

## **Network Determinants of Knowledge Utilization: Preliminary Lessons from a Boundary Organization**

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**KEY WORDS:** Knowledge utilization, knowledge transfer, social networks, boundary organization, science-policy

**Abstract**

Knowledge utilization studies propose two models of knowledge transfer between science and policy; the engineering and socio-organizational model. We extend the socio-organizational model by examining how social interactions between researchers and policy makers facilitate scientific information uptake in the context of a boundary organization ('borg'), designed to straddle the science-policy interface and facilitate information flow. Quantitative social network analysis identified two types of social interactions with independent, positive effects on uptake. Uptake was more likely if policy makers had direct interactions with researchers, and if they discussed borg research with other policy makers. The latter 'indirect network effects' demonstrate the importance of policy makers' embeddedness in the social network and the importance of the external reputation of the borg. We discuss the implications of this for increasing borgs' effectiveness.

**KEY WORDS:** Knowledge utilization, knowledge transfer, social networks, boundary organization, science-policy

### **Introduction and background**

Policy makers are currently calling for research with the potential to inform complex environmental decisions, however, the practical problem of reconciling policy makers' information needs with the production of relevant scientific information has not been adequately resolved. Understanding how best to achieve this reconciliation is a pressing science policy issue (Klerkx & Leeuwis, 2008; Lahsen & Nobre, 2007; McNie, 2007; Sarewitz & Pielke, 2007). Within the field of knowledge utilization studies two main types of explanations have been offered to account for knowledge transfer from researchers to policy makers (e.g. Landry, Lamari, & Amara, 2003). The first, known as the engineering model, suggests that utilization follows a linear sequence from producer (researcher) to consumer (policy maker), with uptake determined by the quality of the scientific product. However, this model of knowledge transfer has been called into question with the emergence of research demonstrating the importance of social context for knowledge utilization. On the basis of such critiques a second set of explanations emphasizing the role of social factors in influencing the use of scientific research by policy makers has been forwarded. While research in this area has begun to uncover the social determinants of knowledge utilization, more information is needed to understand the social mechanisms by which information is transferred between researchers and policy makers.

This paper works to provide such information by analyzing social interactions between researchers and policy makers in the context of a boundary organization (hereafter 'borg'). Borgs are organizations designed to exist at the interface of the science and

policy communities and facilitate information flow between them (Guston, 1999, 2001).

Because borgs operate to align organizational interests and reduce cultural barriers between researchers and policy makers – two primary social barriers to knowledge utilization – they serve as ideal settings for examining a third social determinant of knowledge utilization, namely, social interactions between researchers and policy makers. In this paper we extend social interaction explanations of knowledge utilization by using quantitative social network analysis to examine how different types of social interactions facilitate the utilization of scientific information by policy makers.

The study is presented in three sections. First, we detail existing models of knowledge transfer, conceptualizing the role that different types of social interactions have for knowledge transfer and building hypotheses on the basis of this conceptualization. Second, we describe our methods, data and case study. Third, we present findings and discuss them in light of current research.

### **Models of knowledge transfer and utilization**

There is an expanding body of research examining the factors which influence the utilization of scientific information by policy makers. Despite this, methodological inconsistencies have made cross-case comparisons difficult, and demands for a more integrated conceptual model have long been raised (e.g. Mandell & Sauter, 1984). In response, scholars have worked to synthesize existing research into a more parsimonious set of explanations for the determinants of knowledge utilization. Landry et al. (2003) usefully sort existing research into two main explanatory categories, the engineering

model and the socio-organizational model. We use this framework for conceptualizing the determinants of knowledge utilization and developing our empirical approach.

The engineering model suggests that research will be used by policy makers if it is methodologically sound and of high scientific quality (see Landry et al., 2003 and references therein). This has also been referred to as the ‘linear’ or ‘pipeline’ model and can be traced back to Vannevar Bush’s (1945) essay, *Science: The Endless Frontier* (Kleinman, 1995). This model assumes that researchers pursue answers to societal problems and in doing so the results gradually diffuse across the science-policy boundary and inform public policy. The engineering model has been critiqued for failing to recognize the importance of social context and social relations in knowledge transactions (see e.g. Cash et al., 2003).

