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TOWARDS BEHAVIORAL MEASURES OF BOUNDARY SPANNING SUCCESS: THE EFFECTIVENESS AND EFFICIENCY OF TEAM BOUNDARY SPANNING IN ENTERPRISE SOCIAL MEDIA

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Research

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Abstract

Boundary spanning has gained significant popularity in the field of information systems given its role as a critical antecedent to innovation and organizational performance. The majority of boundary-spanning studies have focused on assessing the impact of boundary spanning—as an activity—on distinct dependent variables, such as team innovativeness or operational performance, rather than on measuring the success of the boundary spanning efforts per se. In this conceptual paper, we integrate the literature on boundary spanning and usability to delineate three distinct dimensions of boundary-spanning success by measuring the effectiveness and efficiency of a boundary-spanning interaction—that is the dyadic relation between the boundary spanner and the responder. Our exploratory descriptive statistics reveal that although ESM may be useful in supporting teams in enacting effective information search in reaching the requisite target audience and yielding the desired resources, it is less useful for supporting effective representation and coordination. Developing success metrics not only helps us determine the role of IS in boundary spanning interactions, but also provides a behavioral approach to assessing whether or not boundary spanning is successful in itself rather than determining its downstream performance impacts.

Keywords: Boundary Spanning, Enterprise Social Media, Hierarchical Alignment, Goal Alignment, Response Timeliness

1 Introduction

Team boundary spanning is one of the most significant challenges for organizations today as it involves overcoming detrimental knowledge silos within the organization that may exist between various organizational teams, groups, or units. Team boundary spanning—a group's effort to establish and manage interactions with other individuals and teams inside the organization (Ancona, 1990; Ancona & Caldwell, 1992; Marrone, Tesluk, & Carson, 2007)—is therefore considered a critical antecedent to collaboration and innovation inside organizations (Hardy, Lawrence, & Grant, 2005).

The topic of team boundary spanning has become increasingly popular in the field of information systems given the potential role of IS as a facilitator in team boundary spanning activities. Today, one IS in particular appears to have profound implications for such team boundary spanning interactions and activities in organizations, namely Enterprise Social Media (hereafter, ESM). ESM encompass a range of information and communication tools (ICTs) for supporting interaction, collaboration, and co-creation, such as blogs, content communities, and internal social network sites (Leonardi, Huysman, & Steinfield, 2013; Treem & Leonardi, 2012). Studies of ESM use suggest that these systems have the potential to enhance boundary-spanning activities by enabling the identification of and interaction with relevant external individuals and information (cf., DiMicco et al. 2008; 2009; Steinfield, DiMicco, Ellison, & Lampe, 2009; Shami, Ehrlich, Gay, & Hancock, 2009).

Within the team boundary spanning literature, recent papers have proposed the need for future research to move beyond traditional offline settings to study virtual contexts and in particular assess how the use of virtual tools, such as ESM, affects the success of boundary-spanning activities (Kirkman & Mathieu, 2005). However, hitherto, the success of boundary-spanning activities has solely been assessed by measuring the downstream impacts of these activities on other organizational performance metrics, most importantly operational performance.

However, as the goal of many novel enterprise systems, such as ESM, is to connect dispersed organizational individuals and enable the sharing of information and ideas, measuring the impact of such boundary-spanning activities on team innovativeness or operational performance is questionable for two reasons. First, usage of ESM is largely at the individual level and interactions are mostly dyadic, hence, these individual or dyadic level behaviors may not be valid, reliable or even meaningful predictors of team or organizational level performance metrics. Second, measuring the impact on innovativeness or operational performance assumes that the boundary-spanning activity per se is successful without offering an empirical validation of the effectiveness and efficiency of the boundary spanning interaction.

In this conceptual paper, we use a data science approach to study team boundary spanning and propose three behavioral metrics of the success of a boundary-spanning interaction, which include two distinct measures of boundary spanning effectiveness and one measure of boundary spanning efficiency as critical behavioral proxies of team boundary spanning success. In doing so, this paper offers several contributions to theory. First, it moves beyond the myopic focus in the team boundary spanning literature on the isolated behavior of the boundary spanner and instead highlights the importance of the relationship between the boundary spanner and the responder (or potential reciprocator) and therefore offers a unique dyadic perspective of team boundary spanning. Second, offering a set of behavioral measures of boundary spanning success allows researchers to assess the actual success of a boundary spanning activity rather than the self-reported impacts of presumed successful boundary-spanning activities on downstream team-level outcomes, such as operational performance. Finally, by measuring the success of boundary spanning interactions per se, we can assess the role information systems, such as ESM, play in enhancing the effectiveness and efficiency of these cross-boundary interactions.

