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Knowledge sourcing methods

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Abstract

Many knowledge management (KM) initiatives in organizations seek to improve how employees draw on each others' expertise, experience, advice, and opinions, which we call *knowledge sourcing* behavior. Employees can source knowledge recorded in document form, through dyadic conversations, or in-group settings. We proposed and tested a theory to support the idea that employees' use of different classes of knowledge sourcing methods produced different kinds of performance outcomes. Our findings suggested that (1) different classes of knowledge sourcing methods are not as interchangeable as the KM literature might suggest, (2) technology-based methods are neither inherently superior nor inferior to traditional methods and (3) that group knowledge sourcing supports a wider range of performance outcomes than other methods. Together, these results highlight the importance of aligning KM efforts with their intended outcome. Before launching a project designed to enhance knowledge sourcing, managers should decide which performance outcome they wish to affect and select a KM tool that is aligned with the desired effect.
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1. Introduction

Knowledge management (KM) research and practice continues to grow dramatically [40], with new technologies and methods for managing knowledge appearing on a regular basis. KM is "a conscious strategy of getting the right knowledge to the right people at the right time . . . to improve organizational performance" [54]. KM practices enhance the flow of insight and advice between employees (e.g., [69]), so that they benefit from each other's expertise. The idea that organizations can improve employees' use of knowledge has become well accepted amongst practitioners [30], even though there is little consensus on how this can best be achieved.

Much of the KM literature treats different methods of sourcing knowledge as broadly interchangeable [23,26]; whether knowledge is accessed via a document or a dialogue is not expected to fundamentally alter the kinds of performance outcomes that are likely to result. Yet, it seems unlikely that accessing knowledge in document form will provide identical

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benefits as conversations with individuals. Further, communities of practice provide situated knowledge exchange that is simply not available via documents or one-on-one dialogues [9]. Thus, there is reason to believe that different knowledge sourcing methods have theoretically important differences. Clarifying the various kinds of performance outcomes that are likely to result from employees' use of different knowledge sourcing methods is thus an important goal for KM research.

We therefore question the degree to which different knowledge sourcing methods are substitutes for each other. The first goal of this research was to develop an improved understanding of key distinctions between different types of knowledge sourcing methods and their impact on different performance outcomes (for example, enhanced efficiency through knowledge re-use, or greater innovation through knowledge re-combination). Our second goal was to explore the use of IT to support knowledge sourcing behaviors; because the KM literature offers contradictory claims about the value of IT for KM purposes, we investigated the differences in effectiveness between IT-enabled KM practices and traditional ones.

Our past research [33] suggested that drawing on others' expertise enhances individuals' learning outcomes, particularly for those who are performing intellectually demanding work and for those who have a weaker learning orientation. This generalized model treated knowledge sourcing as a single high-level aggregate behavior, without examining the different associations between classes of knowledge sourcing methods and specific outcomes. To address the need for a theory that distinguished between different knowledge sourcing methods (rather than treating them as formative indicators of a higher-order general-knowledge sourcing construct), we proposed a mid-range theory to explain how each category of theoretically-similar knowledge sourcing methods affects different kinds of performance outcomes.

2. Knowledge sourcing behaviors

A growing proportion of the KM literature addresses issues that concern the knowledge recipient rather than the provider. A sampling reveals two primary themes: choice and performance.

Researchers in the first group focused on recipients' choices that guide their search for knowledge, developing predictive models of individual behavior in certain search activities and determining how search results were evaluated. In this vein, Menon and Pfeffer [50] provided evidence to explain managers' preferences for external versus internal knowledge sources as a function of the scarcity of external sources and the perception that external sources held higher status implications. Borgatti and Cross [6] found that characteristics of the relationship between recipient and information provider predicted individuals' decision to seek information from others. Sussman and Siegal [65] found that individuals' perceptions of the usefulness of information they received mediated the effect of social influence variables on recipients' intention to act on it.

Researchers in the second group assessed the extent to which newly transferred knowledge impacted recipients' performance levels. For example, Barrick and Spilker [4] noted the importance of recipients' pre-existing knowledge and choice of search strategy in understanding the effect of information acquisition on performance outcomes. Boland et al. [5] examined the effects of different knowledge representations on recipients' decision-making outcomes, and found that some representations were superior. Markus [48] provided a typology of knowledge reuse scenarios and argued that the fit between the knowledge provider's intended recipient type and the actual recipient type predicted the extent of likely performance improvements.

In our previous research, we sought to develop a general-purpose model that could answer questions about both choice and performance, and provide points of attachment to other related theories. Our findings (see Fig. 1) demonstrated the effect of perceived intellectual demands and learning orientation as antecedents of individuals' overall engagement in knowledge sourcing behavior, and also as moderators of the extent to which this behavior produced beneficial outcomes.