In contrast, socio-organizational explanations suggest that knowledge utilization is determined primarily by the character of social relations between researchers and policy makers. Three main ways in which social relations affect knowledge transfer processes have been suggested: *Organizational-interests* explanations suggest that use of scientific information increases when research incorporates the needs of the end users. Knowledge transfer thus increases as the salience of research for policy makers increases (e.g. Huberman & Thurler, 1991; Landry, Amara, & Ouimet, 2007). *Two-communities* explanations assume a difference in culture between researchers and policy makers. This cultural barrier hinders communication and prohibits knowledge utilization due to a lack of shared norms and values related to knowledge production, interpretation and

dissemination (e.g. Amara, Ouimet, & Landry, 2004; Oh & Rich, 1997). Finally, *social interactions* explanations contend that interaction (or lack thereof) between researchers and policy makers is a major factor determining the use of research for decision making. Proponents of this perspective claim that interactions between researchers and policy makers increases the likelihood of use by providing opportunities for early involvement by policy makers into research, and increasing the transparency of the research process, thereby enhancing the credibility, legitimacy, and saliency of knowledge produced (e.g. Amara et al., 2004; Landry, Amara, & Lamari, 2001).

The aim of this paper is to extend social interactions explanations by examining such interactions through quantitative social network analysis of relations between scientists and policy makers. We consider these issues in the context of a borg. Borgs offer an ideal setting for examining social interaction explanations because they are designed to align organizational interests and lower cultural boundaries. By controlling for these other two sets of explanations borgs act as a natural experiment for exploring social interactions in the absence of these potentially confounding factors. Our case study borg is working to align organizational interests and has been successful in doing so over time (Parker and Crona, *forthcoming*). As we demonstrate below, there are also no important cultural differences hindering knowledge utilization between the two communities involved in our case study borg. This is thus the ideal settings for examining the effects of different types of social interactions on knowledge utilization. We consider how different types of social interactions might matter for knowledge utilization in the next section.

### **Direct and Indirect Paths to Knowledge Transfer**

Social interactions explanations suggest that the form and content of social relations between researchers and policy makers influence knowledge utilization above and beyond the technical quality of scientific information. However, the specific mechanisms through which social interactions facilitate knowledge uptake by policy makers remain poorly understood. While network analysis offers a powerful means of examining the effects of different types of social interactions and structural positions in the network on knowledge utilization, it has yet to be applied in this context. Below we consider three different ways in which social interactions between researchers and policy makers could potentially affect knowledge utilization by policy makers.

*Direct network effects:* The most straightforward way in which social interactions can influence knowledge utilization is through direct interaction between policy makers and researchers regarding borg research. As suggested by Huberman and Thurler (1991), direct forms of interaction between policy makers and researchers such as informal personal contacts and co-participation in committees have the potential to increase knowledge utilization (see also Argote & Ingram, 2000). According to this logic, policy makers who have greater numbers of direct contacts with researchers will have greater access to the information which they produce and will therefore be more likely to use it (see e.g. Inkpen & Tsang, 2005 and references therein). Further, policy makers with greater numbers of contacts in the research community are more likely to be involved in research from its inception, aiding in the co-production of research, thereby increasing its salience, credibility and legitimacy (Cash et al., 2003; Jasanoff, 2004). In these ways

direct network ties between researchers and policy makers are likely to increase knowledge utilization.

*Indirect network effects:* More interestingly, though less intuitively, interactions among policy makers regarding research may also determine knowledge utilization in important ways. At a general level, such embeddedness of an actor in social networks has been shown to promote knowledge acquisition (e.g. Adler & Kwon, 2002; Nahapiet & Ghoshal, 1998). There are also several reasons for thinking this may be the case for knowledge utilization by policy makers. First, in discussing borg research with other policy makers individuals may become aware of findings and research projects of which they were previously unaware (Inkpen & Beamish, 1997; Inkpen & Tsang, 2005). As with interactions between policy makers and researchers, interactions among policy makers may promote awareness of salient research. Second, by discussing borg research with other policy makers the perceived legitimacy of the research may increase (Landry et al., 2001), thereby increasing the likelihood of knowledge utilization. Third, the perceived credibility of the research may increase as policy makers realize that others are also using and trusting it (Landry et al., 2001), thereby increasing the likelihood of knowledge utilization. We refer to these as indirect network effects because they do not involve interaction between researchers and policy makers, but rather among policy makers.