The remainder of this paper is organized as follows. First, we review the existing literature on team boundary spanning in order to differentiate important boundary spanning activities that occur between teams inside organizations. Then, we theoretically propose a typology of team boundary spanning success that encompasses three distinct behavioral dimensions of team boundary-spanning interactions using a dyadic perspective. Subsequently, we provide behavioral operationalizations of the three proposed behavioral dimensions of team boundary-spanning success using a data science approach with regards to interaction data from 656 teams from the ESM platform of a large office furnishing design company. Finally, we conclude by discussing the theoretical and practical implications of these measures for the boundary-spanning literature as well as proposing a set of research questions and avenues that could leverage these measures in future team boundary-spanning studies.

2 Team Boundary Spanning: A Review of Existing Literature

Team boundary spanning—sometimes also referred to as boundary work or boundary management—can be defined as a team's or group's effort to establish and manage interactions with parties in the external environment that enhance the team and others linked to the team in meeting performance goals (Ancona, 1990; Ancona & Caldwell, 1992; Marrone et al., 2007). The use of the word team signifies that the activities are directed at acquiring resources that benefit the performance of the team at large, even though individual members of the team rather than the team as a whole may conduct specific activities on behalf of the team.

Team boundary spanning thus involves the engagement of diverse participants in a joint discourse, joint identification (Kilker, 1999; Hinds & Bailey, 2003; Hardy et al., 2005), as well as the constitution of joint practices via the use of joint artifacts (Levina & Vaast, 2005) with actors in the external environment. Boundary spanning, more broadly, concerns itself with the external environment as including other actors and teams residing both within or outside of the boundary spanner's host organization (Marrone, 2007); however, the concept of team boundary-spanning focuses specifically on communication between teams belonging to the same host organization.

Team boundary-spanning has been proposed as a critical antecedent to the performance of not only the boundary-spanning team itself, but also to the performance of other organizational parties that are interdependent with the boundary spanning team as well as the organization as a whole (Mathieu, Marks, & Zaccaro, 2001; Marrone, 2007). Boundary spanning has been shown to be crucial for information transfer, knowledge creation, and innovation inside organizations (c.f., Argote, McEvily, & Reagans, 2003; Hargadon, 1998).

Recent research on individual-level boundary spanning also emphasizes the critical role of internal cross-boundary interactions performed by individuals called 'connectors', particularly in R&D settings (Whelan et al., 2010; Whelan, Golden, & Donnellan, 2013; Whelan & Teigland, 2013). These connectors are linked to others who obtain information from outside the organization, but aid in the process of dissemination of this information by virtue of their extensive internal social network ties and their ability to help translate this information so that it is useful to other members of the organization.

Given its focus on the importance of communication links to external sources of information (Tushman & Scanlon, 1981), team boundary spanning is also closely related to popular concepts from social network theory, including bridging or weak ties (Granovetter, 1973), and structural holes and information brokerage (Burt, 1992), all of which focus on the importance of establishing and maintaining external linkages as conduits to critical resources—monetary, informational, social, or reputational (e.g., Argote et al., 2003; Hargadon, 1998).

Within the literature on team boundary spanning, three distinct and mutually exclusive boundary-spanning activities have been proposed and validated empirically, namely representation, coordination of task performance, and general information search (Grabher, 2004; Ancona & Caldwell, 1992)[1]. This categorization of team boundary spanning emerged from seminal survey work (e.g., Ancona & Cald-

[1] Please note that the actual terms used to describe these three team boundary-spanning activities by various authors differ.

well, 1992) that focused on behaviors and outcomes of these activities for the team as a whole, its members, but also the organization at large (Marrone, 2010). The work has since been advanced to also understand team boundary-spanning actions at diverse levels of analysis, including teams and intra-organizational networks of multiple teams or actors (c.f., Marks, Mathieu, & Zaccaro, 2001). Given this background, we next provide a more detailed overview of the primary types of team boundary-spanning activities identified in the prior literature as these will be foundational in the proposition of our success measures.

