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Social network theory and analysis: a preliminary exploration

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1. Introduction

The rationale for addressing the issue of social networks and social network analysis in the context of health policy is to investigate the extent to which these theoretical and analytical paradigms represent feasible and useful tools to evaluate the effectiveness of strategies aimed at increasing the likelihood that policy makers will use evidence from research in formulating health and health services policy. In this context, the investigation of social network theory and analysis is informed by the needs of the Sax Institute, which is a coalition of University and research groups undertaking public health and health services research in NSW. The aim of the Institute is to build partnerships between researchers and health policy and service delivery agencies and, through these partnerships, develop research assets and programs and support researchers to enable and strengthen policy and practice focused research.

Although the final outcome of interest is the formulation of evidence-informed policy (and, by inference, its implementation and the subsequent improvement in outcomes such as enhanced health services delivery and/or improved health status of those affected by the policy), it is unlikely that a direct link between the research evidence used, the formulation of policy, its implementation and any outcomes will be able to be observed within the limited resources available to the Sax Institute. Therefore, for the purposes of this paper, policy formulation and implementation will be treated as processes, and their link to health services and patient/population health status will be assumed. The paper will focus on the use of social networks in encouraging or enhancing links between the research evidence and policy formulation aspects of the process and the feasibility of using social network analysis to evaluate the effectiveness of such links. In particular, the issue of researcher-policy maker interaction will be dealt with, in terms of the extent to which a social network is likely to encourage such interactions and the extent to which interactions, in turn, facilitate the development of evidence-informed policy.

The paper is structured as follows[a]: social networks and social network analysis are described in section 2, including a brief explanation of the theoretical underpinnings of the constructs. Section 3 covers some literature describing how networks have been used to link researchers and policy makers (research policy networks) and any evaluations of such networks. Section 4 will repeat this exercise with examples from the literature of health research policy networks (or similar) and will focus on the extent to which networks are likely to be effective in the context of policy relating to health and health services, and, if they are, what might be the characteristics required for a network to be successful. In turn, this will allow some consideration of how the effectiveness of a network could be evaluated. The final section (section 5) will draw some conclusions from the preceding sections and raise some issues for the Sax Institute to consider.

[a] It should be noted that the published papers referred to in this paper were not identified via a systematic search and no systematic review of the literature has been undertaken. Both peer-reviewed and "grey" literature have been used.

2. What are social networks?

A social network is a social structure made up of *nodes* (individuals or organisations) which are linked (*tied*) by one or more specific types of relationship or interdependency, such as values, ideas, financial exchange, trade, friendship, kinship, social role as well as affective (respect, dislike etc) or action (eg talks to, has lunch with) relationships[2]. In its simplest form, a social network is a description or map of all the relevant ties between the nodes being studied[3]. The more ties an individual has within a network and beyond the network (ie through the ties of other network members), the more knowledge, influence and power the original actor will have and, importantly, control[5].

Social network theories

The overarching principle of social network theory differs from many traditional sociological theories which assume that it is the attributes of individuals which are important in determining their "place" in the world; network theory proposes that such attributes are less important than the relationships between actors in the network/s to which they belong. A single unified theory of social networks does not exist; rather, a number of theories have been proposed or adopted as describing or predicting the various patterns of interactions which are observed to occur. Table 1 lists a number of theories, their types and the mechanisms by which they operate[6]. These theories have been selected on the basis of their possible relevance to the needs of the Sax Institute.

Table 1: Selected theories of social networks and proposed mechanisms of action

Theory	Type of theory	Theoretical mechanism
Strength of Weak Ties theory	Self-interest	Control of information flow
Transaction costs theory	Self-interest	Minimise the cost of transactions
Critical Mass theory	Mutual self-interest & collective action	Number of people with resources and interests
Social Exchange theory	Exchange and dependency	Exchange of valued resources (material or non-material)
Semantic networks theory	Cognitive	Cognitive mechanisms leading to shared interpretations
Knowledge structures theory	Cognitive	Cognitive mechanisms leading to knowledge transfer

A number of other theories also come under the types listed above. In addition, theories are listed under Contagion theories (eg social processing theory, social cognitive theory), Homophily theories (eg social comparison and social identity theories), theories of proximity (eg physical proximity theory and electronic proximity theory), theories of uncertainty reduction (eg uncertainty reduction theory, contingency theory) and social support theories.