It is important to note the difference between drawing on others' knowledge and accessing information in general. Information seeking research (e.g., [41]) typically does not distinguish between knowledge as the product of human thinking and facts as representations of reality. To lump all human
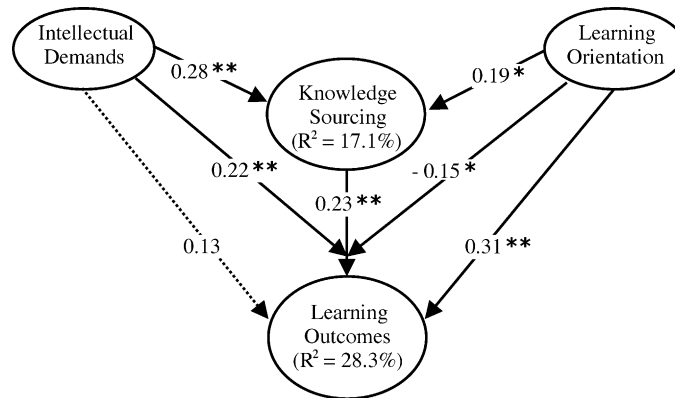
Fig. 1. Results of prior work [33]. Significance levels (2-tailed) are indicated as follows: $^*p < 0.05$ and $^{**}p < 0.01$.

behaviors relating to both advice and facts into the same category discounts important differences between them; one improves recipients' causal maps and helps them understand and predict future events, while the other contains nothing about causes and effects. Because the focus of KM efforts is not on the transfer of factual information (that is, mere representations of reality), we focused on individuals' *knowledge sourcing* behavior, defined as an individual's intentional actions taken to locate and access others' expertise, experiences, insights, and opinions. Organizations often support a wide variety of mechanisms for accessing others' knowledge, which range from ones recently proposed in the KM literature (e.g., knowledge repositories, virtual communities of practice) to well-established organizational practices (e.g., meetings, memos).

Much of the research on knowledge transfer has investigated individual methods for transferring knowledge (e.g., social networks, knowledge repositories, e-mail, etc.). What has not yet been theorized or investigated are the different effects that various types of knowledge sourcing methods have on performance outcomes. Given the many channels by which individuals can access knowledge, there is a surprising lack of theory to predict the relative usefulness of different methods of accessing others' knowledge.

We grouped knowledge sourcing methods according to Harasim's [36] typology communication-based learning models: one-to-one, one-to-many, and many-to-many. These three categories were also used by Culnan and Markus [20] to group electronic media according to underlying communication model.

Because knowledge sourcing is fundamentally a communication behavior that can be accomplished using either electronic or non-electronic means, we used these categories to identify three distinct forms of knowledge sourcing behaviors:

- Dyadic: based on person-to-person communication wherein a single knowledge provider communicates directly with a single knowledge seeker;
- Published: involving the codification and storage of knowledge from a single knowledge provider that may be accessed by many knowledge seekers;
- Group: where knowledge is exchanged amongst multiple seekers and multiple sources in an open venue.

A first strategy for sourcing knowledge is simply to ask someone who is likely to have the required knowledge. These dyadic, two-way, peer-to-peer interactions can be accomplished through a variety of channels (e.g., telephone, e-mail, face-to-face conversation) that permit a single knowledge seeker to interact with a single individual acting as a knowledge source. *Dyadic knowledge sourcing* thus refers to intentional individual efforts to locate and access others' expertise, experience, insights, and opinions by engaging in dialogue with individual employees.

Individuals may also search for knowledge that has been recorded and stored, via what is often described as a "people-to-documents" KM strategy [35]. The connection between the individual who provided the knowledge in question and the individual who retrieved it is mediated by a document. Sourcing published

knowledge therefore involves one-way communication, whereby many individuals can access one's knowledge. We define *published knowledge sourcing* as intentional individual efforts to locate and access others' expertise, experience, insights, and/or opinions that have been expressed in language and separated from their originator. While an individual may choose to go beyond a document and communicate directly with its author, such follow-up behavior would be considered an instance of dyadic knowledge sourcing.

In contrast to these methods, a variety of literature exists that stresses the distribution of knowledge amongst communities of individuals engaged in common types of work [8]. The concept of group knowledge sourcing encompasses such situations that involve open conversations amongst multiple knowledge seekers and multiple sources. Examples include question-and-answer systems [31], work teams [27], and communities, both co-located and distributed (e.g., [60]). *Group knowledge sourcing* refers to intentional individual efforts to locate and access others' expertise, experience, insights, and opinions by engaging in public conversation.

3. Performance outcomes

Following March's [46] distinction between the *exploration* of new possibilities and the *exploitation* of old certainties, there are at least two broad types of performance improvements may be expected when individuals have better access to others' knowledge: enhanced efficiency through the re-use of knowledge, and improved innovation through the creation of entirely new knowledge. However, following Porra [58], there may be a superset of the exploitation/exploration argument, drawn from three fundamentally different system metaphors:

- Mechanical systems, which cannot evolve or adapt beyond conditions specified by their creators. They focus principally on repetition and replication as goals [74]. Knowledge re-use falls naturally into this category.
- Organic systems, which are adaptive and evolve through feedback with their environment and are capable of changing in response to some stimulus. This entails knowledge adaptation.

- Colonial systems, which consist of self-aware colonies of humans who anticipate the need for change and innovate proactively [68], resulting in individual creativity [2].

Using the idea of *replication* from the mechanical metaphor, *adaptation* from the organic metaphor, and *innovation* from the colonial metaphor, we developed a set of performance outcomes.

