 2.

Action research step	Application to research
1. Data gathering	Extracting SNA data specific to the coachee
2. Data feedback	Discussing the meaning of the SNA data with the coachee
3. Data analysis	Understanding the meaning of the SNA data for the coachee
4. Action planning	Helping the coachee design new behavioural strategies based on insights from the SNA data
5. Implementation	Allowing the coachee to execute their strategies between coaching sessions
6. Evaluation	Reflecting on the success of the strategy in the next session

Table 2: Micro level action research steps applied to this study

These steps are described in more detail in the sections that follow.

Research setting and participant selection

The researcher collaborated with the head of Human Resources (HR) and the Chief Technology Officer (CTO) of a high-tech software engineering company to request the availability of a group to participate in the research. They suggested the product development team consisting of 34 engineers. Of the 34 people, 32 volunteered to participate. During the five-month research period, seven people left the group. They were excluded from the pre-coaching data to ensure a like-for-like comparison.

From the 32 participants, six people were identified as potential coaching candidates and invited to participate in the coaching intervention and four accepted. This selection process is described in more detail later in the '*SNA data analysis'* section as SNA was applied to select people who would potentially benefit the most from coaching based on selected criteria.

Coaching intervention

The coaching intervention applied in this research formed the vehicle for facilitating change in individuals to help redesign their relationships with others in the organisation. The intervention was transformational in its approach, aiming to help coachees identify and change existing patterns of thinking and behaving that they considered limiting. The intervention consisted of six sessions of one-hour duration each per coachee over a period of 4 months.

Data collection

Both qualitative and quantitative data were collected. The quantitative data included the pre-coaching and post-coaching SNA data and graphs. The qualitative data included the observations and verbatim comments of the researcher and the participants (coachees) as captured during the coaching intervention sessions, answers to the post-coaching semi-structured interviews conducted with the coachees, and the pre- and post-coaching meetings with the management team (HR Manager and the CTO) of the company where the research was conducted. Triangulation was used to cross-validate the

research results and therefore provide more credibility to the study. This implied using multiple sources of data, both qualitative and quantitative as described above, in an attempt to measure the change in relationships after the coaching intervention (Babbie & Mouton, 2001; Creswell, 2003).

The following data were collected for this research and are explained in more detail below:

- Two sets of SNA data (before and after the coaching)
- Post-coaching semi-structured interviews with coachees
- Researcher notes during coaching sessions
- Researcher notes in feedback sessions with HR and CTO.

Social Network Analysis data (quantitative):
   Data for SNA processing were collected twice from the participants, once before and once after the coaching intervention. Recall that SNA measures and depicts specific relationship aspects in a group. For this research the relationship aspects that could influence knowledge sharing was important.

   With this in mind, SNA data were collected for six relationship aspects specifically chosen to be relevant to knowledge sharing in a high-tech, knowledge intensive context. The rationale behind the choice of questions was informed by the following theory. For knowledge to be shared effectively, people have to know who possesses the information. Then it must be possible to have access to that person. Next the knowledgeable person must be able to help the information seeker to think through the problem. The information seeker is in a potentially vulnerable position and therefore the knowledgeable person must be able to create a safe and trusting environment for effective knowledge transfer. Lastly, people are more likely to approach someone for information if that person leaves them in an energised state (Borgatti & Molina, 2002; Cross, Parker & Borgatti, 2002). These principles form the basis for the questions in Table 3 that were used in this SNA data collection process.

Relationship question	Source
1. How often do you use this person as a sound-board or to bounce ideas off when you have a work problem to solve?	(Borgatti and Molina, 2002)
2. How knowledgeable is this person in their field of expertise?	Cross, Parker and Borgatti (2002)
3. How easy is it to gain access to this person?	Cross, Parker and Borgatti (2002)
4. How effective is this person in helping you think through and solve a problem?	Cross, Parker and Borgatti (2002)
5. How safe and trusting is your relationship with this person?	Cross, Parker and Borgatti (2002)
6. How much does this person energise you during your interactions?	Cross, Parker and Borgatti (2002)

Table 3: Six relationships questions measured by SNA in this research

   In both cases of SNA data collection, a spreadsheet was created consisting of the six SNA questions and the names of all the research participants. The spreadsheet was emailed to all participants asking them to rate every person in the group based on the six questions on a scale from 0 (lowest) to 5

(highest). Completed spreadsheets were formatted to conform to the input requirements of the SNA software, UCINET and NetDraw (Borgatti, 2011) that was used to process the SNA data.

