The Engineering Project Organization Journal (March 2011) **1**, 27–39

Taylor & Francis
Taylor & Francis Group

The impact of cultural boundary spanners on global project network performance

MELISSA K. DI MARCO and JOHN E. TAYLOR*

Department of Civil Engineering and Engineering Mechanics, Columbia University, 618 S.W. Mudd Building, 500 West 120th Street, New York, NY 10027, USA

Received 22 November 2010; accepted 26 November 2010

Architecture, engineering and construction projects are becoming increasingly global. In addition to understanding cultural differences, global project managers must be aware of the effects of these differences on performance. In this paper, we empirically examine the impact of cultural boundary spanners (CBSs) on global project network performance. Past research has examined collaboration in project networks comprising organizations from multiple countries. However, including CBSs to resolve cultural differences and investigating the resulting impact on performance have received limited attention. Through quantitative analyses of project network performance and participant communications, we found that cultural boundary-spanned multi-cultural networks significantly outperformed multi-cultural networks without CBSs and performed comparably to mono-cultural networks in initial performance. Analysis of participant communications revealed that CBSs communicated significantly more than other project participants during the first project, which may have been a key factor enabling those networks to achieve the initial performance of mono-cultural networks. CBSs can play a crucial role in off-setting the initial performance liability of working across cultural and linguistic boundaries in global project networks.

Keywords: Boundary spanners, boundary spanning, culture, globalization, performance, project networks.

Introduction

Globalization has far reaching impacts on architecture, engineering and construction (AEC). Distributed, multi-cultural and virtual project networks are redefining the AEC industry. Organizations have recognized that global project networks require a distinct strategic approach (Kini, 2000). Global project networks entail work being conducted across organizational and national boundaries, which creates asymmetric challenges and conflicts (Nayak and Taylor, 2009). The distinct national cultures within global project networks are deeply imbedded in the individuals and organizations that populate them. This means that the underlying attitudes, thought patterns, assumptions and expectations of each culture can be significantly different and when brought together in a professional environment—such as a global AEC project network—can lead to conflicts that are difficult to resolve. The way in which global networks and organizations produce, diffuse, transfer, broker and translate project knowledge across both organizational and cultural boundaries has been of growing interest to the research community.

A key to gaining a competitive advantage in the globalizing AEC industry involves organizing a project network's systems, skills and persons in order to mitigate potential problems. In global project networks, this requires developing appropriate global knowledge transfer procedures (Javernick-Will and Levitt, 2010). Skill development in the global context includes a comprehensive inter-firm cultural intelligence (Janssens and Brett, 2006; Ang and Inkpen, 2008) where the key persons are global project managers (Miller *et al.*, 2000) and immigrant managers (Levina and Kane, 2009). Previous research observing collaboration across national boundaries has identified criteria for global project networks to collaborate more effectively (Levina and Vaast, 2008; Di Marco *et al.*, 2010; Hong, 2010), yet we still know little about the potential

*Author for correspondence. E-mail: jt2411@columbia.edu

The Engineering Project Organization Journal
ISSN 2157-3727 print/ISSN 2157-3735 online © 2011 Taylor & Francis
http://www.informaworld.com
DOI: 10.1080/21573727.2010.549607

performance impact of involving individuals that have spent considerable amounts of time living, studying and working in the countries of their international counterparts on a project. The aim of this paper is to empirically examine how a cultural boundary spanner (CBS) can influence performance by spanning cultural and linguistic boundaries in global project networks.

Background

Cultural implications and performance measures of global project networks

Organizational research that explores inter-cultural collaborations has evolved beyond that of Hofstede's (1996) cultural indices. Scholars have found that cultural diversity can decrease performance (Porter, 1995; Barkema *et al.*, 1997; Brouthers and Brouthers, 2001). Like Hofstede (1996), they argued that culturally diverse participants in a project network will have different values and norms and that these may decrease both financial and schedule efficiency (Makino and Beamish, 1998; Mahalingam and Levitt, 2007). While some researchers identified a negative impact on effectiveness in global project networks, others investigated cross-national joint ventures and found performance to improve as a result of cultural diversity (Shenkar and Zeira, 1992; Park and Ungson, 1997; Chan *et al.*, 2004; Ozorhon *et al.*, 2008). Ozorhon *et al.* (2010) recently studied both the internal and external factors affecting performance in international collaborations on the basis of three factors: (1) the project, (2) the international partnership, and (3) the inter-firm organization. Using proxies for performance, their results were inconclusive as to the performance impact of collaborating within a multi-cultural environment. A key requirement to evaluate the success of global project networks is a performance measurement to compare project network performance directly. To date, researchers have focused on evaluating global project networks based on effective collaboration (Vadhavkar and Peña-Mora, 2000; Manzoni and Islam, 2007; Levina and Kane, 2009; Hong, 2010) or comparing aggregate performance in terms of overall project success and failure (Cooke-Davies, 2002; Cheah *et al.*, 2004; Fong and Kwok, 2009). A focus on collaboration effectiveness is only an indicator of performance and may not reflect the actual performance impact of a national cultural boundary in global project networks. Moreover, aggregate measures of performance may not accurately capture the performance impact of one or more cross-cultural boundaries on a large and complex global project. We need research narrowly focused on performance at the cross-cultural boundary to understand the performance implications of working across cultures.

CBSs in global project networks

As the AEC industry adapts to trends in globalization and project networks collaborate inter-culturally, network participants are bound to encounter a distinct set of conflicts due to differences in national culture (Chan and Tse, 2003; Hinds and Bailey, 2003; Powell, 2006; Mahalingam and Levitt, 2007; Chen *et al.*, 2009). Researchers have found a number of key practices to reduce conflicts within global networks. Particularly, some have studied the roles played by participants within global organizations to mitigate conflicts such as the role of expatriates (Yates, 1989; Au and Fukuda, 2002; Mahalingam and Levitt, 2005), immigrant managers (Levina and Kane, 2009) and CBSs (Di Marco *et al.*, 2010). In this paper, we will focus on the performance impact of CBSs on global project networks. CBSs are not necessarily formal team leaders or project managers, but can be any member of a team that can provide vital cultural insight from which the entire project network can draw upon to enact work. Put simply, a CBS is an individual whose understanding of the multiple cultures and languages—common to their collaborative counterparts within the network—is sufficient to connect members in a global project network.