First, the firm's ability to grow depends on whether it can replicate the skills and routines across employees [43]. Organizations have an incentive to ensure that their successful business practices are widely accepted and used by employees [67], which reduces costs and improves the predictability of quality levels. Thus, *behavioral replication* is defined as the extent to which an individual's behavior has changed over time to more closely reflect others' successful behavior within the organization.

Second, incremental changes in an individual's behavior can result from an improved understanding of their work environment [26]. Enhancing employees' level of adaptation is thus a goal of KM efforts [16]. Therefore, *behavioral adaptation* is defined as the extent to which an individual's behavior has evolved over time to reflect changes in his/her environment. The idea that organizations can encourage employees to adapt to evolving circumstances moves away from ideas of best-practice efficiency and towards individual-level effectiveness as a key goal.

Third, individuals may experiment and develop entirely new solutions to problems, and pursue radically different work practices. The KM literature treats such creativity as the result of new recombinations of existing knowledge [51]. Thus, *behavioral innovation* is defined as the extent to which an individual has made novel and creative behavioral changes.

4. Theory

While the categories of knowledge sourcing and performance outcomes are conceptually distinct, a test of their theoretical and practical value involves hypothesizing and confirming that they are related in meaningful and different ways.

4.1. Replication

Published knowledge is often considered to be a superior mechanism for transferring best practice. For example, Hansen et al. [35] argued that the transfer of knowledge via documents was superior to direct contact between employees when the recipient needed to re-use existing knowledge because it saved time and effort. Davenport and Klahr [24] noted that repositories of knowledge were an improvement over dyadic employee interaction for customer support, as the knowledge was indexed, searchable, and easier to locate. Others have argued in favor of IT-based repositories as forms of organizational memory that enhance the re-use of knowledge within organizations [37], on the basis that written knowledge is a recipe for action that can be followed to produce a desired result.

Knowledge about best practices in document format may be superior because it is more clear and objective than that conveyed through conversation, which is often intermixed with irrelevant information [21]. Further, organizational systems for publishing knowledge generally require that it be vetted and approved by third parties or experts [75], which limits the possibility that it will be distorted by a single source's own biases. Thus, published knowledge is likely to be superior for transmitting clearly bounded chunks of knowledge about best practices and known solutions to problems [10], which is expected to enhance individuals' replication outcomes.

In contrast, dyadic and group sourcing are not expected to be effective tools for enhancing replication. Knowledge that has not been written down and vetted by experts may be difficult to verify, inaccurate, inappropriate, or otherwise incomplete [19]. In this vein, Olivera [55] found that individuals seeking to re-use existing solutions trusted a repository much more than an electronic bulletin board. Particularly because replication involves carrying out specific actions suggested by others, it carries significant risks when actions may be inappropriate or wrong, making verification and accuracy crucial. Thus,

- P1: replication outcomes are enhanced when knowledge that is sourced has been expressed in writing and vetted by experts;

- H1A: individuals' level of published knowledge sourcing will influence their level of replication outcomes;
- H1B: individuals' level of dyadic knowledge sourcing will *not* influence their level of replication outcomes;
- H1C: individuals' level of group knowledge sourcing will *not* influence their level of replication outcomes.

4.2. Adaptation

While any exposure to new inputs may trigger an adaptive response, the underlying communication model may either hamper or promote the extent to which knowledge obtained from others affects one's level of adaptation. This hinges on the likelihood that individuals will (a) appreciate the relevance of the knowledge that they have received and (b) understand its implications to their own work.

Developing an understanding of the relevance of knowledge often requires interactive cycles of interpretation (e.g., [22]) as a precursor to adaptive response. When recipient and source can engage in a dialogue, the recipient is able to pose questions, probe, and clarify the relevance of certain knowledge to his or her situation. March and Olsen [47] argued that processes "like discussion and persuasion" are important for individuals in understanding the relevance of external events. With better understanding of each others' respective context, it is more likely that the relevance (or irrelevance) of a given piece of knowledge will become apparent.

Dialogue also improves the likelihood that recipients will understand the implications of a particular piece of knowledge. Any communication can have different implications for recipients in different situations, and dialogue is key to comparing across contexts to understand applicability. Hinds and Kiesler [38] argued that a high level of interactivity "may be especially important in exchanging and discussing complex information" and that it "permits … ongoing feedback so that people can adjust what they say to one another, correct misunderstandings, and fill in details."

Only dyadic knowledge sourcing mechanisms expressly support the kind of rich dialogue between source and recipient required to compare contexts and

enhance adaptive outcomes. Published knowledge often anticipates only a limited range of contexts in which it will be applied, and does not support two-way communication. Group knowledge sourcing is also unlikely to enhance adaptation, because such contexts tend to discourage repeated interactions between source and recipient that enhance understanding of context and recognition of relevance (participants are intolerant of in-depth discussion of context that take up time and attention). Computer-based modeling of online communities [12] supports this with findings that discussion groups have limits on the range of topics discussed and the volume of messages that can be supported before people abandon the group. This normative pressure to keep discussions group-focused may partially account for the results of Stasser et al. [64], who found that individuals in groups tended to communicate less about their own context and stay with general-knowledge. Group knowledge sourcing contexts are therefore not expected to support detailed comparison of contexts required to enhance adaptation:

- P2: adaptation outcomes are enhanced by knowledge sourcing when individuals both appreciate the relevance of the knowledge and understand its implications for their own work context;
- H2A: individuals' level of dyadic knowledge sourcing will influence their level of adaptation outcomes;
- H2B: individuals' level of published knowledge sourcing will *not* influence their level of adaptation outcomes;
- H2C: individuals' level of group knowledge sourcing will *not* influence their level of adaptation outcomes.