Researcher notes during coaching sessions (qualitative):

During each coaching session, the researcher made notes to capture the insights from the coachees relating to their interpretation of the SNA graphs. By interpreting and discussing the graphs, coachees were able to identify coaching goals aimed at addressing their perceived limiting patterns of thinking or behaviour revealed by the graphs.

Post-coaching semi-structured interviews with coachees (qualitative):

Once the second round of SNA data were processed, a pre-coaching and post-coaching comparative SNA graphs were discussed with each coachee. They were asked to reflect on the results. Were the changes due to the coaching, or was it structural and contextual such as working on a new project or moving to another team? This feedback was captured for later use in correlating the SNA results with the coaching process.

Researcher notes in feedback sessions with HR and CTO (qualitative):

The pre- and post-coaching comparisons for each coachee were discussed with HR and the CTO in a meeting. Their comments and feedback provided additional context for the results. These were captured and provided further triangulation data for the SNA data.

Data analysis

Data analysis consisted of SNA data analysis (quantitative) and analysis of the effect of coaching on SNA results (combining qualitative and quantitative data)

SNA data analysis:

There were two stages to this step; identification of coachees and comparison of pre- and post-coaching results: stage one to identify coaches and stage two to compare pre- and post-coaching results.

At stage one in order to identify coaches, pre-coaching SNA data were used to generate four graphs for each of the six SNA questions for further analysis, yielding 24 graphs in total. The graphs were derived as follows. Recall that the six SNA questions had a 6-level rating scale (0 to 5). For each question, a 'high-score' filter (data filtered with responses at the high-end of the scale) and a 'low-score' filter (data filtered at the lower end of the scale) were applied.

In addition, In- and Out-Degree calculations were made for each of the high- and low-score filters. 'In-Degree' is an SNA term referring to the number of people who rated an individual (referred to as 'group-perspective' in the rest of this paper). 'Out-Degree' refers to the number of people whom the individual rated (referred to as 'individual-perspective' in the rest of this paper).

To illustrate this, examples are provided in figure 2, which represents one of the 24 graphs. The SNA graph in figure 2 shows the results of applying a filter at level 5 (high frequency), on the question of frequency of sound-boarding. The largest node (red node 'K') has the highest group-perspective, implying that this person is used by more people than anyone else as a sound-board. Note that the different colour nodes represent the five sub-teams that made up the product group.

The 24 graphs generated were analysed by HR, the CTO and the researcher to identify individuals who showed perceived discrepancies that were not in line with their position or role. They were therefore selected as people who would potentially benefit from coaching.