There have been a number of attempts to empirically examine how boundary spanners improve collaboration effectiveness. Ancona and Caldwell (1992) found that teams with boundary-spanning capabilities have a tendency to be perceived as more effective and are therefore more likely to achieve their final goals. Luo (2006), though not specifically looking at conflict resolution, researched cross-cultural joint ventures and found boundary spanners to play a key role in mitigating cultural differences in cross-cultural collaborations. Some researchers found that boundary spanners can increase the chances of success in inter-organizational collaboration (Aldrich and Herker, 1977; Ancona and Caldwell, 1992) and more specifically cross-cultural organizations (Ansett, 2005). These studies are critical to understanding cultural boundary spanning; however, they do not measure the performance implications of involving CBSs in global project networks. The measure of how CBSs impact global project network performance has been qualitatively examined through constructs such as success and failure (Chua, 1999; Cheah *et al.*, 2004), through their boundary-spanning capabilities (Hong, 2010) or through their ability to increase collaboration effectiveness (Di Marco *et al.*, 2010). It is not known to what extent (or if at all) CBSs impact the actual performance of global project networks. In this paper, we examine how CBSs impact collaborative performance by spanning national cultural boundaries and linguistic barriers that can challenge global engineering project network collaborations.

Research methodology

Hypotheses

We chose to test the extent to which CBSs impact performance by adopting an experimental design by Çomu *et al.* (in press). That study examined the dual impact of cultural and linguistic differences on project network performance and found that, on average, multi-cultural networks experienced worse initial performance; however, their adaptation performance over five successive projects outperformed that of mono-cultural networks. The multi-cultural networks were able to overcome these boundaries, enabling those networks on average to surpass the mono-cultural networks in terms of project performance by the fourth project. In our research, we replicated their experiment to compare the initial and adaptation performance to a new set of multi-cultural project networks that included a CBS. We measured performance in this study as the time required to execute and successfully complete a project, evaluating each network over a period of five consecutive projects.

Global project networks with a CBS may be able to achieve the initial performance advantages of working in a mono-cultural network, while maintaining the adaptation performance benefits of working in multi-cultural networks. Multi-cultural settings have been shown to improve creativity and problem-solving ability, resulting in a more comprehensive approach to engineering challenges (Ozorhon *et al.*, 2008). We postulate that the mediating role of the CBS will enable global project networks to potentially overcome the initial performance liabilities of working across cultural and linguistic boundaries. Moreover, we postulate that a strong adaptation performance will also be achieved by multi-cultural project networks with a CBS. To examine these conjectures we tested the following hypotheses.

> *Hypothesis 1a*: Including a CBS in multi-cultural project networks will result in better initial performance than multi-cultural networks without a CBS.

> *Hypothesis 1b*: Including a CBS in multi-cultural project networks will result in statistically indistinct initial performance compared with mono-cultural networks.

> *Hypothesis 2a*: Including a CBS in multi-cultural project networks will result in better adaptation performance than multi-cultural project networks without a CBS.

> *Hypothesis 2b*: Including a CBS in multi-cultural project networks will result in better adaptation performance than mono-cultural project networks.

As many researchers have observed, conflicts may arise between diverse cultural and linguistic members in a team (Chan and Tse, 2003, Levina and Vaast, 2008), which in turn can negatively impact performance, leading to a poor initial performance (Çomu *et al.*, 2010) or low project quality (Bryant, 2006). In contrast, appointing a boundary spanner within a nationally diverse team has been observed to create improved group identity with increased frequency of intra-team contact within healthcare organizations (Richter *et al.*, 2006). Di Marco *et al.* (2010) demonstrated that in an engineering context, cross-boundary difficulties were alleviated by CBSs due to their potential to improve collaboration effectiveness. We anticipate that when CBSs participate in global networks, they will intervene to resolve the conflicts that arise and develop between culturally distinct members. If we can demonstrate through Hypothesis 1b that the presence of a CBS in a multi-cultural network enables those networks to approach the initial performance of mono-cultural networks, then it is useful to understand the communications that occur over successive projects. On the first project interaction, we anticipate that the CBS will mediate most communications, resolving cultural and linguistic conflicts that emerge. However, over successive projects, we anticipate that a shared understanding will develop, requiring less communications by the CBS. This would align with Di Marco *et al.*'s finding that the centrality of a CBS dissipates after initial conflicts are resolved. That finding was related to collaboration effectiveness and did not examine whether such communication patterns correlated with performance. By collecting the frequency of interactions occurring between members of cultural boundary-spanned project networks, we will test the following hypotheses.

> *Hypothesis 3a*: CBSs communicate more frequently than non-CBSs in an initial global project network collaboration.

> *Hypothesis 3b*: The frequency of cultural boundary-spanner communications relative to non-CBSs decreases with successive global project network collaborations.

Experimental design

We replicated the experimental procedures in a study conducted by Çomu and colleagues (2010) for mono-cultural and multi-cultural project networks; however, we included a CBS in the multi-cultural networks. Only by strictly adhering to the same procedures could we directly compare and contrast the measured performance results for cultural boundary-spanned networks to those previously collected for multi-cultural and mono-cultural networks. To examine the initial and adaptation performance in global engineering project networks, a set of independent and inter-dependent tasks was developed. The overarching scenario of the experiment was modelled on the design and construction process of an engineering project. To emulate this process, we required the participation of three distinct roles in every project network. These included an architect, an engineer and a contractor. The objective of each project was thus to design, specify and build a model of a building. Each assembled project network comprised all three roles, and together they were required to complete up to five successive projects of a similar nature. By having only one representative for each role in the simulated project networks, there is a possibility that the assembled networks would adopt a team structure. However, the following features of the simulated project networks were included in the formulation of the experimental tasks and the participant interactions to address this possibility (Çomu *et al.*, 2010).

- Each individual role had its own distinct and independent set of tasks which it necessarily completed separately from the other individuals in the network.
- Each role had a portion of its task dependent on the output of another role. For example, the engineer needed to get the design from the architect to develop the specifications and the contractor needed both the design and specifications to assemble the model. In the rework phase, the architect depended on the contractor if there were insufficient materials to construct the original design.
- The participants conveyed only the necessary information (i.e. the graph paper with the design and specifications).
- The participants were spatially separated from each other at three different tables in the same room to ensure that each role did not collaborate on the independent tasks but that they could still communicate.
- The time required to complete the five successive projects was a maximum of 90 minutes, leaving insufficient time for a team to complete its formative stage or move on to other later stages of team formation.