4.3. Innovation

Individuals are more likely to produce innovative solutions when they perceive a situation from a new perspective [71]. Because knowledge sourcing in a group setting likely taps a wider range of perspectives than does dyadic or published sourcing, it is most likely to increase innovation.

Dyadic knowledge sourcing generally requires that an individual identify a specific person with whom to communicate. However, in-group contexts it is seldom necessary to identify such an individual. Instead, one

can target a group whose collective identity is a shared issue, problem, or interest and thus "meet other like-minded people whom they might not otherwise have come to know because of differences in geographical location or position in the organizational structure" [20]. Group-based, topic-oriented communication thus results in a broader range of communication partners (and greater diversity in knowledge) than does dyad-based, target-oriented communication [56]. Knowledge sourcing in a group setting is therefore more akin to weak ties in social network theory (e.g., [11]) in that they provide superior access to broader contact networks than do strong ties, which provide more redundant information.

Broader exposure to individuals with potentially diverse backgrounds increases the number of minority viewpoints, which stimulate individuals to develop more novel solutions [52]. Hagel and Armstrong [34] argued that the value of group discussions was exposure to the "comparative experiences and perspectives of many individuals," and that this diversity led to more innovative outcomes. Similarly, Kanter [42] described how highly innovative companies favor diverse teams, recognizing that multiple points of view need to be used to foster innovation.

Because individuals who source knowledge via published sources must be able to define what they are searching for, published sourcing is also unlikely to expose them to divergent viewpoints that stimulate innovative responses. This may produce a form of confirmation bias [70], where individuals use documents to strengthen existing opinions. This preference may be most pronounced when individuals must choose documents to read, and least pronounced when they participate in conversations with groups who have different perspectives [66]. Published knowledge sourcing is therefore not expected to affect an individual's level of innovation:

- P3: innovation outcomes are enhanced by knowledge sourcing when individuals interact with a wide range of individuals holding different viewpoints;
- H3A: individuals' level of group knowledge sourcing will influence their level of innovation outcomes;
- H3B: individuals' level of published knowledge sourcing will *not* influence their level of innovation outcomes;

- H3C: individuals' level of dyadic knowledge sourcing will *not* influence their level of innovation outcomes.

5. Methods and analysis

Senior managers at the manufacturing engineering division of TechCo (a pseudonym), a technology manufacturer with globally distributed operations, agreed to sponsor this study. Employees in this division performed jobs that were built on the application of professional expertise and had access to a variety of knowledge sourcing methods. We collected the data reported in this paper as part of a larger research project into knowledge sourcing. We analyzed the data using partial least squares (PLS Graph version 3.00) to test the effects of the three knowledge sourcing methods on each performance outcome.

5.1. Instrument development

We constructed a cross-sectional survey instrument following the techniques prescribed by Dillman [25]. Questions for multi-item constructs were developed for use with seven-point Likert-type scales anchored on "strongly disagree" and "strongly agree". We also assessed individuals' use of a variety of specific knowledge sourcing tools and methods using nine-point scales anchored on "never" and "once an hour or more". Control variables employed in this analysis included individuals' learning orientation, the degree to which they perceived their jobs to be intellectually demanding, their age, gender, and organizational tenure. A full list of all items reported in this paper is included in Appendix A. With the exception of items measuring learning orientation, which were adapted from Brett and VandeWalle [7], we constructed all other items. As definitions of "knowledge" can vary considerably, we asked respondents to consider knowledge as "expertise, experience, insights and opinions". Consistent with arguments about the value of an organization's internal knowledge (e.g., [18]), respondents were asked to consider only their internal work-related knowledge sourcing when answering.

Following Churchill's [17] recommendations, we carried out four stages of validation to test the research instrument; this included a review by several KM researchers and practitioners, a pre-test with a convenience sample of knowledge workers (primarily consultants and administrators), interviews with TechCo managers and employees, and a pilot test of the online questionnaire with a small group of TechCo employees. At each stage, our survey was refined to improve respondents' comprehension and to adapt questions they found vague or unclear.