Stage two was designed to compare pre- and post-coaching results. In order to determine the effect of the individual coaching, ego network analysis was used. As described earlier, an ego network is the network that is formed by selecting a node, including all actors that are connected to that node, and all the connections among those other actors (Hanneman & Riddle, 2005). During this stage of the analysis the focus shifted from the entire group to the individual who was being coached and to how the group perceived them.
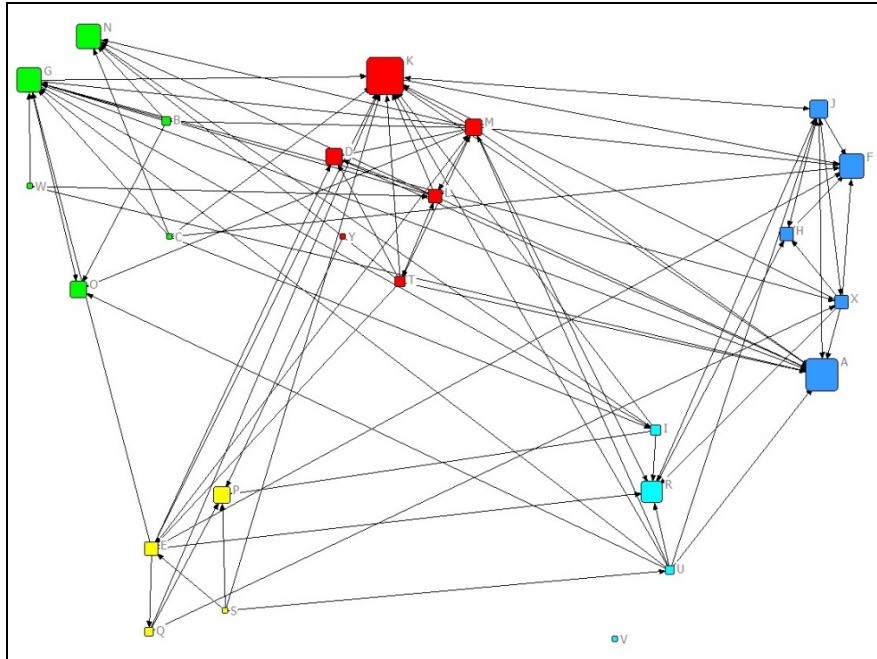

Figure 2: SNA graph showing the group-perspective of responses to frequency of sound-boarding filtered at level 5 (high frequency)

NetDraw was used to create two sets of results depicting the ego network of each coachee before and after coaching. In this analysis, 14 graphs were generated per coachee. For each of the six SNA questions, one high-score and one low-score graph were created, yielding 12 graphs. They were all group-perspective graphs, showing how the rest of the team viewed each coachee. Two additional graphs that considered the *individual-perspective* for the high- and low-score filters of specifically the SNA sound-boarding question were added, giving the total of 14 graphs.

Table 4 contains details of the 14 SNA results.

SNA Result	SNA Question	Response Scale	Measure
1	1. Frequency of sound-boarding	High-score (4 and 5)	Group-perspective
2	1. Frequency of sound-boarding	High-score (4 and 5)	Individual-perspective
3	1. Frequency of sound-boarding	Low-score (0)	Group-perspective
4	1. Frequency of sound-boarding	Low-score (0)	Individual-perspective
5	2. Level of knowledge	High-score (5)	Group-perspective
6	2. Level of knowledge	Low-score (0)	Group-perspective

| 7	3. Accessibility	High-score (5)	Group-perspective
8	3. Accessibility	Low-score (0)	Group-perspective
9	4. Effective thinking partner	High-score (5)	Group-perspective
10	4. Effective thinking partner	Low-score (0)	Group-perspective
11	5. Safe and trusting	High-score (5)	Group-perspective
12	5. Safe and trusting	Low-score (0,1,2)	Group-perspective
13	6. Energising interaction	High-score (5)	Group-perspective
14	6. Energising interaction	Low-score (0 and 1)	Group-perspective

Table 4: Details of 14 SNA results

The two graphs in figure 3 and 4 are examples of pre-coaching and post-coaching ego networks for coachee R on frequency of sound-boarding.
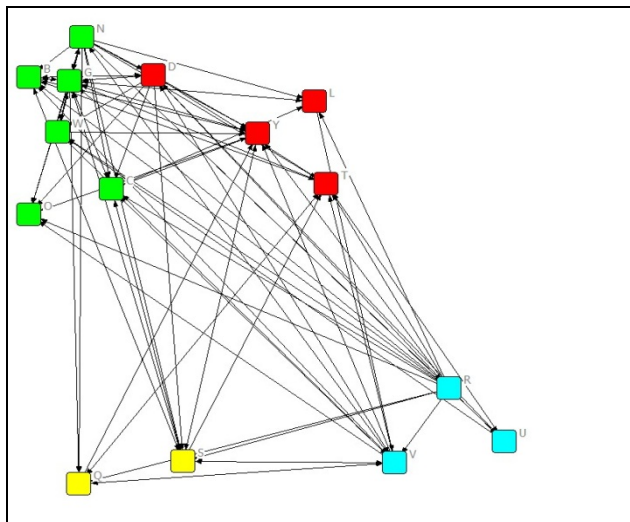
Group-perspective	2
Individual-perspective	13