Social network analysis

Social network *analysis* is the mapping and measuring of relationships and flows (ie the patterns of interactions) between individuals, groups or organisations. Making use

of mathematical tools and concepts belonging to graph theory, it is used to graph or produce matricies (called social network diagrams) illustrating these structures, which are often very complex. Thus, it is largely a descriptive method of analysis. The actors (nodes) within a particular network may be linked by many types of ties and the number and complexity of the relationships identified for a particular node is said to illustrate the *social capital* of individual actors[1]. In this context, social capital refers to the network position of the actor or node and consists of the ability to draw on the resources contained by the members of the network[4.] Social network analysis is based on an assumption of the importance of relationships among interacting units in affecting or influencing important features of the units (eg efficiency in performing a task, leadership, satisfaction). Gretzel[3] has noted that the following are important principles underpinning a social network perspective:

i. Actors (nodes), and therefore their actions (behaviour) are viewed as interdependent, rather than independent and/or autonomous;
ii. Ties (linkages) between actors are channels for transfer of "resources" – which can be material or non-material;
iii. The network structure is viewed as constraining individual behaviour; and
iv. Social, economic, political and other structures are conceptualised as lasting patterns of relationships (ties) between actors (individuals or organisations).

In the context of social network analysis, the unit of analysis is not the individual but an entity consisting of individuals (ie at least two) and their relationships or linkages – between each other and with others. Analysis focuses on the relationships between actors, not on their individual characteristics or organisational attributes. For example, at an actor level, analysis would map the extent to which an individual within a network has a central role, his or her level of prestige or isolation and the extent to which s/he acts as a liaison person etc. Analysis of dyads (ie two actors in a network) would evaluate distance, reachability, reciprocity etc, while those of a sub-set (ie more than three actors) would examine such issues as cliques and cohesiveness[2].

A complete description of an example of social network analysis is not possible within this paper. However, to begin to understand the method, a brief description of three of the most important concepts in this type of analysis – centrality of individual actors, centralisation of the network and average path length in the network – is warranted[7].

Centrality is measured in three ways – Activity, Betweenness and Closeness. Activity measures the number of direct connections each node (actor) has. Although the number of connections is important, it is not always true that the more an individual has, the better. Although it is true that a node with many connections is very active, if these connections are only within an immediate cluster and do not lead outwards, some may be redundant. Betweenness measures what may be described as a liaison role; nodes who are observed to have a high level of betweenness are often positioned between two important organisations or constituencies and may play a brokerage role, a powerful role in social networks in terms of controlling flows. However, in a setting of two or more networks, if only one or two nodes have a high level of betweenness (ie only they can operate as brokers), the risk of failure may be as high as that of success. Closeness measures the length of the pathways between individual nodes. Ensuring that as many nodes as possible have short paths connecting them to many other nodes is said to improve the quality of communications and other flows (ties)

between nodes. Maximising the closeness of only one or a few nodes is said to be counter productive in terms of flows[7].

Centralisation of the network is a measure of the relationship between the centralities of all nodes. This is said to reveal much about the overall structure of the network. If a network is dominated by one or two central nodes, their removal will lead to fragmentation of the network into unconnected sub-networks. Therefore, it is recommended that networks be constructed to have a low level of centralisation – allowing it to be resilient in the face of some local failures.

Average path length is a measure of the number of steps taken to reach from one node to another within a network. Short paths imply quicker flows and less distortion. This measure is said to be closely correlated with the degree of Closeness within the network. In the descriptions provided of these concepts, it is difficult for the naïve reader to distinguish between these measures.

The types of ties (or relationships) observed with a social network are described as:
Weak: these are ties which enable networks to introduce new ideas. Two types of weak ties are bridging and vertical ties.

> Bridging ties are those which connect "distant" members eg actors who may be alike but operate in different networks;
> Vertical: ties connect unlike members;

Cross-cutting: these are connections which operate across natural boundaries with credibility.

As well as being guided by formal theory organised in mathematical terms, social network analysis requires empirical relational data. Data can be collected via questionnaires, by direct observation, using written records (eg diary) and via experiments in the formation of social networks[2]. A number of software applications have been developed to support social network analysis[3]. The availability of relatively powerful computers has facilitated a burgeoning of studies in such areas as organisational behaviour, inter-organisational relations, the spread of contagious diseases, mental health, social support, the diffusion of information and animal social interaction[3].

Although the range of analyses are too broad and numerous to describe here, Ethier has described relatively recent research in the field as including using social network theory to describe how public opinion is formed, to evaluate personal reputations, to examine the characteristics of stable networks, to describe similarities between computer and human networks, to investigate the implications of social network diversity (number of roles within networks) for personal health, the value of using social networks for marketing, the role of the internet in social networks and the application of social network analysis to security intelligence applications[5].