5.2. Data collection

We carried out the final survey using electronic questionnaires, which was standard practice at TechCo. Top managers in the manufacturing engineering division sent an e-mail requesting participation to 1009 employees, and reminder e-mails 5 and 10 days afterwards. A total of 417 responses (41%) were received within 14 days, at which time the questionnaire was moved off-line. Respondents ranged in age from 21 to 59 years (a mean of 36.0), with mean TechCo tenure of 6.3 years, and roughly one-third were female. Fifty-nine percent were front-line employees, while 25% were project leaders and 16% were managers or supervisors. Thirty-six percent of the respondents performed technical work, 24% non-technical, and 40% straddled both. Sixty-eight percent were located in a single U.S. city, with 16% in other parts of the U.S., and the remaining 16% distributed globally. We found no significant demographic differences between respondents and population figures supplied by the HR department for all manufacturing-engineering employees; this therefore supports the sample's representativeness. We assessed non-response bias by testing for differences between early and late responders (first 10% and last 10%) on the basis that late responders would be most similar to non-respondents [3]. No significant ($p < 0.05$) differences were found, suggesting that non-response bias was unlikely.

We retained 313 cases following removal of respondents who either left more than 25% of the items blank, or had less than 1-year tenure in their job (and thus could not provide appropriate responses to learning outcome questions that were focused on within-job improvements over the previous year). Responses were anonymous, making it less likely that respondents provided biased responses (e.g., systematically over-reporting performance).

5.3. Measurement model

The results of three tests of reliability that are commonly used in PLS analyses [39] are shown in Table 1. First, the degree to which an item loaded on its intended construct was taken as a measure of individual item reliability. All items except one featured a loading of 0.7 or greater for their intended construct; the single item that did not (ID_4, loaded at 0.66) would have a negligible impact on reliability if removed, and therefore it was retained. Second, the internal consistency [29] of scales was assessed using composite reliability [73], and all scales exceeded Nunnally's recommended value [53] of 0.7. Internal consistency measures are considered superior to Cronbach's alpha, which assumes tau equivalency and also is known to be biased against short scales [14]. Third, the average variance extracted (AVE), which measures the average variance of a construct from its indicators relative to the measurement error, was calculated for each scale. All scores exceeded Chin's [15] 0.5 cut-off, and thus at least 50% of the variance has been accounted for.

Discriminant validity was supported by the findings that (a) all items correlated most strongly with their intended construct/dimension and (b) the square root of AVE for these constructs (see Table 1) was larger than any respective inter-construct correlations.

Because all data were self-reported using the same questionnaire, special attention was required to assess the possibility of common method variance. If a common method effect exists, then the observed correlations between variables may be artifactual [45]. Two analyses were performed to assess the likelihood of mono-method bias. First, we tested for a common influence (e.g., [57]) across all responses. Using a factor analysis, we found no single factor that explained variance across all items, suggesting that a mono-method bias is unlikely. Second, the smallest correlation among manifest variables provides a reasonable proxy for common methods variance [44]. Since data were collected as part of a larger survey, we examined correlations amongst the full set of measured items and found several correlations below the $r = 0.01$ level. Together, these procedures suggested that mono-method bias was unlikely to be a threat.

Table 1
Measurement characteristics for multi-item constructs and control variables

No.	Construct name	No. of items	Internal consistency	Cronbach's α	AVE	Item loadings	Average variance extracted and correlations										
							1	2	3	4	5	6	7	8	9	10	11
1	Published Sourcing	3	0.89	0.81	0.73	0.87, 0.88, 0.80	0.85[a]										
2	Dyadic Sourcing	3	0.81	0.67	0.59	0.78, 0.72, 0.80	0.09	0.77									
3	Group Sourcing	3	0.84	0.73	0.64	0.77, 0.78, 0.83	0.25	0.42	0.80								
4	Replication	3	0.90	0.83	0.75	0.87, 0.86, 0.87	0.35	0.10	0.26	0.86							
5	Adaptation	3	0.90	0.83	0.74	0.83, 0.88, 0.86	0.20	0.28	0.30	0.50	0.86						
6	Innovation	3	0.90	0.82	0.74	0.83, 0.89, 0.87	0.18	0.11	0.25	0.56	0.66	0.86					
7	Intellectual demands	4	0.89	0.85	0.86	0.87, 0.86, 0.90, 0.66	0.07	0.13	0.09	0.14	0.25	0.25	0.93				
8	Learning orientation	3	0.87	0.78	0.69	0.77, 0.87, 0.85	0.10	0.20	0.13	0.17	0.36	0.34	0.22	0.83			
9	Age	1	n.a.	n.a.	n.a.	n.a.	0.13	0.06	0.11	0.06	0.08	0.02	0.13	0.13	n.a.		
10	Tenure in position	1	n.a.	n.a.	n.a.	n.a.	0.03	-0.09	-0.15	-0.09	0.03	0.04	0.12	-0.04	0.30	n.a.	
11	Gender	1	n.a.	n.a.	n.a.	n.a.	0.11	0.10	0.07	0.12	0.03	0.05	-0.19	0.07	-0.03	-0.13	n.a.

Sample size = 313. Correlations ≥ 0.11 are significant at $p < 0.05$, and ≥ 0.15 are significant at $p < 0.01$ (two tailed).
[a] Diagonal elements are the square root of average variance extracted.