Figure 3: Pre-coaching ego network for coachee R showing responses to frequency of sound-boarding filtered at level 0 – (low-score)
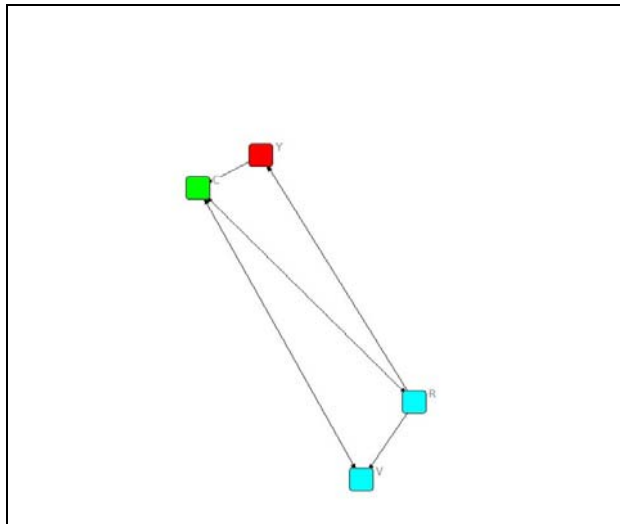
Group-perspective	1
Individual-perspective	3

Figure 4: Post-coaching ego network for coachee R showing responses to frequency of sound-boarding filtered at level 0 – (low-score)

As shown in figure 3, before the coaching, coachee R never sound-boarded at all against 13 people (individual-perspective). There were two people who never used R as a sound-board (group-perspective). Figure 4 shows that after the coaching there were only three people against whom R never sound-boarded, and only one person who never sound-boarded against R. It is a clear improvement.

A set of pre- and post-coaching ego network analysis graphs similar to this example was compiled for all four coachees and for all 14 results. This was used in the post-coaching semi-structured interview to obtain triangulation data from the coachees on why they thought the graphs had changed.

Analysis of the effect of coaching on SNA results

Human relationships may change unexpectedly and for many reasons, therefore changes in SNA ego network data cannot be solely attributed to coaching. To attempt to determine the role that coaching played, SNA results were analysed by considering whether the qualitative data supported the quantitative changes. This included whether coaching goals focusing on the SNA questions were linked to the SNA result, and whether the session notes and post-coaching interviews supported the SNA results.

Four classifications were made:

1. Positive change – a coachee had more positive relationships after coaching and the SNA question linked to the result was addressed in the coaching
2. Negative change - a coachee had fewer positive relationships after coaching and the SNA question linked to the result was addressed in the coaching
3. No effect - a coachee had the same number of relationships after coaching and the SNA question linked to the result was addressed in the coaching
4. Not applicable (N/A) – SNA result was not specifically targeted during coaching or no data were present.

Table 5 provides a summary of the classification of relationship changes per coachee and per SNA result and is discussed in detail in the 'Findings and Discussion' section.

Findings and Discussion

The main objective of this research was to explore the use of SNA as a tool during a coaching intervention, as well as to use SNA to investigate the possible benefits of individual coaching, beyond the individual, on improved knowledge sharing within the team. The findings of this research relative to the research objectives are discussed.

Using SNA data to identify potential coachees

SNA data were used to identify the four coaching candidates from the original group of 32. Various SNA graphs showing different rating scales for each of the six questions were created and presented to HR and the CTO at a meeting. They analysed the graphs looking for anomalies relating to senior engineers. One such example is illustrated in figure 5.