At the start of each experiment, a brief presentation was delivered to all three participating roles, providing instructions and an explanation of the general procedure of the experiments. During the presentation, researchers encouraged communication in any language, suggesting that this was important to their success as a network because only through interactions would they overcome the challenges of the various projects. The first project began when the architect was given an envelope that included a sheet of graph paper and a list of design requirements. These included the number of interior and exterior walls, doors and windows, as well as the orientation of a building to be designed. The architect had to then draft a plan and elevation views of the building described. Once this first task was complete, the design schematic was passed to the engineer who in turn specified the dimensions and types of materials to be used for the building. This was based upon a set of hypothetical building code requirements provided to the engineer. The building code remained unchanged throughout the successive projects. Once the building layout was adjusted to the required specifications, the graph paper was then given to the contractor whose task was to build the model to the design and specifications provided. This was accomplished with a limited number of Lego® blocks provided. We observed and noted the communications of all three network participants. Once the building was complete, the constructed model was inspected by the research team to ensure it conformed to the required design and specifications. If errors were found, a punch list was prepared and the project network was tasked with adjusting the design, specifications and the model. This rework time was included in the total time required to complete each project.

Once the first project was complete, the network participants moved on to the second project, and then the third and so on until up to five projects were completed. A limited 90-minute period was set to complete the five projects. In order to compare the results of the cultural boundary-spanned project networks with those collected by Çomu *et al.* (2010) a total of 30 participants were recruited to populate 10 project networks. To maintain consistency across the 10 cultural boundary-spanned project networks, in all cases the CBS held the role of architect, the international participant (INT) held the role of the engineer and the American citizen (US) held the role of the contractor. As in Çomu *et al.*'s study, our research design included only participants recruited from the Columbia University student body studying at either the undergraduate or graduate level. All the US citizen participants were native English speakers. The international student participants recruited were required to have been in the USA for less than three years. Finally, the CBS participants recruited were required to have been born in a foreign country, to have lived in the USA for at least five years, to have received either their high school diploma or an undergraduate degree in the USA and to have a strong command of both English and their native language to be eligible to participate in the experiments. The INT participants had to share the same nationality and maternal language as the recruited CBS participants. This experimental design consideration was critical in order to ensure that the CBS was capable of spanning cultural and linguistic differences. Each of the 10 project networks examined involved a different country for the nationality of the CBS and INT participants to remove any bias that may have been produced by focusing on one or a small number of countries (e.g. due to similarities in language or other factors). The backgrounds of the participants were not taken into account since the assigned tasks were sufficiently general that they did not require specialized knowledge.

The data sample size of this research therefore consisted of approximately 50 projects, each with an associated initial and adaptation performance value, which allows for comparison between project performance values and similarly sized data sets for mono-cultural and multi-cultural project networks. The cultural boundary-spanned networks were encouraged to communicate in whichever language they were most comfortable with; in our case, either English or the maternal language common to the CBS and INT. Table 1 summarizes the national origin of each participant in all thirty of the project networks.

Table 1 Project network experimental design

Project networks								
Cultural boundary-spanned multi-cultural			*Multi-cultural*			*Mono-cultural*		
Network 1	CBS	Turkish	*Network 11*	*INT*	*Turkish*	*Network 21*	*US*	*American*
	INT	Turkish		*INT*	*Chinese*		*US*	*American*
	US	American		*INT*	*Indian*		*US*	*American*
Network 2	CBS	French	*Network 12*	*INT*	*Greek*	*Network 22*	*US*	*American*
	INT	French		*INT*	*Colombian*		*US*	*American*
	US	American		*INT*	*Turkish*		*US*	*American*
Network 3	CBS	Korean	*Network 13*	*INT*	*Chinese*	*Network 23*	*US*	*American*
	INT	Korean		*INT*	*Israeli*		*US*	*American*
	US	American		*INT*	*Nigerian*		*US*	*American*
Network 4	CBS	Taiwanese	*Network 14*	*INT*	*Vietnamese*	*Network 24*	*US*	*American*
	INT	Taiwanese		*INT*	*Chinese*		*US*	*American*
	US	American		*INT*	*Indian*		*US*	*American*
Network 5	CBS	Chinese	*Network 15*	*INT*	*Turkish*	*Network 25*	*US*	*American*
	INT	Chinese		*INT*	*Chinese*		*US*	*American*
	US	American		*INT*	*Kazak*		*US*	*American*
Network 6	CBS	Indian	*Network 16*	*INT*	*Indian*	*Network 26*	*US*	*American*
	INT	Indian		*INT*	*French*		*US*	*American*
	US	American		*INT*	*Chinese*		*US*	*American*
Network 7	CBS	Greek	*Network 17*	*INT*	*Chinese*	*Network 27*	*US*	*American*
	INT	Greek		*INT*	*Thai*		*US*	*American*
	US	American		*INT*	*Korean*		*US*	*American*
Network 8	CBS	Nigerian	*Network 18*	*INT*	*Chinese*	*Network 28*	*US*	*American*
	INT	Nigerian		*INT*	*Indian*		*US*	*American*
	US	American		*INT*	*Taiwanese*		*US*	*American*
Network 9	CBS	Venezuelan	*Network 19*	*INT*	*Bulgarian*	*Network 29*	*US*	*American*
	INT	Venezuelan		*INT*	*Chinese*		*US*	*American*
	US	American		*INT*	*Cypriot*		*US*	*American*
Network 10	CBS	Russian	*Network 20*	*INT*	*Russian*	*Network 30*	*US*	*American*
	INT	Russian		*INT*	*Indian*		*US*	*American*
	US	American		*INT*	*Chinese*		*US*	*American*

Note: Italicized data entries are sourced from Çomu *et al.* (2010) (with permission from ASCE).

Data collection

Each network was required to complete up to five successive projects. The participants were instructed that their performance depended on how quickly they could design, specify and build each project to conform to the required standards. To measure their performance quantitatively, each network's performance was assessed by measuring the time taken to complete each of the five successive projects. Additionally, data on the number of communications by each participant on each project were collected. Throughout the projects, a standard procedure was used to collect the data. The results were then used to compare the performance of the cultural boundary-spanned networks to that of mono-cultural and non-cultural boundary-spanned multi-cultural networks. In order to minimize the potential impact of external factors on individual network performance, a controlled experimental environment was utilized for all experiments which was also identical to the environment utilized by Çomu *et al.* (2010).