5.4. Confirmatory analysis

We tested our research hypotheses by examining (a) the size and significance of structural paths in the PLS analysis output and (b) the percentage of variance (see Fig. 2) for each of the three dependent variables. Path significance was assessed using bootstrapping techniques, a nonparametric approach for estimating the precision of paths. The results of the confirmatory (hypothesis-testing) portion of the PLS analysis are shown in Fig. 2 and are summarized in Table 2 (paths from the control variables were omitted from Fig. 2 to enhance its readability, but are reported in Table 2).

First, the model explained 19.3% of the variance in replication outcomes. As hypothesized (H1A), published knowledge sourcing significantly predicted replication ($\beta = 0.288$, $p < 0.01$), and dyadic sourcing (H1B) did not ($\beta = 0.049$, n.s.). However, contrary to H1C, an unexpected effect emerged: group sourcing significantly predicted replication ($\beta = 0.156$, $p < 0.01$). P1 was thus partially supported; the logic that governed this proposition appeared to apply to published and dyadic but not to group sourcing.

Second, the model explained 24.7% of the variance in adaptation outcomes. As hypothesized (H2B), published knowledge sourcing did not significantly
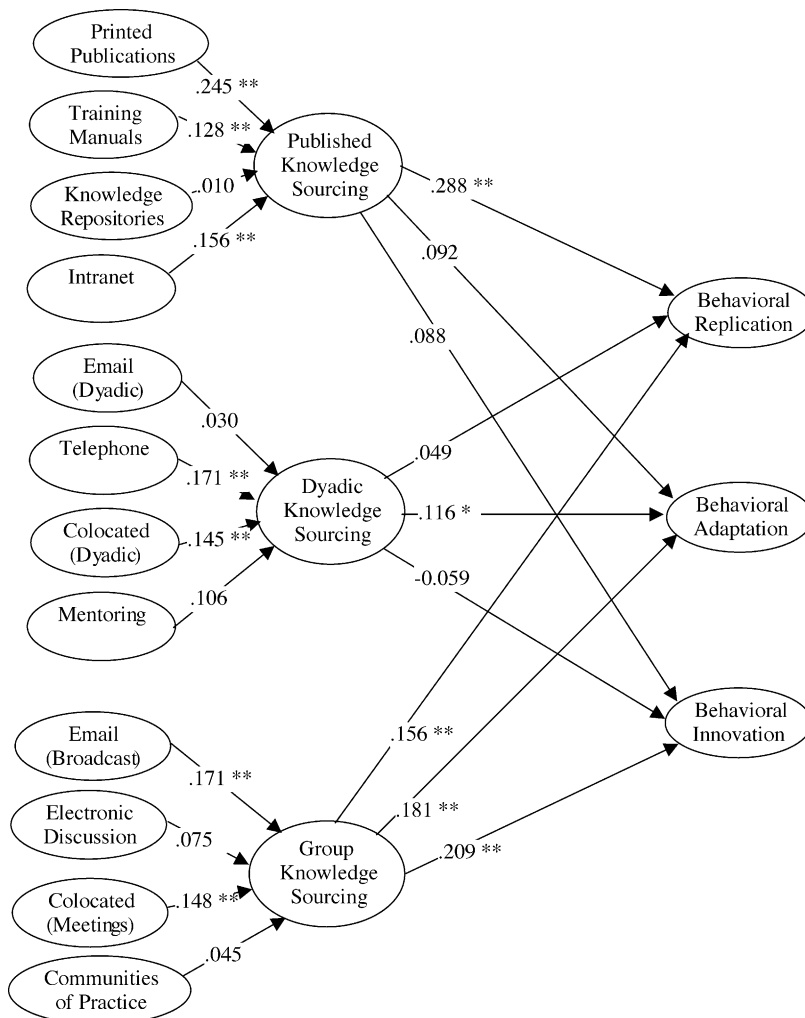

Fig. 2. Results of PLS analysis (control variables omitted). Significance levels (2-tailed) are indicated as follows: $^*p < 0.05$ and $^{**}p < 0.01$.

Table 2
Coefficients for PLS analysis (confirmatory results)

	Dependent variable		
	Replication	Adaptation	Innovation
Hypothesized effects (standardized β)			
Published knowledge sourcing	0.288[**]	0.092	0.088
Dyadic knowledge sourcing	0.049	0.116[*]	−0.059
Group knowledge sourcing	0.156[**]	0.181[**]	0.209[**]
Control variables (standardized β)			
Intellectual demands	0.108[*]	0.137[**]	0.173[**]
Learning orientation	0.107	0.285[**]	0.272[**]
Age	0.046	0.049	−0.011
Tenure in position	−0.096	0.044	0.063
Gender	0.084	0.011	0.054
Equation			
R^2 (adjusted)	0.193	0.247	0.201

[*] Significance levels (2-tailed) are indicated as follows: $p < 0.05$.
[**] Significance levels (2-tailed) are indicated as follows: $p < 0.01$.

predict adaptation ($\beta = 0.092$, n.s.), but dyadic sourcing (H2A) did ($\beta = 0.1162$, $p < 0.05$). Contrary to H2C, another unexpected effect emerged: group sourcing significantly predicted adaptation ($\beta = 0.181$, $p < 0.01$). P2 was thus partially supported with confirmation of the difference between published and dyadic sourcing but no evidence of the hypothesized inadequacy of group sourcing for adaptation.