Figure 5 shows the SNA graph of the entire team for the question on 'how knowledgeable do you consider this person to be' and filtered on rating 5 (high-score). The size of each node is relative to the group-perception, in other words the number of people who rated a person highly. The graph shows that person R was rated by more people as an expert, than anyone else. Clearly R, who incidentally is a senior engineer, has much to contribute to the team knowledge.
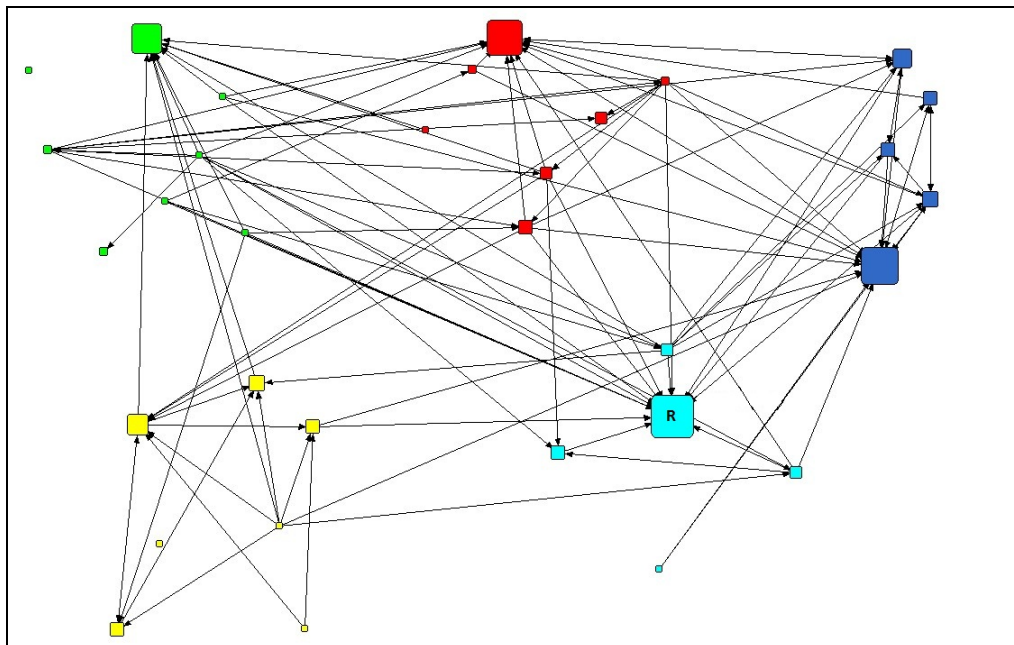
Figure 5: SNA graph of group-perspective centrality measure for question on 'knowledgeable' with response scale 5 (high)

When the graph in figure 6 was examined, a discrepancy emerged. This graph shows the group-perspective for the question on 'how safe and trusting is your relationship with this person' with a low rating. The same person R, who was rated as the most knowledgeable person in the team, was also the least trusted.
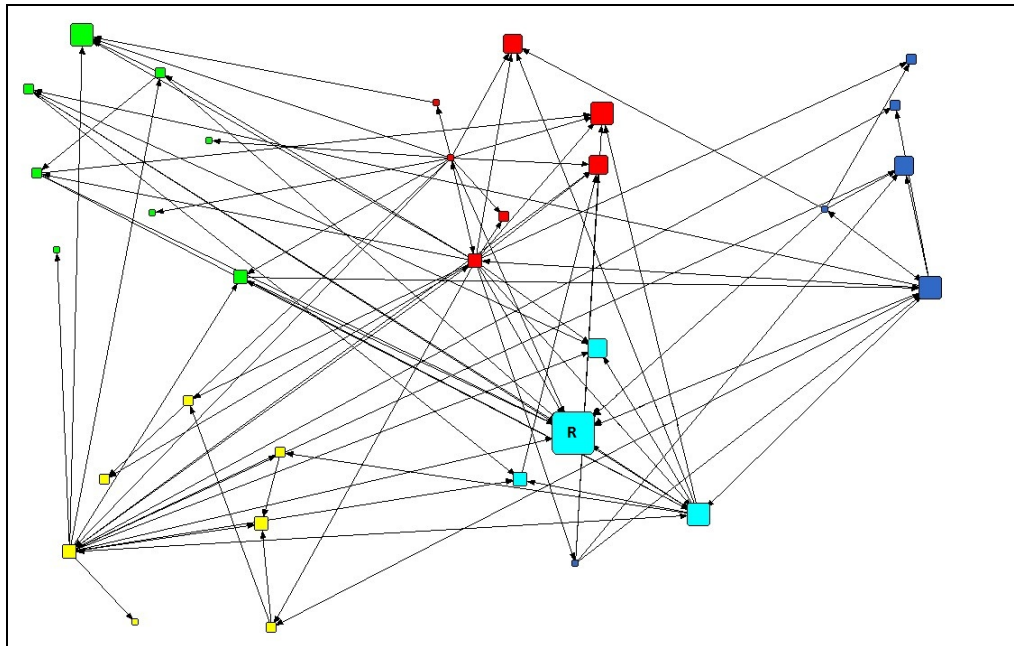
Figure 6: SNA graph of group-perspective for question on 'safe and trusting relationships' with a low response scale.