Representation, also referred to as ambassadorial or impression management (Ancona & Caldwell, 1992) involves the lobbying for individuals or team members up the corporate hierarchy in order to establish favorable impressions among senior management. Hence, representation is a vertical form of boundary spanning targeting organizational actors higher in rank that the boundary spanning actor. Representation is critical for teams as it may provide them with access to additional monetary support or team members and can further result in high-level commitment, legitimacy, and a positive organization-wide reputation. Representation can further benefit the organization at large by enabling managers in their budget allocation decisions.

Coordination, also referred to as task coordination (Ancona & Caldwell, 1992) or interteam process (Marks et al., 2001), involves the facilitation of effective decision-making and design implementation through cross-boundary strategizing, planning, and evaluation; hence it is a horizontal form of boundary spanning. Coordination is critical for teams as it affords greater efficiency, effectiveness, flexibility, and potential innovativeness of goal delivery. Coordination further benefits the organization by ensuring projects are delivered on-time and within budget.

General information search, also referred to as scouting (Ancona & Caldwell, 1992), involves the general scanning of the external team environment for gaining access to relevant information, knowledge, and expertise; hence, is a largely horizontal form of boundary spanning. Information search is critical for teams as it provides them with insights into trends, opportunities, and threats in the broader environment that may impact their team activities and performance. Information search further benefits the organization by ensuring that team projects are in sync with developments in the extra-organizational environment.

To date, research on team boundary-spanning activities almost invariably focus on the perspective of those attempting to connect to external resources, i.e., the boundary spanner (Van Osch and Steinfield, 2013, 2015). Yet boundary-spanning efforts can also be viewed from the perspective of the reciprocator who may or may not respond to the boundary-spanning activity. In other words, attempts to access external resources must yield a favorable response from those who possess the desired resource in order for the boundary-spanning activity to be considered successful. For instance, attempts to engage in *representation* activities must generate explicit recognition or financial support in order for the representational activity to be considered effective. Similarly, efforts to coordinate tasks across groups should produce responses that help to manage dependencies between teams, units, and departments within the organization. Finally, efforts to search for information from others should yield provision of information, knowledge or expertise relevant to the team's activities in order for the information search to be considered successful.

The important implication here is that we can have a better insight into the potential success of boundary-spanning activities as well as the benefits of information systems, such as ESM, if we not only investigate team boundary-spanning attempts from the perspective of the boundary spanner, but also examine if and when such efforts are successful. Hence, the only way to adequately determine boundary-spanning success is by examining the dyadic interaction between the boundary spanner and responder and the effectiveness and efficiency thereof. In order to inform the assessment of such dyadic boundary-spanning success, we will next propose a theoretical taxonomy of potential dimensions of team boundary-spanning success.

3 Toward a Theoretical Taxonomy of Team Boundary-Spanning Success

Given that successful boundary-spanning activities can best be described along the two dimensions of effectiveness and efficiency, we focus on these two aspects of boundary spanning interactions to determine their success. However, given the multi-dimensional and dyadic nature of boundary spanning, as explained earlier, there are two complicating factors in terms of applying the measures of effectiveness and efficiency to the boundary-spanning context directly. First, given that team boundary spanning is not a one-dimensional activity but may actually refer to one or all of the three activities outlined earlier—namely representation, coordination, and information search (Ancona & Caldwell, 1992)—success measures need to be contextualized for each of these activities to reflect their respective goals. Second, given that distinct boundary-spanning activities—representation, coordination, and information search—can be either horizontal or vertical, effectiveness in the context of boundary spanning does not only refer to the effectiveness of meeting the envisioned goal (i.e., obtaining the desired resource), but also includes a hierarchical component in terms of reaching the most correct target audience in terms of likelihood of possessing the requisite resource. Therefore, effectiveness of boundary spanning can refer both to goal alignment and/or hierarchical alignment, as we will elaborate on below. Furthermore, beyond effectiveness, the efficiency of a boundary-spanning interaction may be an additional determinant of its success.

3.1 Team Boundary Spanning Effectiveness: Goal Alignment

As aforementioned, effectiveness is related to the extent to which the goal of a particular actor is satisfactorily achieved through his or her action. In the context of ESM-based team boundary spanning, we define this dimension of effectiveness as goal alignment. Goal alignment refers to the extent to which the strategic goal of the original boundary spanning activity (i.e., the boundary spanner) is reciprocated by a response providing the desired resource. In the case of representational activities, attempts by the boundary spanner to lobby up the corporate hierarchy must yield responses that indicate legitimization or the commitment of additional (monetary) resources in order to be considered effective and thus successful. In the same vein, information search attempts need to be met by some form of information provision while coordination attempts should be reciprocated with efforts to manage dependencies or negotiate project deadlines.