All of the above assumes that some social networks form "naturally" (eg kinship networks, friendship networks, many work-based networks) ie they are formed as a result of individuals coming together for a reason or reasons beyond the network. Thus, social network analysis as a descriptive method is a useful means of understanding how such networks operate. However, the policy or research policy networks which will be the subject of the rest of this paper are usually formed

specifically for the purpose of bringing together individuals in a network. A number of papers have described social networks specifically formed to influence policy, including health policy[8-10]. No published evaluations of the effectiveness of such networks have been identified but some frameworks for evaluation have been developed[8]. An important issue for the Sax Institute to consider is whether social network analysis is a suitable method for evaluating the success of such networks, when the method has been designed to describe their operation, rather than measure the relationships between the formation and composition of the network, its processes (operation) and outcomes.

3. Using networks to link researchers and policy makers

The most comprehensive and accessible work identified in this brief review is a Working Paper by Perkin and Court[8] published by the Overseas Development Institute (UK) in 2005. This work is described as a literature review, which, although written in the context of International Development, provides very useful information about the ways in which networks can develop and/or enhance links between research, policy and practice and the opportunities and challenges of such enterprises. However, it is important to note that although the authors state that their conclusions have been reached using a review of over 100 texts, the paper does not include a "methods" section or any description of the way in which the texts were identified, any inclusion or exclusion criteria or how their quality was judged. Therefore, the results must be treated with caution. In addition, there is no suggestion by the authors that they have classified or evaluated such networks using social network theories or analysis. However, within the paper, a discussion of social capital, organisational management and the use of new methods of communication (ie email and the internet) explicitly acknowledges the use of social network analysis as a well-known tool for analysis. The information available in this working paper incorporates much of that covered in a 2003 paper by Peterson[9] and is referred to in a subsequent paper by Mendizabal[10].

A number of terms are used to describe research policy networks. Apart from the general umbrella term of Policy Network, other terms used include:

i. Policy Community, which describes stable networks of actors from both inside and outside government, well integrated with the policy process;
ii. Global Public Policy Networks, which are overarching networks including government, business and civil society, addressing all stages of the policy process;
iii. Epistemic Community, informal networks operating via shared values and ideas;
iv. Knowledge Networks, incorporating academic, scientific and professional individuals and groups organised around a specific topic or issue;
v. Community of Practice, groups of professionals embodying a set of knowledge and operating through shared understandings of problems and the pursuit of solutions;
vi. Advocacy Network, which may be any combination of actors who come together to influence the policy process; and
vii. Private-Private policy network, consisting of groupings of private business and civil society which acts to formulate and implement policy.

This list may not be exhaustive. From the perspective of social network analysis, the title of or description of the network is less important than its functions and functionality, as measured by the number of nodes and ties and the relationships between them.

Characteristics of successful research policy network

Perkin and Court identify the following characteristics as indicators of a successful network. Where appropriate, following the descriptions of each characteristic, the related concept from social network theory and/or analysis is identified and the connection described, in italics:

i. A unifying purpose; this refers to networks needing to have a clear purpose, or set of goals and objectives. *In the context of social network theory, this idea resonates with that of a network having shared values.*

ii. Interactive communications; information is freely accessible, with feedback potentially available from all members. There is no monopoly on knowledge. *This characteristic is linked to one of the most important ideas in social network theory - that of the use of a network to facilitate and control flows of resources and information. In social analysis terms, the characteristic may be evaluated using all the measures of Centrality.*

iii. Autonomous actors. This refers to the idea that autonomous or independent actors (in their own sphere) are more likely to be able to cooperate in the interdependent context of a network, are able to lead and adapt to a flexible structure. *This characteristic of a successful network appears to conflict with the ideas that, from the perspective of social network theory, actors (nodes), and therefore their actions (behaviour) are viewed as interdependent, rather than independent and/or autonomous and that the network structure is viewed as constraining individual behaviour.*

iv. Simultaneous action from multiple nodes is possible. This characteristic is said to indicate a well-coordinated network. *This characteristic is in concert with the concepts in social network theory of the complexity of networks and the capacity of actors to belong to and (depending on their position within networks) act as connectors. In terms of social network analysis, this characteristic could be evaluated using measures of betweeneness, closeness and centralisation.*

v. The culture of a successful network is dynamic. This refers to the ability of enhanced capacity for communication among multiple actors to foster a capacity for creativity and risk taking. *It is difficult to identify the relevant concepts within social network theory and/or analysis.*

vi. Shared interests or values. While the structure of a network may be fluid, cohesion is provided by the actors having shared interests or values. *In a similar fashion to the first point above, this characteristic resonates with the concept that a social network consists actors linked by one or more specific types of relationship or interdependency, such as values, ideas etc.*

From the above, it can be seen that while there is much overlap between the characteristics of successful networks and the concepts articulated in social network theory and analysis, there are also areas of discrepancy. In particular, there are gaps between them in terms of the concepts of autonomy versus interdependency and social networks' lack of recognition (at least from the perspective of the superficial examination undertaken for this paper) of concepts such as creativity and risk taking is worth noting.