Findings

The project performance results of the three network study groups—cultural boundary-spanned multi-cultural, mono-cultural and multi-cultural project networks—are presented in Table 2. It is important to note that not all of the project networks were able to complete all five of the successive projects. The superscript 'a' on the right of some of the project performance values represent the networks that were unable to complete all five projects. Those data are projected using a fitted regression. The missing performance results were predicted through fitting a learning curve to the collected data points. Wright (1936) empirically derived a straight-line logarithmic model for learning curves and we utilized this method in our research to project any missing values. The model in Equation 1 assumes that the learning improvement rate follows a straight line in a logarithmic scale as described in Equation 2:

$$y_a = x \cdot a^n \tag{1}$$

$$\log(y_a) = n \log(a) + \log(x), \tag{2}$$

where y_a is the duration of the ath project, x the duration of the first project and $n = \log_2 \text{LR}$, LR being the learning rate.

The learning rates for each of the 10 networks in the experiment were calculated from Equations 1 and 2. The projected values were derived from the data collected from each project network. They do not impact the adaptation performance calculated for each project network. To the contrary, these projected data points are calculated from the adaptation performance (or learning rate) for each project network. This prevents the extrapolated data of the incomplete projects from having any bearing on the adaptation performance allowing for inferences to be made regarding the average learning rate (adaptation performance) across the project networks studied.

Hypotheses 1a and 1b: initial performance of cultural boundary-spanned project networks

Previous research from Levina and Vaast (2008) as well as Di Marco *et al.* (2010) suggests that cultural boundary-spanned networks might initially outperform multi-cultural project networks due to improvements in collaboration effectiveness. But they did not measure the performance improvements this may have enabled and they did not consider how initial performance might compare to that of mono-cultural project networks. From Table 2, we observe that in the first project, the cultural boundary-spanned networks were able to outperform the multi-cultural networks on average. The average initial performance of the cultural boundary-spanned project networks was 33% faster (i.e. the less the time taken to complete a project, the better the initial performance of the networks) than that of the multi-cultural networks. Also, the average cultural boundary-spanned network performance was within 4% of that of the mono-cultural networks. This result is supported by a *t*-test. When comparing the multi-cultural and the cultural boundary-spanned multi-cultural project networks, we found them to be statistically distinct with a p-value of 0.0029, which is well below the significant level of 0.05 (Hypothesis 1a supported). When comparing the initial performance results for the mono-cultural (USA only) and cultural boundary-spanned (CBS) multi-cultural networks, we found the initial performance between these two groups to be statistically indistinct with a p-value of 0.71, far greater than the 0.05 value required for the two samples to be distinct (Hypothesis 1b supported).

Hypotheses 2a and 2b: adaptation performance of cultural boundary-spanned project network

Based on the regression techniques used to predict the unknown data entries, we were able to logically estimate the average adaptation performance (expected learning rate) of each project network, as they worked successively through up to five building projects. The adaptation performance, or *learning rate*, of all cultural boundary-spanned multi-cultural project networks are

Table 2 Project network performance durations (in seconds)

Network type	Network	Project 1	Project 2	Project 3	Project 4	Project 5
Cultural boundary-spanned multi-cultural project networks	Network 1	1341	785	596	603	452
	Network 2	1658	975	643	625	482
	Network 3	1575	1409	905	410	330[a]
	Network 4	1203	787	720	646	491
	Network 5	1678	1006	563	356	337
	Network 6	1616	699	490	443	364
	Network 7	1523	726	453	296	270
	Network 8	1572	1250	823	608	523[a]
	Network 9	1130	697	487	360	251
	Network 10	1516	1055	783	524	442[a]
	Average	1481	939	646	487	394
Multi-cultural project networks	*Network 11*	*2523*	*740*	*399*	*362*	*219*[a]
	Network 12	*1911*	*956*	*746*	*407*	*369*[a]
	Network 13	*1984*	*1196*	*1091*	*880*[a]	*776*[a]
	Network 14	*2598*	*1071*	*557*	*387*[a]	*284*[a]
	Network 15	*2136*	*807*	*619*	*694*	*457*[a]
	Network 16	*2029*	*1129*	*988*	*770*[a]	*662*[a]
	Network 17	*1915*	*1062*	*545*	*378*	*307*[a]
	Network 18	*2693*	*1155*	*826*	*579*[a]	*454*[a]
	Network 19	*2881*	*900*	*530*	*326*[a]	*230*[a]
	Network 20	*1515*	*754*	*542*	*392*	*255*
	Average	*2219*	*977*	*684*	*518*	*401*
Mono-Cultural Project Networks	*Network 21*	*1472*	*944*	*543*	*456*	*487*
	Network 22	*1346*	*448*	*391*	*324*	*380*
	Network 23	*1665*	*929*	*593*	*375*	*326*[a]
	Network 24	*1514*	*1104*	*911*	*1144*	*925*[a]
	Network 25	*1981*	*987*	*657*	*614*	*458*[a]
	Network 26	*948*	*338*	*204*	*225*	*179*
	Network 27	*860*	*762*	*612*	*562*	*555*
	Network 28	*1395*	*1816*	*408*	*323*	*293*[a]
	Network 29	*1933*	*1077*	*712*	*913*	*644*[a]
	Network 30	*1129*	*502*	*349*	*310*	*277*
	Average	*1424*	*891*	*538*	*525*	*452*

Note: Italicized data entries are sourced from Çomu *et al.* (2010) (with permission from ASCE).
[a]Projected results.

presented in Table 3, along with the adaptation performance results for the previously examined mono-cultural and multi-cultural networks. The results demonstrate that, on average, adaptation performance of cultural boundary-spanned networks is 0.57, which is approximately 20% higher than that of multi-cultural networks, but about 3% lower than that of mono-cultural networks. Given the improved initial performance of the cultural boundary-spanned networks, we would expect the learning rate of the multi-cultural networks to be greater as there is more opportunity for enhanced performance over time. The r^2 values are the measures of association for determining how well the actual data of performance are predicted through the learning rate function. The r^2 values for each of the adaptation performance results for Networks 1–10 can be found in Table 3. The values range from 0.83 to 0.99, with an average of 0.95. This represents an accurate estimation for predicting the actual learning rate of the cultural boundary-spanned project networks. We again conduct a t-test to statistically compare the adaptation performances of the project networks. Comparing multi-cultural and mono-cultural project networks with cultural boundary-spanned project networks resulted in p-values greater than 0.05, and therefore, we reject Hypotheses 2a and 2b.