This caught the attention of HR and the CTO and person R was nominated for coaching. In a similar manner all graphs were analysed to identify the other senior engineers who would possibly benefit from coaching. This mechanism provided insight into the informal structure of the team that was often not known to HR or the CTO.

This is evidence that SNA data can provide powerful and surprising insights into team dynamics which can be of value to management. It also shows that SNA data can assist in identifying coaching candidates, specifically in cases where candidates have relationship issues.

The use of SNA to create self-awareness, set goals and new strategies during coaching

SNA data served as a reality-check for coachees. The quantitative, group-perspectives offered by the data, and the fact that it was shared in a safe, contained environment, prompted coachees to take the messages seriously. It was difficult for them to remain in denial. The graphical and quantitative nature of the data specifically appealed to the group since they were all engineers who are typically analytically minded. This led to a number of new insights, assisted them in designing new strategies to overcome the limiting patterns that they identified, and helped them to reach their coaching goals.

Using SNA to investigate the possible improvement in knowledge sharing attributable to coaching

In order to assess the magnitude of change in relationships pre- and post-coaching, and the reasons for these changes, this section will analyse the classification results derived in Table 5.

Sound-boarding

SNA results 1 to 4 (see table 5) focused on the frequency of sound-boarding between the four coachees and the group. Coachees A, E and R show large increases for result 4 (the number of people that a coachee never sound-boarded against). Coachee A used 7 more people as sound-boards post-coaching, coachee E used 5 more and coachee R used 10 more. They all explicitly identified, as coaching goals, increasing the number of people to sound-board against. Their typical pattern of interacting with the group was to wait for people to approach them with questions. In studying the SNA

graphs during the coaching sessions, they came to the conclusion that there may be benefits in sound-boarding more broadly. Accordingly they designed new behavioural strategies related to this insight.

There is evidence that the change had a positive effect on the group, since all four of the coachees showed a decrease in the number of people who never used them as a sound-board (SNA result 3). The new behaviour strategy of coachees A and R was also noticed by the CTO who noted in the post-coaching interview that he had observed them interacting more frequently and widely with the group. The CTO considered this to be a valuable shift in helping to spread the knowledge in the group.

Coachee A and I had decreased relationships for SNA result 1 (number of people who sound-board against him on a daily basis). In both cases their environment changed during the coaching intervention (new people joining the team and regular colleagues went overseas). The important observation here is that SNA data must be contextualised and cannot be taken at face value.

Level of knowledge
SNA results 5 and 6 focused on how people perceived each other's level of knowledge. This is an important relationship aspect. One study found that people are up to five times more likely to turn to other people for knowledge than to conventional sources such as books, databases or file cabinets (Allen, 1977). Only coachee I explicitly targeted this aspect through a new behavioural strategy to include the team in meetings where his level of knowledge was demonstrable. Two more people now consider him to be an expert.