How research policy networks work

However, despite the confidence with which Perkin and Court present the successful indicators described above, they also admit that there is limited understanding of why,

when and how networks function optimally for policy impact. Most of the evidence presented by Perkin and Court, relates to *how* a network operates. For example, there is evidence suggesting that networks which *work* can help improve policy processes through the better use of information, by, for example:

i. Assisting in marshalling evidence, particularly high quality research evidence and ensuring that the policy implications of research are identified and understood
ii. Fostering links between researchers and policy makers this enhancing the probability that free and interactive communication among a diverse range of actors will occur
iii. Bypass formal barriers to consensus
iv. Bring additional resources and expertise to policy making;
v. Assist in addressing the multiple, sometime conflicting objectives of policy

Table 2, adapted from Perkin and Court[8] outlines how research policy networks may assist in ensuring that the processes and outcomes of policies are informed by evidence. It begins with policy stages, includes objectives and then suggests ways in which networks may operate. As such, this table outlines the "when" and "how", but not the "why" of optimal operation of networks. The emphasis on "when" and "how" fits well with social network analysis as a descriptive method. Thus, an examination of the number of nodes and their ties within a research policy network may provide insights into how (for example) a brokering process operates to marshal evidence or encourage consensus; it may also lead to a greater understanding of how links between the nodes within such a network operate to facilitate communication (or not).

Table 2: How networks may impact on policy

Stage of policy process	**Key objectives for networks**	**How networks may influence the processes**
Agenda setting	Convince policy makers of need to address a particular issue	• Marshall evidence • Foster links between policy makers and relevant researchers
Formulation	Provide information about policy options Build consensus	• Act as a resource for the collation of high quality evidence • Direct expertise and other resources to the process • Bypass formal barriers to consensus
Implementation	Complement formal implementation activity	• Advocate for implementation • Enhance sustainability of the policy
Evaluation	Provide information about the effectiveness and other policy outcomes and direct them to the formal process	• Provide expertise in evaluation to advise on the evaluation process • Connect policy makers with users of the policy

The authors point out that some networks do not work. Although this issue is not covered in any detail, they identify variable access, low levels of interaction, marginal influence and lack of support and resources for sustainability as potential reasons for network failure. In the context of social network analysis, a formal analysis may indicate that such reasons for failure are identifiable as problems with aspects of centrality and centralisation of the network.

4. Using networks to link health researchers and policy makers

No literature specifically focussing on research policy networks or social networks within the context of health policy was identified. (However, this may be the result of the lack of a systematic search). Within the field of health (as opposed to health policy) one article[11] and one description of a doctoral research project[12] were identified which used the concepts previously described in social network theory and analysis to describe networks operating across providers of primary health care services[11] or health promoting services[12]. However, it is clear from the papers that the authors of both papers are advocates of the social network approach, encouraging decision makers to use this approach in planning new services, but not providing much in the way of independent evidence of its effectiveness . No attempt is made to either evaluate or outline a framework for evaluating the effectiveness of the networks described in the papers. Thus, these papers do not extend our understanding of the use and effectiveness of social networks in healthcare.

Attributes of a successful research policy network in health

Although no specific literature reporting any analysis or evaluation of research policy networks in health was identified, it is possible to draw out from the general body of work on social networks and the work of Perkin and Court[8], some attributes of networks which seem likely to be relevant to those formed for the purpose of increasing the level of research evidence available for consideration and incorporated into health policy. Based on the information reviewed in this paper, a successful research *health* policy network would seem to be one that is:

i. tied by interdependency based on ideas and/or values and/or vision;
ii. formed for the purpose of solving problems;
iii. made up of members with high levels of "social capital" ie knowledge, influence and power;
iv. willing to be administered or coordinated to the extent that consensus is encouraged or reached. (Note that this may conflict with the level of social capital in the network);
v. likely to be stable so that a lasting pattern of positive relationships is formed;
vi. has members with different types of ties or relationships; and
vii. made up of members who are perceived as having structural equivalence or status. New ideas are more likely to be adopted by a network if its members perceive that such ideas have been adopted or championed by others (peers or opinion leaders) who are judged to be "equivalent".