Hence, goal alignment measures success of a boundary-spanning activity by assessing whether or not the goal of the response matches the goal of the original boundary-spanning attempt. When the nature of the response matches that of the attempt, the boundary-spanning activity can be considered *effective* from the perspective of goal alignment. Alternatively, if a representational activity is met with a response that offers advice or an attempt to coordinate, there is a lack of goal alignment, which would indicate a lack of effectiveness of the boundary-spanning activity.

3.2 Team Boundary Spanning Effectiveness: Hierarchical Alignment

In addition to goal alignment as a proxy for effectiveness of a boundary-spanning attempt, hierarchical alignment is equally important as different boundary-spanning activities are targeted at different organizational audiences defined by their hierarchical rank in the organization. Therefore, hierarchical alignment is inherently a measure of whether or not a boundary-spanning attempt reaches the appropriate target audience and therefore has the potential to be successful in terms of achieving the goal (i.e., effectiveness).

For instance, of the three boundary-spanning activities, representational activities are the only vertical boundary-spanning activity (Ancona & Caldwell, 1992), hence, representational activities by an organizational member are always aimed at someone of higher rank, that is, representation involves acts of impression management that aim to draw the attention of seniors managers in the organization. Hence, part of the effectiveness of representational activities should be determined by the extent to which the attempt is perceived and subsequently reciprocated by users with a higher organizational position than the boundary spanner. In other words, in the context of representation, a *lack* of hierarchical alignment—specifically so that the reciprocator is superior to the originator of the boundary-spanning attempt—is an indicator of effectiveness. Although, an acknowledgement or compliment by peers may offer an intrinsic reward for the person engaging in a representational activity, it could never satisfy the goal of representational activities, namely to achieve legitimization or monetary support.

On the other hand, the remaining two boundary-spanning activities, namely coordination and information search, are considered horizontal forms of boundary spanning (Ancona & Caldwell, 1992). Coordination and information search in ESM aim to gain access to relevant information or knowledge and engage in task coordination (Ancona & Caldwell, 1992) and consequently target peers who can offer the requisite expertise or who participate in the negotiation of inter-departmental dependencies. These two horizontal boundaries spanning activities—as opposed to representational activities—thus require hierarchical alignment, as general members of the organization that occupy the same rank would be more likely to effectively reciprocate information search or coordination activities (Ancona & Caldwell, 1992). Effective coordination and information search activities are activities where the boundary spanner and the reciprocator display hierarchical alignment.

3.3 Team Boundary Spanning Efficiency: Response Timeliness

In addition to the effectiveness—i.e., goal and hierarchical alignment—of a boundary spanning activity, efficiency could be an additional indicator of boundary spanning success. Efficiency is broadly defined as how quickly an activity can be accomplished by a user.

In the context of ESM-based boundary spanning, efficiency refers to the time lapse or interval between the initiation of the original boundary-spanning attempt by the boundary spanner and the response or reciprocator by the responder.

It is important to acknowledge that efficiency does not imply effectiveness. That is, the quickest response to an attempt for information search may not actually yield a response that offers relevant information, knowledge or expertise or is even perceived and reciprocated by the appropriate target audience. While existing studies have explored the quality and quantity of knowledge provided in online knowledge seeking attempts (c.f., Chiu, Hsu, & Wang, 2006; Wasko & Faraj, 2005), we did not identify any literature focusing on the timeliness of responses during our literature review.

However, there are reasons to believe that efficiency may—at least in some cases—be at odds with effectiveness. In other words, the quickest responses are typically unlikely to be the most applicable in terms of goal and hierarchical alignment. Yet, this does not undermine the salience of the timeliness of response, as an efficient response may be more critical than an effective response in the case of boundary-spanning attempts characterized by high urgency. That is, when someone is in need of rapid advice or swift coordination for a fast-approaching project deadline, a quick reciprocating action may be more significant than a high-quality response. Therefore, the importance of efficiency for boundary spanning success should not be undervalued.

4 Data Collection and Algorithm Development

4.1 Data Collection and Study Context

In order to develop our operationalization of boundary-spanning success metrics, data was collected from the ESM platform of a large worldwide provider of workplace products, furnishings, and services. The company has approximately 11,000 employees around the world and is headquartered in the U.S. with offices and divisions in 40 countries in North and South America, Europe, Africa, Asia, Oceania, and the Middle East.