Table 3 Project network adaptation performance

Network type	Network	Adaptation performance	r^2	Average adaptation performance	Average r^2
Cultural boundary-spanned multi-cultural project networks	Network 1	0.65	0.96	0.57	0.95
	Network 2	0.59	0.98		
	Network 3	0.50	0.83		
	Network 4	0.71	0.95		
	Network 5	0.48	0.97		
	Network 6	0.53	0.97		
	Network 7	0.46	0.99		
	Network 8	0.61	0.95		
	Network 9	0.54	0.98		
	Network 10	0.59	0.96		
Multi-cultural project networks	*Network 11*	*0.36*	*0.97*	*0.48*	*0.96*
	Network 12	*0.49*	*0.96*		
	Network 13	*0.68*	*0.95*		
	Network 14	*0.38*	*1.00*		
	Network 15	*0.55*	*0.82*		
	Network 16	*0.63*	*0.96*		
	Network 17	*0.44*	*0.98*		
	Network 18	*0.47*	*0.99*		
	Network 19	*0.34*	*1.00*		
	Network 20	*0.48*	*0.98*		
Mono-cultural project networks	*Network 21*	*0.59*	*0.94*	*0.59*	*0.86*
	Network 22	*0.57*	*0.82*		
	Network 23	*0.48*	*0.98*		
	Network 24	*0.83*	*0.58*		
	Network 25	*0.54*	*0.98*		
	Network 26	*0.49*	*0.92*		
	Network 27	*0.81*	*0.95*		
	Network 28	*0.45*	*0.66*		
	Network 29	*0.64*	*0.81*		
	Network 30	*0.54*	*0.97*		

Note: Italicized data entries are sourced from Çomu *et al.* (2010) (with permission from ASCE).

Hypotheses 3a and 3b: CBS frequency of communications

We anticipated that CBSs would carry out a significant role in the initial stages of collaboration, intervening to resolve conflicts encountered across the cultural and linguistic boundary within the global project network. We hypothesized that they would communicate more frequently as they mediated communications between the international participant and the US participant in their project network. During each of the five projects, we observed and recorded the communications of the three members of the network. The average of observed communications across the 10 project networks was calculated for each project. The average frequency of communications for each of the network members decreased over the five successive projects. The average frequency of observed communications was far greater in the initial project at 137 average communications. In the ensuing four projects, average observed communications reduced to 55 in the second project, 28 in the third, 17 in the fourth and only 8 in the fifth project.

To examine Hypotheses 3a and 3b, we plotted the average number of observed CBS and non-CBS communications over each of the five projects in the experiment (refer to Figure 1). In the first project, there is significantly more communications involving the CBS than the non-CBS participants. A t-test comparing the two sample means for all 10 of the cultural boundary-spanned networks for the first project also showed that the CBS and non-CBS communication frequencies are statistically distinct sets of data ($p < 0.001$). The average number of communications by the CBS was 108 in the first project, while that by the non-CBS

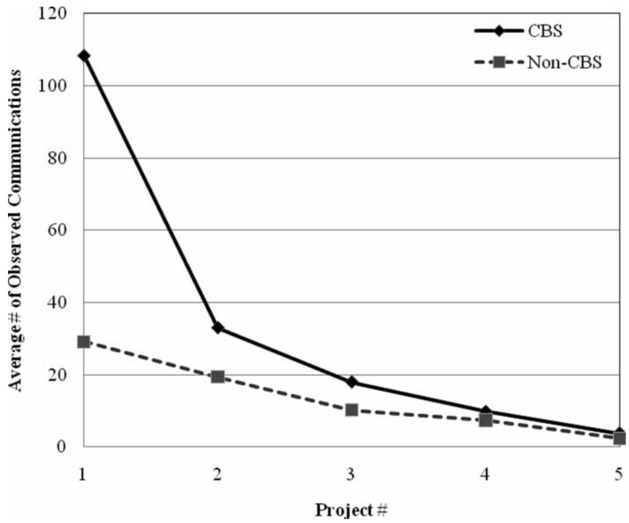

Figure 1 Average number of observed communications per project involving CBSs and non-CBSs (with permission from ASCE)

participants was 29. Based on this difference and the strength of the *t*-test result for these two samples, we find strong support for Hypothesis 3a.

Over time, across successive projects, the variance of communication frequency between CBS and non-CBS participants narrowed. In fact, by the second project, the *p*-value in the *t*-test comparing CBS and non-CBS samples increased to nearly 0.2. In the remaining projects, the *p*-value increased up to a value of 0.5. The average number of observed communications for both the CBS and non-CBS participants converged to approximately the same point by the fifth project. Since the variance in the frequency of communications decreased to non-significant levels by the second project and continued to decrease, Hypothesis 3b is supported.

Discussion

In this paper, we investigated the impact of CBSs on performance in culturally and linguistically diverse project networks. Statistical analysis of our results revealed that a participating CBS within global project networks can significantly improve the initial network performance when compared with multi-cultural networks without CBSs ($p < 0.05$). The *t*-test for paired two-sample means also demonstrated that CBS networks, at the initial stages of collaboration, are statistically indistinct from mono-cultural project networks in terms of performance. In other words, cultural boundary-spanned multi-cultural project networks in this study performed as well on the first project as the mono-cultural networks. This is in stark contrast to the findings of Çomu *et al.* (2010) in which the average time to complete the first project took the multi-cultural networks over 50% longer than the mono-cultural networks. The cultural boundary-spanned networks performed as well as the mono-cultural networks initially while still outperforming the mono-cultural networks by the fourth project.

Including CBSs in a global project network may negate the performance liabilities created by the challenges of working in culturally and linguistically diverse environments. Much of the extant literature on cross-cultural collaborations suggests that researchers focus on the barriers and conflicts associated with cultural differences (Hinds and Bailey, 2003; Mahalingam and Levitt, 2007; Levina and Vaast, 2008) as opposed to the business opportunities. Firms involved in global project networks may be able to benefit from cultural diversity. By the fourth project in this empirical study, the culturally and linguistically diverse networks began to outperform mono-cultural networks on average. Our research suggests that it may be possible to achieve mono-cultural network initial performance levels and still outperform mono-cultural networks within several projects by implementing a CBS in a multi-cultural network. The AEC industry is globalizing with increasing competition by international firms domestically, expansion of domestic firms into international markets and offshore outsourcing collaborations where both firms remain in their respective countries. In all of these cases, a global project network of firms must identify ways to achieve strong performance to remain competitive. The inclusion of a CBS, particularly in initial global project collaborations, may significantly enhance global project performance.