*Centrality:* Finally, social network research suggests that individuals occupying central brokerage positions in social networks (i.e. those connecting otherwise disparate groups

of actors), have a higher chance of receiving information from diverse sources than do actors in less well connected positions within the network (Burt, 2005; Freeman, 1979). Highly central policy makers should thus benefit from network positions combining direct and indirect influences. On one hand their centrality should make them more aware of available research in the same ways as those with direct ties to the research community, while at the same they will be better connected to the policy community, accruing the benefits of indirect network effects noted above. Together, these processes should increase the likelihood of knowledge utilization.

In sum, we therefore expect: 1) Policy makers who interact with greater numbers of borg researchers will be more likely to utilize borg research, 2) Policy makers who discuss borg research with greater numbers of other policy makers will be more likely to utilize borg research, and 3) Policy makers occupying central brokerage positions within the network of interacting researchers and policy makers will be more likely to utilize borg research.

## **Methods**

### **Case Study and Research Context**

This paper examines these issues in the context of a borg designed to manage the boundary between researchers and policy makers concerning issues related to water and urban development in the arid Southwestern United States. The organization meets the three criteria for borgs (Guston, 1999, 2001): It involves participation by actors from the policy and research communities, engages in the creation and use of boundary objects,

and exists at the frontier of the science and policy communities but is accountable to both.

### **Data and Metrics**

Data were gathered via an online survey of research scientists and policy makers affiliated with the borg. Respondents were selected on the basis of their inclusion on communication lists used by the organization. All respondents were sent a written invitation to take the survey, followed by three email reminders at two week intervals. A total of 177 invitations were sent, with an overall response rate of 60% (69% for researchers: n=75, 47% for policy members: n=32), which is higher than typical for studies of knowledge utilization (Landry et al., 2003). Questions focused on respondents' opinions regarding factors associated with knowledge utilization by policy makers, policy makers' contacts with researchers and others in the policy community, and the extent to which policy makers' organizations utilize research produced by the borg. Each metric is discussed in turn. See Table 1 for a description of each variable. Specific question items used in the survey are included in the *Appendix*.

*Cultural differences:* To test for cultural differences in the opinions of researchers and policy makers regarding factors associated with knowledge utilization we use four questions designed to capture the essence of the two models of knowledge utilization (sensu Gano, Crowley, & Guston, 2007). For the engineering model these include two questions regarding their views on the importance of scientific merit and experimental design for knowledge utilization. For the socio-organizational model these include two

questions regarding their views on the importance of interpersonal contacts and dissemination strategies for knowledge utilization. Answers were measured using a five-point Likert Scale (1 = very unimportant and 5 = very important).

*Network Measures:* Three network measures were used to test the effects of social interactions on knowledge utilization. Direct network effects - To assess the effects of interactions between researchers and policy makers, we asked policy makers how many borg researchers have supplied them with information. Respondents were limited to a total of five contacts when responding to this question<sup>1</sup>. This measure is referred to as 'contact.' Indirect network effects - To assess the effects of interactions among policy makers on knowledge utilization, we asked policy makers to indicate the number of other policy makers with whom they discussed borg research. Respondents were limited to a total of five contacts when responding to this question. This measure is referred to as 'polcom'. Centrality - We used betweenness-centrality to assess the effects of occupying central brokerage positions on knowledge utilization. Betweenness centrality is defined as the degree to which an actor occupies the shortest path between all other actors in the network of interacting researchers and policy makers. This measure is referred to as 'betweenness' and was calculated using Ucinet 6.164 (Borgatti, 2002).

*Knowledge utilization:* We measure knowledge utilization using the well-established scale developed by Knott and Wildavsky (1980). This scale has been widely used and validated by several studies (Landry et al., 2001; Landry et al., 2003). Landry et al. (2003) modified this scale to include six stages of knowledge utilization: reception,

cognition, discussion, reference, effort and influence. Since our independent variables are related to the social interactions of policy makers we excluded the 3<sup>rd</sup> stage of the scale (discussion) to avoid any autocorrelation effects. Following Landry et al. (2003) each stage of the knowledge utilization scale was assessed using a five-point Likert scale, where respondents were asked how accurately each stage described their use of research coming from the borg (1 = never and 5 = always). Each response was then multiplied by the scale score for each stage (1 for stage one, 2 for stage two, and so on), giving a minimum possible score of 0 and a maximum of 90 for each respondent.