SNA Result	SNA question	COACHEE			
		A	E	I	R
1	Sound-boarding: high-score, group-perspective	-3	+1	+2	0
2	Sound boarding: high-score, individual-perspective	0	0	-2	0
3	Sound boarding: low-score, group-perspective	+1	+2	+1	+1
4	Sound boarding: low-score, individual-perspective	+7	+5	-2	+10
5	Level of knowledge: high-score, group-perspective	N/A	N/A	+2	N/A
6	Level of knowledge: low-score, group-perspective	N/A	N/A	N/A	N/A
7	Accessibility: high-score, group-perspective	N/A	N/A	N/A	N/A
8	Accessibility: low-score, group-perspective	N/A	N/A	N/A	N/A
9	Effective thinking partner: high-score, group-perspective	N/A	0	N/A	N/A
10	Effective thinking partner: Bottom-end, group-perspective	N/A	N/A	N/A	N/A
11	Safe and trusting: high-score, group-perspective	-1	+2	+1	0
12	Safe and trusting: low-score, group-perspective	-1	-2	+2	+8
13	Energising interaction: high-score, group-perspective	0	+2	+2	-1
14	Energising interaction: low-score, group-perspective	+3	0	0	+2
	TOTAL CHANGE	**+6**	**+10**	**+6**	**+20**

* Each number indicates the change in number of relationships that may have been due to coaching.

Table 5: SNA and coaching classification matrix

Accessibility

Results 7 and 8 relate to how easy it was to gain access to a person. This was not a relevant issue for any of the four coachees, as they were rated by the group as always available. This result is therefore not analysed further.

Effective thinking partner

This set of results (9 and 10) relates to how effective a person is in helping others think through and solve problems. No significant data existed for result 10 as none of the coachees were rated as low in this category.

Only coachee E focused on SNA result 9. The objective was to increase his effectiveness, as perceived by the rest of the team, in helping them think through and solve problems. The results show no change. In the post-coaching interview he could not find any specific link between the result and his new strategy. None of the other coachees focused on this aspect and no significant insights emerged during the post-coaching interviews.

The insight here is that coachees are not always able to attribute shifts in SNA data to anything specific. This may point to the need to broaden the post-coaching qualitative data sources to include the respondents of the SNA questionnaire.

Safe and trusting relationship
SNA results 11 and 12 relate to how safe and trusting people consider their relationships with each other to be. Trust is an important aspect in knowledge sharing (Cross, Parker & Borgatti, 2002).
All coachees included these results in either their goals or new strategies. The greatest positive result is observed for coachee R's result 12, which shows an increase of 8. In other words, 8 fewer people rated their trust relationships with R to be at a low level. He ascribed this improvement to his practical strategies of having lunch with the rest of the team in the social areas instead of at his desk, and to initiate conversations.

Coachee I also ascribed his increase of 1 and 2 for results 11 and 12 respectively to his coaching strategy of not leaving people in an excited state after interactions with them, as he suspected this influenced their ability to trust him. The CTO also remarked that coachee I appeared to be more relaxed and engaged than he had been before the coaching.

These two examples provide evidence of how coaching may help to change limiting patterns of thinking and behaving. It illustrates the capacity of SNA data to provide insights into these patterns both before and after coaching, and also how these insights can translate into the setting of goals and creation of new strategies.

Coachee A shows a decrease in both SNA results 11 and 12. During the post-coaching interview this came as a surprise to him as he had specifically targeted these aspects. On further reflection he admitted that it was something that he still struggled with. SNA data can therefore be useful to motivate the continuation of a coaching intervention with renewed focus on areas of development.

Energising interactions
SNA results 13 and 14 relate to how energising members of the group find each other. The importance of organisational energy is an emerging field of study with significant implications for how an organisation is viewed (Derman, Barkhuizen & Stanz, 2011).
Result 13 represents a high-score rating while result 14 represents a low-score rating. All coachees targeted these results via either direct coaching goals or new strategies. Coachee A's result 14 increased by 3. He attributed the positive change directly to the coaching intervention through the self-awareness it gave him and the opportunity to design and practice the new strategies.

Coachee E's result 13 increased by 2, meaning that 2 more people considered him to be highly energising. In the post-coaching interview he drew a correlation between his strategy of 'being more energising by not being sarcastic' and the improved results. He attributed the positive change to the coaching.