We also compared the adaptation performance of mono-cultural and multi-cultural networks with that of the cultural boundary-spanned networks. The experimental results showed that the adaptation performance for multi-cultural networks with CBSs was worse than multi-cultural networks without CBSs and approximately equivalent to the learning rate of mono-cultural networks. We can observe these results in Figure 2, which contains a graph of the average adaptation performance (learning curves) of all three network study groups. The cultural boundary-spanned networks began to outperform the mono-cultural networks between the third and fourth projects; at approximately the same time the multi-cultural project networks began to outperform the mono-cultural networks in the Çomu *et al.* (2010) study. The faster adaptation performance of the multi-cultural project networks compared with the cultural boundary-spanned and mono-cultural networks is somewhat expected, given their need to overcome the challenges that led to the poor initial performance. We applied a

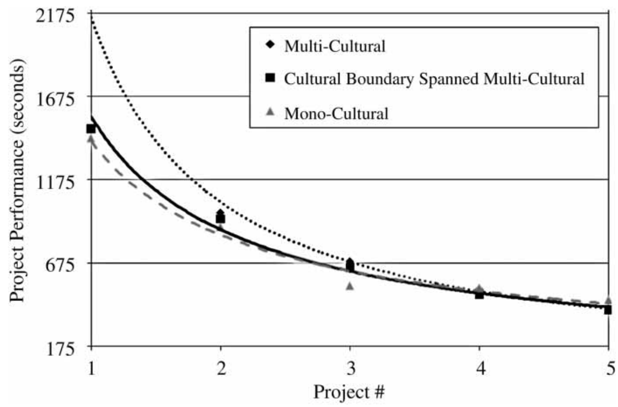

Figure 2 Average performance of multi-cultural, cultural boundary-spanned multi-cultural and mono-cultural project networks (with permission from ASCE)

statistical *t*-test analysis to ascertain whether the adaptation performances were statistically distinct between the study groups. Although there was an observable difference in the adaptation performance of cultural boundary-spanned and non-cultural boundary-spanned project networks ($p = 0.15$), the *t*-test results did not support Hypothesis 2a or 2b. Further research is needed to examine and verify whether a significant difference exists between adaptation performance and the type of network.

We also found that during the initial stages of collaboration (particularly during the first project) the CBS communication frequency was significantly greater than the non-CBS communications. Yet, this greater frequency of CBS communications decayed quickly. Both Hypotheses 3a and 3b were supported. Analysis of the observed communications revealed a significant difference in the average communication frequency of the network members in the first project. Although the variance in the frequency of communications dissipated over the course of the five projects, the results show that the CBS played a boundary-spanning role, which was a critical factor in initiating and facilitating communication between the INT and the US members. We posit that this boundary-spanning effort by the CBS enabled this multi-cultural project network to achieve the initial performance level of a mono-cultural project network. This finding is interesting considering that the two network types have different characteristics and belong to different cultural, social and economic backgrounds which make their coordinated project efforts and motivation quite different. In order to increase the likelihood that performance objectives are attained, fostering communications by the individuals that span cultural boundaries may provide an effective mechanism to engender knowledge transfer, mutual understanding and, ultimately, improved performance.

By utilizing CBSs in a global project network at the initial stages of collaboration, the benefits are two-fold. The skills of the CBS can be employed to mitigate the cultural and linguistic boundaries at the initial stages of collaboration. And overcoming these initial collaboration barriers and increasing the overall performance of the networks may allow for a higher probability of innovation and creative problem solving over successive projects. Research has shown that multinational diversity in organizations can lead to an increase in innovativeness (Miller *et al.*, 2000; Page, 2007); however, this capability is seldom reached due the cultural and linguistic conflicts resulting in short-lived collaboration attempts. Global networks given the opportunity to work together over successive projects may realise the potential for creating new knowledge and innovation. Hence, the capability of CBSs can be leveraged within global project networks in order to make learning and knowledge transfer across contexts less arduous and may facilitate innovation in global project networks. In our experiments, this may have been the factor that enabled the culturally and linguistically diverse project networks with and without a CBS to outperform mono-cultural networks by the fourth project.

Notwithstanding the findings of our research and the potential impact of CBSs to impact innovativeness, researchers have shown that CBSs do not necessarily emerge to span cultural boundaries (Levina and Kane, 2009). Cultural considerations, lack of effective communication skills and inter-cultural competency are factors that may impact the degree to which CBSs are effective in global projects. Managers, especially expatriates who have no knowledge of their collaborative counterparts' background, may be viewed as dictatorial figures that are indisputable and seen to have all the answers and solutions by members of the project network, which can be a barrier to collaboration effectiveness (Yates, 1989; Levina and Kane, 2009). Levina and Kane's findings also suggest that managers can potentially possess ethnocentric attitudes towards the local counterparts which may cause conflict, strained relationships and most of all the inability to cross salient national cultural boundaries. Perhaps by empowering and training these individuals as CBSs and placing them in cultural boundary-spanning roles with the purpose of fostering communication and improving collaboration, the effectiveness of such expatriates can improve and their knowledge of the various cultures represented on the global project be exploited. We need further research to identify the specific cultural boundary-spanning skills to ensure effective participation of the CBS. These competencies may include adequate linguistic knowledge, awareness and sensitivity to cultural differences and understanding local customs and norms. Developing such skills and exploiting the role of CBSs in global project networks may enable projects to more predictably achieve project objectives in initial collaborations. Approximately 40% of international joint ventures have been shown by researchers to perform poorly (Beamish and Delios, 1997); thus, finding ways to develop and exploit CBSs may represent a critical competence for firms and networks of firms executing global projects to achieve.