Third, the model explained 20.1% of the variance in innovation outcomes. Here the results were fully in accordance with P3; neither published (H3B) nor dyadic (H3C) sourcing significantly predicted innovation ($\beta = 0.088$ and $−0.059$, respectively), but group sourcing (H3A) did ($\beta = 0.209$, $p < 0.01$). P3 was therefore fully supported.

5.5. Exploratory analysis

The KM literature has advanced strong opinions about the usefulness of IT in solving KM problems. Two conflicting arguments can be found. The first builds on the proposition that communication via IT is faster and less costly than traditional media [63]: ''[d]igital technologies ... have resulted in huge reductions in the cost of storing, processing, and transferring explicit knowledge'' [32] in addition to reducing search costs. Some practitioners concur; for example, one CEO asserts that IT ''is the key to allowing people to work with others – to share knowledge and solve problems – across the bound-

aries of countries and companies and corporate structures'' [59]. According to this line of thinking, the lower cost and effort of sourcing and sharing knowledge via IT-based methods makes them inherently superior to non-technology based knowledge methods.

Within the anti-technology camp, IT is seen as either useless or harmful to knowledge transfer. For example, Ruggles [61] claimed that ''if technology solves your problem, yours was not a knowledge problem''. Similarly, O'Dell and Grayson contended that IT could not help in knowledge transfer ''because all the important information about a process is too complex and too experiential to be captured electronically'' [54]. Further, Fahey and Prusak [28] argued that IT-mediated contact ''can never substitute for the rich interactivity, communication, and learning that is inherent in [face-to-face] dialogue'', a position echoed by McDermott [49]. Following this logic, IT-based knowledge sourcing methods are inferior tools because the medium is insufficiently rich to support knowledge transfer.

Fortunately, both of these contradictory arguments can be tested using our data, which suggests that both are extreme positions and neither provides a helpful perspective on the usefulness of IT for KM purposes. As part of our analysis, we included measures of employees' use of four specific knowledge sourcing methods for published, dyadic, and group knowledge sourcing. Each cluster of four included two technol-

Table 3
Technology and knowledge sourcing

Type	Specific method and type of sourcing	Standardized β
Nontech	Printed publications → published sourcing	0.245[**]
Nontech	Training materials → published sourcing	0.128[**]
Tech	Knowledge repositories → published sourcing	0.010
Tech	Intranet → published sourcing	0.156[**]
Nontech	Colocated colleagues → dyadic sourcing	0.145[**]
Nontech	Mentoring → dyadic sourcing	0.106
Tech	E-mail (person-to-person) → dyadic sourcing	0.030
Tech	Telephone (person-to-person) → dyadic sourcing	0.171[**]
Nontech	Colocated meetings → group sourcing	0.148[**]
Nontech	Communities of practice → group sourcing	0.045
Tech	E-mail (broadcast) → group sourcing	0.171[**]
Tech	Electronic discussion groups → group sourcing	0.075

[**] Significance (2-tailed): $p < 0.01$.

ogy-based practices and two that were not. An exploratory analysis of their use is reported in Table 3. There is no consistent pattern that emerges across IT-based and non-IT-based methods; the findings show that both can be useful tools and thus that neither is inherently superior. While exploratory, this analysis does offer firm evidence to refute global superiority and inferiority of technology-based knowledge sourcing methods.

6. Discussion

Our research began with the idea that different forms of knowledge sourcing will not produce identical outcomes. Our results supported the value of examining their underlying communication model as a useful way of explaining differences in performance outcomes associated with different categories of knowledge sourcing methods. We also found partial support for the proposed associations between knowledge sourcing behaviors and performance outcomes: published sourcing appeared to be primarily a tool for promoting replication, and dyadic sourcing for enhancing adaptation. The most surprising results concerned group sourcing, as it was a significant predictor for all three outcomes. While these results were not entirely as hypothesized, they nevertheless support the idea that different forms of knowledge sourcing are not directly interchangeable.

Our findings cast some doubt on the widely-held contention that individuals prefer personal (dyadic) over impersonal (published) sources because they are superior channels for accessing information, advice, and opinions (e.g., [1,62]). If individuals do indeed express such preferences, our results suggest that they may not always be correct in their beliefs about the relative superiority of personal over impersonal sources; much depends on the intended outcome. For example, our results indicate that individuals may correctly believe that dyadic is superior to published sourcing for enhancing adaptation. However, individuals may be incorrectly over-generalizing if they apply the same preference of dyadic over published sources for replicating knowledge. Our findings represent a useful elaboration of the more general model of knowledge sourcing, providing theory to explain the variance in effectiveness of different methods for different outcomes.

For managers, our results demonstrated the importance of aligning KM efforts with their intended outcome. Before launching a project designed to enhance knowledge sourcing, managers should decide which performance outcome they wish to affect and select a KM tool that is aligned with the desired effect. For example, our results suggest that the optimistic claims of software vendors who sell databases as knowledge repositories may be justified if replication is the goal, but misplaced if adaptation or innovation outcomes are the intended outcomes.