All statistical analyses were conducted using SPSS 17.0. Betweenness centrality was calculated using Ucinet 6.164 (Borgatti, 2002).

#### TABLE 1: METRICS

### Results

The social network of communication between scientists and policy makers included 134 actors<sup>ii</sup> and is depicted in Figure 1. Forty-four percent (47) of respondents reported no interaction. On average, policy makers claimed to interact with 2.1 researchers, while researchers reported slightly greater average numbers of contacts in the policy community (2.6). The network was composed of one main component and nine smaller groups. These smaller groups represent researchers who reported contacts in the policy community not named by any other respondent. These researchers were not listed as a

contact by the policy makers who took the survey and hence appear as unconnected clusters in Figure 1.

Independent samples t-tests indicate no significant difference between researchers and policy makers regarding the importance of scientific merit, interpersonal contacts and dissemination strategies for knowledge utilization. Perceptions of the importance of experimental design differed only slightly between the two communities, with policy makers perceiving this to play a somewhat greater role for knowledge utilization ( $p=.02$ ; two-tailed).

In order to test the effects of each type of interaction on overall knowledge utilization we regressed policy makers' total knowledge utilization score onto number of interactions between researchers and policy makers, among policy makers, and the centrality of policy makers within the overall network in a step-wise fashion (Table 2). Direct contacts between researchers and policy makers significantly predicted overall knowledge utilization (Model 1), explaining 10.4 % of the variance in this outcome. Interactions among policy makers was an even stronger predictor of knowledge utilization (Model 2), with the inclusion of this variable raising the explanatory power of the equation to 26%. Betweenness-centrality did not significantly predict knowledge utilization.

TABLE 2: OLS REGRESSIONS

## Discussion

Borgs offer an important means by which to facilitate the uptake of scientific information by policy makers. As indicated by the socio-organizational model of knowledge utilization, there are three main social barriers to such utilization. These include divergences in the interests of science and policy organizations, cultural differences in the norms and values guiding the scientific and policy communities, and a lack of meaningful interaction between researchers and policy makers. Our research shows that borgs can operate to lower these three barriers. We have found that by organizing focus groups involving members of the scientific and policy organizations served by this borg it was possible to bring organizational interests into greater alignment (Parker and Crona, *forthcoming*). In addition, this study shows that researchers and policy makers participating in the borg do not differ significantly in their perceptions of the determinants of knowledge utilization. By lowering these two barriers knowledge transfer from researchers to policy makers should be expedited.

The remaining social barrier is a lack of meaningful interaction between researchers and policy makers. The borg examined in this study has successfully facilitated social interactions between members of the research and policy communities. Our data indicate that these social interactions matter for knowledge utilization, and that different types of social interactions have independent, positive effects on research use. On one hand knowledge utilization is facilitated through direct network effects, that is, through direct interactions between researchers and policy makers participating in the context of this borg. However, social interactions also matter in another manner. Policy makers who discuss borg research with others in the policy community are also more likely to utilize

this research, even when controlling for the effects of their direct interactions with researchers. We refer to these as indirect network effects as they demonstrate the importance of embeddedness in the social network of policy makers surrounding the organization (see also Adler & Kwon, 2002; Nahapiet & Ghoshal, 1998).

These findings have several implications for increasing the effectiveness of borgs. Given the importance of direct contacts between researchers and policy makers for knowledge utilization, borg leaders would do well to organize fora in which researchers and policy makers can come into contact with each other. Furthermore, borgs may also benefit from organizing fora in which policy makers can interact among themselves regarding borg research. These types of meetings have the potential to increase perceptions of the legitimacy, credibility and salience of borg research within this community which can, in turn, increase policy makers' utilization of borg research.