Implications

Global collaborations may fail to meet project objectives due to miscommunication and inefficient project delivery (Bryant, 2006). A survey of construction industry respondents in 2004 found that while the majority of firms (48%) aimed to reduce their engineering costs by more than 10% by offshore outsourcing portions of engineering design to low-cost nations, very few firms (2%) expected an overall project delivery time decrease of more than 10% due to outsourcing this work (National Academy of Engineering, 2008). An article in *CIO* magazine aimed at uncovering the secret costs of outsourcing indicated that the transition cost—the initial cost of collaboration—of sending work overseas is often the largest impediment to productivity (Overby, 2003). The significance of our findings to these statistics is that CBSs may be a catalyst for the initial transition periods in a cross-cultural venture and eliminate the 'hidden cost' associated with both the transition period and the cultural and linguistic differences. Researchers have identified the need for firms to develop refined cultural intelligence mechanisms that have managerial, competitive and structural implications in order to collaborate with their culturally distinct colleagues effectively (Ang and Inkpen, 2008). This research suggests that a critical capability in working in global project networks is to identify team members who naturally possess a high degree of cultural intelligence to utilize these members to improve global project network performance. We postulate that CBSs may answer the call for cultural intelligence at the critical intersection between cultures on global AEC projects.

In global project networks, the wide range of players involved include executives, managers, project leaders and members of the multi-cultural project network. Some work locally, others travel as expatriates to their collaborator's location. All are involved in the challenge of achieving high performance objectives and collaborating effectively in a culturally diverse global network. In addition to the technical, managerial, leadership and interpersonal skills required for successful project execution in the AEC industry, training in cultural boundary spanning may be needed to develop and exploit cross-cultural competences. This includes both knowledge about other cultures and the ability to capture the potential benefits that arise out of cultural differences. Even untrained individuals placed into project networks with critical cross-cultural boundary-spanning knowledge were able to significantly impact the performance of multi-cultural networks in this idealized experiment. Training may be necessary to capture similar performance benefits in an industrial setting.

Contributions, limitations and future research

We demonstrated how including a CBS in global project networks can significantly improve the initial performance while maintaining the adaptation performance of a project network. These performance implications should raise awareness in AEC firms and help them to understand the benefits of introducing a CBS into their network, particularly in the early stages of collaboration. This extends earlier research focused on collaboration effectiveness (Levina and Vaast, 2008; Di Marco *et al.*, 2010) by empirically measuring and comparing the performance impact of CBSs to monocultural and non-cultural boundary-spanned multicultural networks as control groups (Çomu *et al.*, 2010). CBSs facilitate the bridging of cultural and linguistic differences from the beginning of a cross-cultural collaboration and provide a common ground for mutual understanding to be established between diverse team members. As a result, we expect cultural boundary-spanned project networks to not only perform better, but also to take better advantage of the diverse set of skills and understandings provided by the culturally diverse participants. This can ultimately prepare the foundation for a sustained and effective collaboration.

Although the research we conducted has valuable practical implications for AEC firms and networks of firms, the limitations must also be noted. An important limitation of this study relates to the fact that the participants being examined were students and were guaranteed monetary compensation irrespective of their overall performance. Quite possibly, with some form of professional recognition associated with the tasks carried out, we might have observed different results had the experiment been performed with industry practitioners working on actual global engineering or construction projects. Furthermore, even though we are testing the capabilities of a CBS to span cultural boundaries in order to improve performance, the number of cultural boundaries being spanned between the cultural boundary-spanned networks (two boundaries) and the multi-cultural project networks (three cultural boundaries) is not consistent. Yet this would also introduce other causal factors and, hence, we believe that the ability to control the various factors influencing performance in the experimental environment outweighed the benefits which may have been gained by conducting a natural experiment in the field of nearly identical projects with nearly identical team sizing and other variables which would certainly have impacted performance. Future research should examine other project network compositions. For example, the inclusion of cosmopolitans that do not share a cultural or linguistic background with the international participant but who have lived in multiple countries and speak multiple languages (Haas, 2006) may have a positive impact on performance even without specific experience working in the countries of the partner organizations. Future research should examine how cosmopolitans and other emerging roles in global project networks can impact performance. Another important limitation to consider is that global project networks, the individual participants of those networks, and their relevant network organizations are influenced by different types of culture such as organizational culture, project culture and national culture. Research has demonstrated that organizational culture is an important predictor of performance (Ozorhon *et al.*, 2008, 2010). Future research may also explore how types of culture other than national culture impact performance and how varying combinations of organizational, project and national culture impact performance.

Acknowledgments

This material is based in part upon the work supported by the National Science Foundation under Grant No. 0729253 and an Alfred P. Sloan Foundation Industry Studies Fellowship. Any opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or the Alfred P. Sloan Foundation. We would also like to thank Haejung Yi and Antonio Pote for her assistance in collecting data for this project.

References

Aldrich H.E. and Herker D. (1977) Boundary spanning roles and organization structure. *Academy of Management Review*, **2**, 217–30.

Ancona D. and Caldwell D. (1992) Bridging the boundary: external activity and performance in organizational teams. *Administrative Science Quarterly*, **37**, 634–65.

Ang S. and Inkpen A.C. (2008) Cultural intelligence and offshore outsourcing success: A framework of firm-level intercultural capability. *Decision Sciences*, **39**(3), 337–58.

Ansett S. (2005) Boundary spanner: the gatekeeper of innovation in partnership. *Accountability Forum*, **6**, 36–44.

Au K. and Fukuda J. (2002) Boundary spanning behaviors of expatriates. *Journal of World Business*, **37**, 285–96.

Barkema H., Shenkar O., Vermeulen F. and Bell J. (1997) Working abroad, working with others: How firms learn to operate international joint ventures. *Academy of Management Journal*, **40**(2), 426–42.

Beamish P. and Delios A. (1997) Incidence and propensity of alliance formation, in Beamish P.W. and Killing J.P. (eds) *Cooperative Strategies: European Perspectives*, New Lexington Press, San Francisco, 103–127.

Brouthers K.D. and Brouthers L.E. (2001) Explaining the national cultural distance paradox. *Journal of International Business Studies*, **32**(1), 177–89.

Bryant P.T. (2006) Decline of the engineering class: effects of global outsourcing of engineering services. *ASCE Journal of Leadership and Management in Engineering*, **6**(2), 59–71.

Chan E.H.W. and Tse R.Y.C. (2003) Cultural considerations in international construction contracts. *ASCE Journal of Construction Engineering Management*, **129**(4), 375–81.