In March 2012, the organization launched an ESM tool based on the Jive Platform. Jive is a provider of corporate social technologies that support business communications and collaborations among employees. Following its global launch in March 2012, the adoption and use of the system has grown substantially, with a total user base of over 9,000 users as of 2014.

In order to detect the various forms of team boundary-spanning in both the original post from the boundary spanner as well as the response, we developed a machine learning algorithm using content and interaction data from the blogs and discussion threads of 656 teams, resulting in a total of 6500 posts for analysis. It is important to note that we only focused on blogs and discussion threads that were part of the group spaces of these 656 teams given our focus on team boundary spanning; rather than all content embedded in the ESM.

Boundary-spanning requests within the system can be either directed at the entire organization, at specific groups of people, or at specific individuals, depending on the selected privacy settings of the group space in which the request was posted.

4.2 Data Analysis

To ensure the reliable development of the machine-learning algorithm, three graduate students were trained to perform manual coding of the content data, assigning the various posts to categories reflecting the type of boundary-spanning activity each contained (or lack thereof). Coding was preceded by an elaborate training session to familiarize the coders with the coding manual and the coding scheme.

The coding manual included five coding categories, namely three categories for each of the three boundary-spanning activities—representation, information search, and coordination—as well as two additional categories for classifying posts that appeared unrelated to boundary spanning. For those activities unrelated to boundary-spanning, coders had to decide whether the activity was related or unrelated (e.g., social) to work.

Following the training, the coders were supervised in the independent coding of 14% of the content to compute interrater agreement. An initial interrater agreement of 89.6% with a corresponding .71 Cohen's kappa (i.e., substantial agreement; c.f. Landis and Koch, 1977) provided confirmation of coding scheme validity and coding process reliability. Following the reconciliation of differences, the remainder of the content data for manual coding was divided across the three coders.

4.3 Algorithm Development

During the next stage, the manually coded data was used to create an algorithm for automated text classification. The problem of text data classification belongs to the area of natural language processing, which is one of the most popular and challenging applications of machine learning. Compared to machine-learning problems that deal with numerical data, text data mining and classification is more tedious given the inherent complexity of textual data over numerical data.

The first step prior to classifier development included data cleaning and preprocessing, during which we (i) removed the html style format, punctuations, numbers, non-English words and stopwords, and (ii) converted all words to lower case.

The second step included feature selection, which is to choose the most representative words and build an overall dictionary. The words chosen have to be biased, in other words, they should be highly related to one or a couple of the boundary-spanning categories. The words should also appear in a higher frequency for a specific category to reflect high reliability. The total number of words extracted from all the posts is 13,791, which constitutes a relatively large original feature dataset, thus, the method chosen for feature selection also needs to be relatively efficient in terms of computation time. Based on these considerations, the gini-index equations (Aggarwal, 2014) were applied to feature selection, since the computation for this method is much faster than some other feature selection approaches such as information gain. The equations are described as follows:

$$p_i'(w) = \frac{p_i(w)/P_i}{\sum_{j=1}^{k} p_j(w)/P_j} \quad (1)$$

$$G(w) = \sum_{i=1}^{k} p_i'(w)^2 \quad (2)$$

In equation (1), the $p_i(w)$ is the fraction of class i presence for the word w. That is to say, pi(w) is the conditional probability that a post belongs to class i, given the fact that it contains the word w. P_i denotes the global distribution of the posts belonging to class i in all the posts. Equation (1) computes the normalized probability for each word in a certain class and equation (2) is used to calculate the gini-index value of each word. The higher the gini-index value is, the more discriminative the word is. For instance, the most indicative words for representation included show, success, embrace, and support. For coordination, the most discriminative words were calendar, meeting, schedule, and poll. Finally, words indicative of information search included help, solve, question, suggestion.

The third step involved the computation of word presence frequencies, which are then sorted in descending order. The final dictionary was eventually built based on the two lists with a threshold which gives the highest accuracy after applying a 10-fold cross validation method.

We next chose a support vector machine (SVM) learning algorithm to develop the prediction model. A support vector machine is a supervised learning algorithm. The idea of this algorithm is to construct a (set of) hyperplane(s) in a high dimensional space, which can be used to separate data samples belonging to different classes. The hyperplane chosen should have the largest distance to the nearest training data points from different classes as a larger margin will lead to lower generalization error.