Our study provides some interesting support for recent research that endorses the creation of group-level structures as powerful KM practices (e.g., [72]). Managers who seek to promote a full range of

performance outcomes should consider group-based knowledge sourcing methods as a particularly effective way of enhancing a wide range of performance outcomes. Given the relatively low costs of supporting such endeavors, they may not only produce more benefits but also offer a superior return on investment.

We also hope our exploratory findings on the usefulness of IT for KM purposes will move researchers and practitioners away from the extreme viewpoints that have been expressed in the past. Our results argue for a balanced view of IT in KM—it is neither panacea nor distraction. There is a clear need for more research to establish theory-based boundary conditions to describe contexts and purposes for which technology-based knowledge sourcing is more or less effective to non-technology sourcing. However, at the very least, these empirical results may help put to rest some common erroneous oversimplifications about the use of IT in KM that persist in the literature.

6.1. Limitations

Our study had several limitations. First, causality may not flow in the direction hypothesized. While we have introduced a causal ordering, the fact that the data were gathered cross-sectionally makes it impossible to conclusively support causality. It is thus possible, for example, that individuals who were more innovative engaged in higher levels of group sourcing for reasons entirely unrelated to the diversity of the available knowledge. A second limitation is that these results may not generalize because they were collected at a single site. Some firms may be more focused on one outcome (e.g., a call center may be more focused on replication) and this may affect the generalizability of the results.

6.2. Conclusions

Through an empirical test of theory that discriminates between different communication models underlying knowledge sourcing methods, our research has offered evidence that different categories of knowledge sourcing methods produce different patterns of performance outcomes. We built on research that showed how knowledge sourcing improves performance and offered a more restrictive assessment of the benefits that may be obtained through organizational KM efforts. In the process, we found evidence that contradicts claims that IT is wholly superior or entirely inferior to traditional methods for sourcing knowledge which may underline the importance of fit between task and technology in realizing positive performance outcomes. The result is a more nuanced theory of KM that stands to cut through some of the KM hype (e.g., [13]) to identify those situations where different kinds of KM efforts are, and are not, likely to improve employees' performance in a variety of ways.

Appendix A

Construct	Item
Published sourcing	I often obtain useful knowledge by reading written materials authored by TechCo people
	I rarely read documents written by TechCo people to increase my knowledge on a topic or issue [r]
	When I'm working on a tough problem, I often refer to documents that were written by TechCo people who may have encountered similar problems
Dyadic Sourcing	I rarely use targeted one-on-one conversations with other employees to acquire work-related [r]
	When I need to access to knowledge, I frequently use personal communication with individual employees
	When I'm working on a difficult issue, I often communicate one-on-one with individual employees who may have encountered similar issues
Group sourcing	I frequently consult with groups of TechCo employees when I need to improve my knowledge on a topic or issue
	I rarely use conversations with a group of TechCo employees as a way of acquiring knowledge [r]
	When I am working on a challenging problem, I often bring it up for discussion with a group of employees who may have encountered similar problems

Appendix A (*Continued*)

Construct	Item
Behavioral replication	I use more best practices now than I did last year
	Over the past year, I have incorporated more established best practices into my work
	Compared to a year ago, I use more proven methods and procedures in my work
Behavioral adaptation	The way I actually do my work has been gradually evolving over the past year in response to new developments
	I am often revising and fine-tuning the way I work to keep up with changes at TechCo
	Over the past year, I have been adapting my work processes to our changing circumstances
Behavioral innovation	I have made a number of substantial improvements in the way I work over the past year
	I have made very creative changes to my work processes in the past year
	I have implemented several ground-breaking changes to the way I do my work in the past year
Learning orientation	I am willing to select a challenging work assignment that I can learn a lot from
	I often look for opportunities to develop new skills and knowledge
	I enjoy challenging and difficult tasks at work where I'll learn new skills
Intellectual demands	My work is actually quite easy [r]
	''Challenging'' would be a good way to describe my job
	It takes a lot of concentration, focus and effort to perform well in this job
	My job is intellectually very demanding
Printed publications	How often do you read internal printed publications authored by others at TechCo that are relevant to your work?
Training manuals	How often do you consult TechCo training materials that are directly related to your work?
Knowledge repositories	How often do you access internal documents or reports that are relevant to your work and are stored in knowledge repositories?
Intranets	How often do you use TechCo's intranet to access web pages that are relevant to your work?
E-mail (dyadic)	How often do you use e-mail to discuss work-related topics one-on-one with other TechCo employees?
Telephone	How often do you use your telephone to discuss work-related topics one-on-one with other TechCo employees?
Colocated (dyadic)	How often do you discuss work-related topics one-on-one with individuals who work close to you?
Mentoring	How often do you discuss work-related topics one-on-one with your mentor(s)?
E-mail (broadcast)	How often do you use e-mail to broadcast messages to a group of TechCo employees to discuss work-related topics?
Electronic discussion groups	How often do you use electronic discussion groups to engage in discussions with a group of TechCo employees about work-related topics?
Colocated (meetings)	How often do you discuss work-related topics with a group of people who work close to you?
Communities of practice	How often do you discuss work-related topics with a group of TechCo employees that you have met through your involvement in communities of practice?

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