Evaluating the effectiveness of networks

As previously explained, little in the way of frameworks for evaluation or reports of the results of evaluations were identified in the literature. Provan and Milward[13] have described a framework for evaluating public sector networks which are formed for the purpose of providing services (eg health or welfare services), in the USA. Although the need to evaluate network effectiveness at the community, network and participant

level is appropriate for the service-delivery model of networks considered by the authors, the framework and criteria (indicators) suggested for evaluation at the network level are useful for the purposes of this paper.

The authors suggest that there are a number of ways in which the effectiveness of a network could be evaluated. In the case of a health research policy network, such an evaluation would be of interest to stakeholders such as member organisations (research and policy organisations or individuals), the network administrative organisation (eg the Sax Institute) and to politicians and their advisors, who can be seen as the first level of clients of the network. (The second level would be patients and the general public, but they may be too far removed from this level of policy making to be able to evaluate the effectiveness of the network; it is recognised that they would certainly be able to evaluate the effectiveness of policies implemented as a result of the work of the network).

Using the framework proposed by Provan and Milward[13], the first question to be addressed is "Is the network producing services that its clients need and/or want?" Clients of the network (ie politicians and political advisors) would be able to evaluate the extent to which the "services" provided by the network are those they actually need. In other words, in the eyes of these clients, does the work of the network result in better policy?

The second question to be addressed is "What ties are formed by network members and how have these changed over time?" Member organisations and the administrative organisation would be able to evaluate the quality and strength of ties between members of the network and the extent to which the connections of the network are broadened over time.

It is also important that, if the network involves some official administrative arrangements, that these also be evaluated. The effectiveness of the administrative organisation itself can be evaluated by, for example, assessing the effectiveness with which the organisation acquires and distributes resources and information across the network[13].

5. Conclusions

The information presented above raises a number of issues and questions in the context of the Sax Institute's programs and strategies aimed at connecting researchers and policy makers, enhancing their interaction and evaluating the processes and outcomes of such initiatives. The main conclusions of this limited review are:

i. The mapping and evaluation of social networks has, thus far, been used to describe connections within and between networks, including the speed and quality of communication and transfer of other products; there seems to have been little or no work analysing the relationships between these descriptions and outcomes;
ii. No published work was identified which described health research policy groups and/or interactions in terms of a social network, or used social network analysis to evaluate the nodes and ties etc; and
iii. The evidence for what are the process indicators and outcomes of successful research policy networks is relatively scant.

In the light of these conclusions, some questions and issues for the Sax Institute to consider are:

i. In light of the limitations of social network analysis outlines in this paper and given the limited understanding of the characteristics of successful research policy networks, particularly in the context of health policy, is social network analysis a suitable tool to use in the evaluation of the processes and outcomes of the programs and strategies required by the Sax Institute?

ii. Are there research policy networks (or other types of networks) operating within the sphere connected to Sax Institute programs? If such networks can be identified, they may provide a starting point for the development of expertise at the Sax Institute in social network analysis;

iii. If no such networks are currently operating, or if they are not considered suitable for the purpose of social network analysis, should one (or more) be formed? While a currently operating network could be mapped and evaluated in terms of how it was operating (ie the number of and relationships between actors) and whether it demonstrated any or all indicators (characteristics) of successful networks, the formation of a new network would enable it to be created in such a way as to maximise its chances of operating successfully. Moreover, individuals and/or organisations agreeing to be members of such a network would do so with the explicit understanding that the processes and outcomes of the network would be evaluated;

iv. The objectives and processes by which networks may influence policy makers listed in Table 2 point to the development of a framework for evaluation of the success or otherwise of the operation of a network ie to address the question “did the network work”? (In fact, any attempt to increase the use of research evidence in policy making could be evaluated using a similar framework). However, such a framework would not be able to answer the question “why did the network work (or not work)? To answer this question, information about the attributes of network members would be required, which, in turn, would need to be preceded by an investigation of what member attributes were likely to be associated the formation and operation of a successful network. Using regression analysis, it would be possible to predict the characteristics of successful networks both in terms of processes (eg the extent to which a network marshals evidence, facilitates communication, acts as a resource for high quality evidence, facilitates consensus etc) and outcomes (eg the extent to which a network oversees the formulation and/or implementation of evidence-informed policy and subsequent changes in health service organisation and/or delivery, patient and/or population health status). In the longer term, such analysis would result in the development of a model of the characteristics of a successful network.

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