SVM is particularly well-suited for text categorization for a number of reasons (Thorsten, 1998). For example, text data has many features with each unique word as a feature, and SVM deals well with high-dimensional data since SVM offers overfitting protection. Also text data, after being processed, will generate a sparse matrix and SVM is well suited for sparsity.

Although the original SVM algorithm was invented in 1963 as a linear model, a kernel trick was later introduced to be applied to nonlinear classifiers (Boser et al., 1992). In this project, we applied a sigmoid kernel function in the nonlinear classification model, which was determined using cross validation by comparing the performance to other kernel functions including linear and RBF functions.

4.4 Algorithm Reliability and Team Boundary Spanning Frequencies

The total number of posts is 6500, of which 14% were labeled manually by the coders. Thus, the unit of analysis is the post. Features (i.e., words) were selected based on two lists: the gini-index value and frequency. Initially the threshold of frequency 1, 2, 3 combined with a gini-index threshold of 0.65, 0.70, 0.76, 0.87, 0.90 were applied to the algorithm and corresponding accuracies generated by 10-fold cross validation were compared. Our reason for choosing 10-fold cross validation is based on the consideration of the size of the training sample dataset. With 5-fold cross validation, some featured words that belong to only the testing data will likely be lost, while 20-fold cross validation would be challenging given that the number of testing samples would become too small to obtain steady accuracy.

Eventually, the combination of frequency of 1 with gini-index number of 0.87 provided a better training sample set generating higher accuracy (Table 1). When the frequency threshold was set to more than 1, some of the training sample vectors turned out to be 0 for all features. This may be due to the very short length of some posts, which may not contain any common word from the dictionary. Finally, Table 1 shows that the overall accuracy of our algorithm reached a high of 86.2% (Table 1), which is beyond the accepted threshold of 80% in machine learning (Wilson, Wiebe and Hoffmann, 2005).

Assembled classifier	Total accuracy (%)	79.0									
	Single accuracy (%)	**86.2**	78.4	85.8	69.6	73.5	85.8	80.1	84.6	72.1	73.5

Table 1. Accuracies of 10-fold Cross Validation of Training Samples

Furthermore, as Table 2 shows, from all activities classified by the algorithm, the most dominant activity was information search, accounting for 35% of all ESM-based inter-team interactions. Furthermore, representation and coordination account for ~19% and ~20% of the classified activities. Finally, 30% of the activities communicated and enacted through ESM do not involve boundary-spanning interactions and may include either work-related or non-work related activities conducted within teams or at the individual level. It is important to note that the percentages add up to a little more than 100% which is due to our assembled classifier which allows for a single post to be classified into more than one category when a single category does not accurately capture the content of the post. Thus a mere 6.98% of all posts were classified into more than boundary-spanning category.

Categories	Representation	Coordination	Information Search	Work Related Other Activity	Non-Work Related Other activity
Distribution (%)	19.05%	19.88%	35.05%	11.95%	21.05%
Example	Here is a great video showing the work of our team in Vodafone's new workplace.	OK, CDC folks, the cancellation of the innovation center meeting threw us a little curve ball, but here's the revised planning.	Has anyone worked on an innovation centre that they could share?	The Steelcase interns had the opportunity to participate in Chicago yesterday. It was great to see the Steelcase show so full and have such an exciting buzz around it.	Have you hopped on a bike lately??? If so how long and where did you ride?

Table 2. Frequencies and Examples of Boundary Spanning in ESM

5 Toward an Operational Taxonomy of Boundary Spanning Success

Goal alignment, as a measure of effectiveness, refers to the score for whether or not the type of boundary spanning activity in which a poster or responder engages is identical. In order to measure whether or not goal alignment occurred, we relied on the results of the machine-learning algorithm explained above in order to determine the boundary-spanning goal of a particular post as well as the response. Goal alignment is thus assessed at the dyadic level as it measures the nature or goal of the original boundary spanning attempt and that of the response or reciprocating action. If the type of boundary spanning activity in which the poster or responder engages is identical—e.g., a representational post that is met with recognition or an indication of monetary support—alignment occurs as indicated by a value of 1. If the type of boundary spanning activity in which a poster or responder engages is not identical, the alignment would be measured as 0.