In terms of future research, quantitative social network analysis is a potentially powerful tool for understanding the social networks created by borgs, and for understanding how the number, type and quality of social interactions among network actors affect knowledge utilization and communication processes. By combining social network analysis with survey methods and qualitative assessment of the actual content of social interactions it becomes possible to produce a much richer and more detailed understanding of science-policy interactions. The findings presented here are based on a small sample of researchers and policy makers. These methods should be extended to larger-scale borgs and to cross-case comparisons to better understand the network

determinants of knowledge utilization. It is possible that increased sample size will also allow the detection of other network effects, such as the effect of centrality, on knowledge utilization.

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**Figure captions:**

**Figure 1.** Network of interaction between researchers and policy makers participating in the boundary organization. Researchers are represented by squares and policy makers by circles. The size of the node indicates its relative betweenness-centrality.

**Table 1.** Measures

<b>Metric</b>	<b>NAME</b>	<b>Mean</b>	<b>Max</b>	<b>Min</b>	<b>S.D.</b>
Direct	Contact	0.78	3	.00	.94
Indirect	Polcom	1.44	5.00	.00	2.08
Centrality	Betweenness	101.30	671	.00	161.87
Knowledge utilization	Knowledge utilization	27.91	62	.00	20.17
Scientific Merit	----	1.70	5	1	1.15
Experimental Design	----	2.00	5	1	1.27
Interpersonal	----	2.17	5	1	1.37
Dissemination	----	1.96	5	1	1.20

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**Table 2.** OLS Regressions of Knowledge Utilization on variables Contact, Polcom, and Betweenness

	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>
<b>Contact</b>	7.80**	7.35**	6.51*
	(.364)	(.343)	(.304)
<b>Polcom</b>		4.06**	3.60**
		(.419)	(.371)
<b>Betweenness</b>			.021
			(.166)
<b>Constant</b>	21.81	16.33	15.56
<b>Adjusted R<sup>2</sup></b>	.104	.260	.259
<b>* p &lt; .1; ** p &lt; .05; ***p&lt;.01</b>			
<b>(two-tailed tests)</b>			

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APPENDIX: Survey Items

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**Cultural Differences**

How important do you perceive the following items to be in terms of influencing members of the policy community about whether to use [borg] research?

Scientific merit

(1 = Very Important, 2 = Somewhat Important, 3 = Neutral, 4 = Somewhat unimportant, 5 = Very Important)

Strong experimental design of studies producing the scientific information

(1 = Very Important, 2 = Somewhat Important, 3 = Neutral, 4 = Somewhat unimportant, 5 = Very Important)

Strong inter-personal contacts between policy makers and [borg] members

(1 = Very Important, 2 = Somewhat Important, 3 = Neutral, 4 = Somewhat unimportant, 5 = Very Important)

Clear dissemination strategy from [borg] to the policy community

(1 = Very Important, 2 = Somewhat Important, 3 = Neutral, 4 = Somewhat unimportant, 5 = Very Important)

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**Contact**

For the purposes of this study we define passive interaction as acquiring information from [borg] *without discussing its content* with a [borg] member (For example, receiving data sets or maps from a [borg] member without discussing their content).

Please list the five people with whom you have had the most passive interaction. If fewer than five, list all that apply.

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**Polcom**

Please list the five people in the policy & water management community with whom you have discussed [borg] research the most. If fewer than five, list all that apply.

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**Knowledge Utilization**

Stage 1: I receive research from the boundary organization pertinent to my work.

(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually, 5 = Always)

Stage 2: I understand the research from the boundary organization that I receive.

(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually, 5 = Always)

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Stage 3: I cite research from the boundary organization as references in my own professional reports or documents.

( *1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually, 5 = Always*)

Stage 4: I make efforts to favour the use of research results from the boundary organization

( *1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually, 5 = Always*)

Stage 5: Research results from the boundary organization influence decisions in my administrative unit.

( *1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually, 5 = Always*)

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<sup>i</sup> We chose this measure of social contact because it represents the minimum level of meaningful interaction possible between researchers and policy makers. We do this in order to avoid issues of autocorrelation which could arise using contacts related to other items on the six stage multiplicative knowledge utilization scale.

<sup>ii</sup> The reason the network contains more people than the total number of survey respondents is that respondents often named as their contacts people who did not take the survey.