Chan A.C., Chan D.W., Chiang Y.H., Tang B.S., Chan E.H.W. and Ho K.S.K. (2004) Exploring critical success factors for partnering in construction projects. *ASCE Journal of Construction Engineering and Management*, **130**(2), 188–98.

Cheah C.Y.J., Garvin M.J. and Miller J.B. (2004) Empirical study of strategic performance of global construction firms. *ASCE Journal of Construction Engineering and Management*, **130**(6), 808–17.

Chen P., Partington D. and Qiang M. (2009) Cross-cultural understanding of construction project managers' conception of their work. *ASCE Journal of Construction Engineering Management*, **135**(6), 477–87.

Chua K.L. (1999) Critical success factors for different project objectives. *ASCE J. Construction Engineering Management*, **125**(3), 142–50.

Çomu S., Unsal H. and Taylor J. (2010) The dual impact of cultural and linguistic diversity on project network performance. *ASCE Journal of Management in Engineering*, DOI: 10.1061/(ASCE)ME.1943-5479.0000052. Published online 2 November 2010.

Cooke-Davies T. (2002) The 'real' success factors on projects. *International Journal of Project Management*, **20**, 185–90.

Di Marco M.K., Taylor J. and Alin P. (2010) Emergence and role of cultural boundary spanners in global engineering project networks. *ASCE Journal of Management in Engineering*, **26**(3), 123–32.

Fong P.S.W. and Kwok C.W.C. (2009) Organizational culture and knowledge management success at project and organizational levels in contracting firms. *ASCE Journal of Construction Engineering and Management*, **135** (12), 1348–56.

Haas N. (2006) Acquiring and applying knowledge in transnational teams: the role of cosmopolitans and locals. *Organization Science*, **17**(3), 367–84.

Hinds P.J. and Bailey D.E. (2003) Out of sight, out of sync: understanding conflict in distributed teams. *Organization Science*, **14**(6), 615–32.

Hofstede G. (1996) *Cultures and Organizations: Software of the Mind*, McGraw Hill, NY.

Hong H.J. (2010) Bicultural competence and its impact on team effectiveness. *International Journal of Cross Cultural Management*, **10**(1), 93–120.

Janssens M. and Brett J. (2006) Cultural intelligence in global teams: a fusion model of collaboration. *Group & Organizational Management*, 31(1), 124–153.

Javernick-Will A.N. and Levitt R.E. (2010) Mobilizing institutional knowledge for international projects. *Journal of Construction Engineering and Management*, **136**(4), 430–41.

Kini D.U. (2000) Global project management—not business as usual. *ASCE Journal of Management in Engineering*, **16** (6), 29–33.

Levina N. and Kane A.A. (2009) Immigrant managers as boundary spanners on offshored software development projects: partners or bosses? in *IWIC'09*, Palo Alto, California, USA, 20–21 February 2009.

Levina N. and Vaast E. (2008) Innovating or doing as told? Status differences and overlapping boundaries in offshore collaboration. *MIS Quarterly*, **32**(2), 307–32.

Luo Y. (2006) Toward the micro and macro-level consequences of interactional justice in cross-cultural joint ventures. *Human Relations*, **59**(8), 1019–47.

Mahalingam A. and Levitt R. (2005) Understanding and mitigating challenges on global projects: the role of the freelance expatriate. in *Proceedings of the ASCE Construction Research Congress*, San Diego, California.

Mahalingam A. and Levitt R. (2007) Institutional theory as a framework for analyzing conflicts on global projects. *ASCE Journal of Construction Engineering and Management*, **133**(7), 517–28.

Makino S. and Beamish P.W. (1998) Performance and survival of international joint ventures with non-conventional ownership structures. *Journal of International Business Studies*, **29**(4), 797–818.

Manzoni A. and Islam S.M.N. (2007) Measuring collaboration effectiveness in globalised supply networks: a data envelopment analysis application. *International Journal of Logistics Economics and Globalization*, **1**(1), 77–91.

Miller D., Fields R., Kumar A. and Oritz R. (2000) Leadership and organizational vision in managing a multi-ethnic and multi-cultural project team. *ASCE Journal of Management in Engineering*, **16**(6), 18–22.

National Academy of Engineering (2008) *The Offshoring of Engineering: Facts, Unknowns, and Potential Implications*, National Academies Press, Washington, DC.

Nayak N. and Taylor J.E. (2009) Offshore outsourcing in global design networks. *ASCE Journal of Management in Engineering*, **25**(4), 177–84.

Overby S. (2003) The hidden costs of offshore outsourcing. *CIO Magazine*, **16**(22), 1 September, 1–13.

Ozorhon B., Arditi D., Dikmen I. and Birgonul M.T. (2008) Implications of culture in the performance of international construction joint ventures. *ASCE Journal of Construction Engineering and Management*, **134**(5), 361–70.

Ozorhon B., Arditi D., Dikmen I. and Birgonul M.T. (2010) Performance of international joint ventures in construction. *ASCE Journal of Management in Engineering*, **26**(4), 209–22.

Page S.E. (2007) Making the difference: applying a logic of diversity. *Academy of Management Perspectives*, **21**, 6–20.

Park S. and Ungson G. (1997) The effect of national culture, organizational complementarity, and economic motivation on joint venture dissolution. *Academy of Management Journal*, **40**(2), 279–307.

Porter J.C. (1995) Facilitating cultural diversity. *ASCE Journal of Management in Engineering*, **11**(6), 39–43.

Powell A., Galvin J. and Piccoli G. (2006) Antecedents to team member commitment from near and far. *Information Technology and People*, **19**(4), 299–322.

Richter A., West M., Van Dick R. and Dawson J. (2006) Boundary spanners' identification, intergroup contact, and effective intergroup relations. *Academy of Management Journal*, **29**(6), 1252–69.

Shenkar O. and Zeira Y. (1992) Role conflict and role ambiguity of chief executive officers in international joint ventures. *Journal of International Business Studies*, **23**(1), 55–75.

Vadhavkar S. and Peña-Mora F. (2000) Geographically distributed team interaction space, in *Proceedings of the Eighth International Conference on Computing in Civil and Building Engineering*, pp. 373–79.

Wright T. (1936) Factors affecting the cost of airplanes. *Journal of the Aeronautical Sciences*, **3**(4), 122–28.

Yates J.K. (1989) Training expatriate engineering professionals. *ASCE Journal of Management in Engineering*, **5** (3), 257–71.