Hierarchical alignment, as a measure of effectiveness, refers to the alignment of hierarchical position between a poster and responder. Hierarchical position of each person in the data set was obtained by matching their user id in the ESM database to the human resources database of the Company, which contains the official position and rank description of each employee. Like goal alignment, hierarchical alignment is also measured at the dyadic level as it compares the rank of the boundary-spanner with that of the responder. If the hierarchical level of the poster is not equal to the responder, so that the poster is lower in rank than the responder, the dyadic relationship would receive a score of 0. If the rank of the poster and that of the responder is equal, alignment occurs as indicated by a value of 1. If the hierarchical level of poster is higher in rank than the responder, their relationship is characterized by a score of 2. It is important to note that, unlike goal alignment, hierarchical alignment is not always desirable. As mentioned before, the effectiveness of coordination and information search—both horizontal boundary-spanning activities—require hierarchical alignment, hence, a value of 1. Representation, on the other hand, is a vertical activity requiring higher ranked responders than boundary spanners, hence, a value of 0.

Finally, response timeliness—as a proxy for efficiency—refers to the time lapse between the original publishing of a poster's boundary-spanning attempt and the comment or reciprocating action by a responder. Response timeliness is measured as a continuous value in minutes (measurement unit) so that higher values indicate less efficient responses whereas lower values indicate more efficient responses. A summary of operationalizations is provided in Table 3.

Theoretical Concept	Operational Variable	Definition	Measurement Level	Proposed Measurement/ Operationalization	Contextualization for Boundary Spanning Activity
Effectiveness	Goal alignment	The alignment of the goal of the original boundary spanning attempt with the reciprocating action	Dyadic	0=not-aligned (i.e., goals do not match) 1=aligned (goals do match)	N/A
Effectiveness	Hierarchical alignment	The alignment of the hierarchical position of the boundary spanner and the responder	Dyadic	0= poster is lower in rank than responder; 1=poster is equal to responder 2=poster is higher than responder	Representation: desired outcome is 0 (poster is lower in rank than responder) Coordination & Information Search: desired outcome is 1 (poster and responder are equal in rank)
Efficiency	Time lapse	The time interval between the original boundary-spanning attempt and the respond-	Dyadic	Continuous value in minutes (number of minutes between original	N/A

		ing or reciprocating action		post and response post in ESM)	

Table 3. The Operationalization of Boundary-Spanning Success

6 Descriptive Statistics of Boundary-Spanning Success Metrics

Based on the proposed operationalization of team boundary-spanning success metrics, we explored its appropriateness by computing a set of descriptive statistics for each of the success metrics—hierarchical alignment, goal alignment, and response timeliness—for each of the team boundary-spanning activities; representation, coordination, and information search. Based on a visual inspection of the demographic data, it appears that, in terms of hierarchical alignment, coordination and information search are effective in terms of reaching target audiences that occupy the same hierarchical position. However, it appears that representation is also largely targeting audiences at the same hierarchical level, although it should be aiming at an audience that occupies a higher hierarchical position, thereby showing that ESM-based representation may not be reaching the correct target audience. With respect to goal alignment, it appears that information search is the most effective boundary-spanning activity, followed by representation, with coordination being the least effective in terms of generating responses that offer the requested resource. Finally, in terms of efficiency—i.e., response timeliness—representation seems to be the most efficient, followed by coordination, with information search being the most inefficient boundary-spanning process in terms of obtaining a response in a timely manner.

	Representation			Coordination			Information Search		
	Hierarchical Alignment	Goal Alignment	Response Timeliness	Hierarchical Alignment	Goal Alignment	Response Timeliness	Hierarchical Alignment	Goal Alignment	Response Timeliness
Avg.	0.891	0.346	3.296	0.931	0.189	3.982	0.952	0.442	5.252
Std. Dev.	0.616	0.476	14.438	0.663	0.392	23.871	0.636	0.497	30.483

Table 3. Descriptive Statistics for the Success Metrics

7 Discussion and Conclusion

Research on boundary spanning has proliferated, however, the majority of prior studies have focused on measuring the impact of boundary spanning on other dependent variables—most frequently a team's operational performance—rather than measuring if the boundary spanning activity per se is successful. In this paper, we used a data science approach to propose three behavioral metrics of boundary spanning success, namely hierarchical alignment, goal alignment, and timeliness of response.