The possible benefit of coaching beyond the individual to improve knowledge sharing in a team

To assess whether SNA can also be used to provide a measure of increase knowledge sharing beyond the coached individual, the assumption is made that if more people are involved in positive relationships with the coachees after the coaching than before it, the assumption holds true. The basis for this assumption rests on the interpretations of Complexity Theory and Complex Adaptive Systems related to organisational dynamics and coaching as discussed in the literature review. For a Complex Adaptive System, the literature suggests a clear link between the relationships between agents (individuals) and the whole (the organisation or team) that emerges through the interactions between the agents.

Kauffman (1995) suggests that a system evolves through novelty when agents are richly connected. It is the patterns of connection between local agents that determine the overall landscape and ability of

the system to survive (Stacey, 2011). The reference to 'richness' here suggests more and healthier relationships. SNA is a method for measuring changes in relationships and was used in this research to measure the change in relationship patterns that may have been caused by the coaching. With this in mind, an attempt is made below to use SNA to quantify the overall improvement in the number of positive relationships.

Recall that ego networks were correlated with qualitative coaching data (notes taken during coaching sessions, post-coaching semi-structured interviews, feedback from HR and the CTO) in an attempt to ascertain whether changes in ego networks were due to coaching. As illustrated in table 5, 56 such comparisons, 14 per coachee, were made. Of the 56 results, 22 were not applicable (SNA data uncorrelated with qualitative coaching data or no data present). Of the remaining 34 results, 18 were positive (more positive relationships), 9 neutral (same number of relationships), 7 negative (fewer positive relationships). This indicates that there was double the number of positive results to negative and overall more positive than other results. Coachees had 42 more positive relationships after the coaching which may have been the result of the coaching.

This analysis indicates the usefulness of SNA to provide some measure of coaching success beyond the individual.

Limitations of the study

This study did not endeavour to use SNA to provide an objective measure of coaching efficacy. Instead the focus was to reflect on the benefits of using SNA during the action research cycle applied to a coaching intervention. It cannot therefore be ruled out that factors other than the coaching intervention may have contributed to the improved observed results.

Research involving people in organisations, such as conducted in this project, constitutes an environment that is not controlled. During the research a number of people left the research group, while others joined. This was accounted for by excluding the people who left the group from the pre-coaching results to ensure a like-for-like comparison.

Of all the available SNA methods, only centrality measures were used in this analysis. This was done since it represents a widely accepted standard measure of importance in a network (Hanneman & Riddle, 2005). There are numerous other SNA methods and techniques that may have provided additional insight into the data, such as closeness and betweenness.

The relatively small sample size of this study means that no generalised conclusions can be made based on the results. The findings do however contribute to a new approach of studying the application of Social Network Analysis to coaching. Further research could build on this exploratory study.

Conclusion

The findings of this study suggest that SNA, when applied during a coaching intervention using an action research approach, could be used in an organisational context in two ways. Firstly, on an intervention design (macro) level the coach and sponsor can use SNA to provide information to *observe* the current state of a team (who is connected to whom and in what way?); can facilitate *reflection* on what the observation means (are connections optimal given the business imperatives and expectations?); assist in *planning* the coaching intervention (who should be coached and on what?); and drive the *execution* of the intervention (what duration and success measures?).

Secondly, during the execution of the intervention (micro level), the coach and coachee can also use SNA to *observe* the individual's position in the network hierarchy; can *reflect* on what the implications of the position are, assist in identifying reasons for the position and set coaching goals to address the situation; then strategise (*plan*) how to achieve the goal given by the SNA data and finally execute (*act*)

on the strategy between sessions to imbed new behaviours that will assist in achieving the coaching goal.

Finally, SNA can also be used to attempt to measure the benefit of coaching beyond the individual by performing a pre- and post-SNA and comparing the change in relationships that may be due to the coaching intervention. Depending on the questions used in the SNA process, the difference between pre- and post-SNA data can provide insight into important aspects such as the level of knowledge sharing, as in the case of this research report. This study demonstrated the novelty of applying SNA techniques using an action research approach in an organisational context and showed the potential benefit of this approach not only to coaches and coachees, but also to organisations that consider relationships between their employees an important determinant of organisational success.

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