Our descriptive statistics also share some initial light on the effectiveness—in terms of hierarchical and goal alignment—and the efficiency of the three boundary-spanning activities of representation, coordination, and information search. Specifically, the descriptive statistics reveal that representation is the least effective activity in terms of reaching the requisite target audience (i.e., in the case of representation, targeting a hierarchically superior audience), moderately effective in terms of yielding the desired resources (i.e., goal alignment), and most efficient in terms of obtaining a response in a timely fashion. Coordination is highly effective in terms of reaching the requisite target audience (i.e., hierarchical alignment) but least effective in terms of yielding the desired resources (i.e., goal alignment). Furthermore, coordination is moderately efficient in terms of generating a timely response. Finally, information search is both most effective in terms of reaching the requisite target audience (i.e., hierarchical alignment) and yielding the desired resource (i.e., goal alignment), but is the least efficient boundary-spanning activity of the three. This seems to offer some preliminary evidence in support of our proposition that effectiveness and efficiency may be conflicting success factors, where the quickest responses to a boundary-spanning attempt tend to be the least relevant. However, an empirical evaluation of the statistical significance of differences in effectiveness and efficiency between different types of boundary-spanning activities is beyond the score of this paper, which aimed to propose measures. Hence, future research should further explore such differences using t-tests.

These measures have three important implications for the literature on boundary spanning. First, this paper moves beyond the dominant individual-level focus on the boundary spanner and instead offers a perspective of the dyadic interaction between a poster and a responder and uses the interaction as a starting point for delineating boundary spanning success. This approach is novel as previous studies have only focused on the boundary spanning activities as enacted by the individual without considering the reciprocating actions of the responding party that are crucial in determining the success of such activities (c.f., Van Osch and Steinfield, 2013, 2015). Furthermore, by offering a set of behavioral measures of boundary spanning success, this study provides researchers with an approach to assess the actual success of a boundary spanning activity rather than the self-reported impacts of presumed successful boundary spanning activities on downstream team-level outcomes, such as operational performance. Finally, by measuring the success of boundary spanning interactions per se, we can assess the role systems, such as ESM, play in the effectiveness and efficiency of these interactions. Based on the abovementioned descriptive statistics, it appears that ESM is primarily useful in supporting effective information search activities, that is, offering support for inter-team knowledge sharing inside large global enterprises. Furthermore, although it allows teams to reach the requisite target audience for coordinating project deadlines and schedules, these activities do not seem to be performed effectively through ESM. Finally, although ESM supports representation by generating moderate levels of effectiveness in terms of generating legitimacy and recognition support, it appears ineffective in assisting teams to reach higher-ranked employees in the organization that can offer the monetary resources necessary for adequate team performance.

Beyond implications for research, the success metrics proposed could also benefit managers interested in assessing the impact of various IS on the effectiveness and efficiency of distinct boundary spanning activities to determine which IS play a pivotal role in supporting boundary spanning. Given that organizational resources are limited, determining which systems provide the best overall support for all three activities simultaneously could help managers optimize their IS investment decisions. Furthermore, leveraging behavioral measures could offer managers with a reliable tool to assess the boundary spanning performance of teams inside the organization.

Despite the contributions offered by conceptualizing and operationalizing these three distinct dimensions of boundary spanning success—goal alignment, hierarchical alignment, and timeliness—additional dimensions may exist and require further exploration. For instance, previous studies on knowledge seeking attempts in online environments measured the quantity of knowledge provided. Such a metric may also be relevant in the context of information search and representational boundary spanning activities, however, is less likely to apply to coordination attempts.

Furthermore, given the focus of this paper on proposing success measures, we only provided descriptive statistics in support of exploring some potential differences in the efficiency and effectiveness of distinct boundary-spanning activities—representation, coordination, and information search. Yet, future research should use additional statistical methods to test the significance of such differences to further validate the measures. Additionally, in future studies we plan to measure the effect of the proposed success measures on the operational performance of teams to validate if our proposed boundary-spanning success measures are a better predictor of team operational performance than the mere occurrence and frequency of boundary-spanning activities per se, as has been the dominant focus in the traditional boundary-spanning literature (Ancona and Caldwell, 1992; Tushman and Scanlon, 1981).

Finally, it is important to keep in mind that even interactions that do not yield an immediately favorable response to a boundary-spanning attempt may result in the establishment of novel social connections which in turn may serve as potential future conduits to necessary legitimizing, monetary, and informational resources. Hence, the lack of goal alignment, hierarchical alignment, and/or efficiency within a specific boundary spanning interaction should not be considered as an indication of an insignificant social relationship. Therefore, future research could employ longitudinal approaches to see if novel social connections established through boundary-spanning attempts may result in the deferred rather than immediate provision of desired resources.

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