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A leadership-as-practice perspective on design in architecture, engineering and construction projects: interaction analysis of a collaborative workshop

VEDRAN ZERJAV[1*], TIMO HARTMANN[2] and FREDERICK M.C. VAN AMSTEL[2]

[1]*Bartlett School of Construction and Project Management, University College London, 1–19 Torrington Place, London WC1E 7HB, UK*
[2]*Department of Construction Management and Engineering, University of Twente, PO Box 217, 7500 AE Enschede, The Netherlands*

This paper proposes an alternative perspective on the role of leadership in the context of collaborative practices in architecture, engineering and construction design. While most of current leadership literature is focused on outstanding individuals with abilities to influence others, the aim of this study is to focus on leadership as a set of emergent interactive practices. To this end, the paper presents a video-based interaction analysis of a collaborative design workshop for a medical imaging centre in the Netherlands. Findings suggest that leadership-as-practice emerged through specific patterns of domain knowledge ownership, frequency of interactions, actor responsiveness and cross-disciplinary knowledge brokering. The paper calls for further empirical studies in the domain of interaction-focused leadership practices.

Keywords: AEC project organizations, collaborative design, leadership-as-practice, video-based interaction analysis, workshops.

Introduction

Projects in the architecture, engineering and construction (AEC) domain are often planned, designed, built, operated and used in complex interdisciplinary and inter-firm organizational arrangements. To mitigate the adverse consequences of working across disciplines and firms, an increasing amount of attention is being paid to activities of design and their organization. As a result, the implementation of collaborative design concepts is becoming increasingly commonplace in a variety of projects that involve numerous stakeholders, organizations, and fields of design expertise. Due to the iterative, complex and multiple nature of decision-making that takes place in such settings, a growing volume of studies is dedicated to the practices of managing collaborative design in the domain of construction projects (Gray and Hughes, 2001). Several recent studies have exposed rich descriptions of collaborative design in AEC projects as a process of creating a shared understanding of a design situation through the use of artefacts as incomplete embodiments of *domain design knowledge* (Ewenstein and Whyte, 2009). This shared understanding is built through *interactive practices* such as talk, gesture, gaze around objects such as drawings and other design representations (Luck, 2010). Given that design occurs in settings mediated by information technology, the interactive practices will emerge across human actors and design artefacts (Harty and Whyte, 2009; Dossick and Neff, 2011). Recent research on design in virtual networks, for instance, posits that *knowledge brokering* between different organizational, disciplinary and cultural domains is one of such key interactive practices (Di Marco and Taylor, 2011; Iorio *et al.*, 2012). Although the existing body of studies successfully exposes a variety of interactive social phenomena in the production of design knowledge for AEC projects, the area of leadership is notably absent from the subject matter research agenda.

*Author for correspondence. E-mail: v.zerjav@ucl.ac.uk

The path of leadership research in mainstream business and management literature took shape from the early studies that focused on personality traits of successful leaders towards the acknowledgment of the context in which leadership is taking place. More recent studies, for instance, analyse the interpersonal relationships that shape the conditions for leading (Müller and Turner, 2010) as well as the notion of revolving leadership based on the task at hand (Davis and Eisenhardt, 2011). Although leadership has been extensively studied in the context of decision-making in new product development and design of manufacturing and fast-paced industries (Davis and Eisenhardt, 2011), this is not the case for AEC project organizations. In this domain, leadership has been mostly studied from the perspective of international cultures (Fellows *et al.*, 2003; Ofori and Toor, 2009), using construction projects, firms and portfolios as the unit of analysis (Cheung *et al.*, 2001; Kissi *et al.*, 2013). Design processes in AEC projects, as a result, have remained largely unexplored in the body of leadership literature.

The relative absence of design leadership studies in the context of AEC project organizations is surprising, given the uniqueness, high costs, complexity and high social impact over long time spans that characterize these projects (Winch, 2010). As a result, the particular features of the setting in which AEC projects are designed, delivered and used warrant a context-specific understanding of leadership in collaborative design. The authors' aim in the present study is to extend this understanding.

The specific objective of this study is to construct a *leadership-as-practice* perspective for collaborative design of AEC projects. This perspective stands in sharp contrast to the traditional perspective in management and business literature that considers leadership predominantly in the context of pre-identified exceptional individuals (Alvesson and Spicer, 2012; Küpers, 2013; Brown, 2014). To be more specific, it can be said that while the bulk of mainstream leadership studies consider leadership practices as a feature of remarkable leadership personalities, the conceptual position that this study adopts is one that considers leadership personalities as a feature of leadership practices. This position is in line with the 'action turn' paradigm in social science where the focus on formal normative concepts slowly gives way to practice as it is observed to occur in reality (Schatzki *et al.*, 2001). Following this line of thought, the present study will analyse situated practices of design (Luck, 2012) in an effort to induce descriptive theory that extends current understanding on leadership practices. Using this analytical lens, leadership is interpreted as a social experience that is created and given meaning through organizational practices (Gephart, 2004). To achieve this objective, the unit of analysis in this study is set to interactions that occurred in a particular design workshop as opposed to studying AEC projects or firms.

The rest of this paper is structured as follows. We first introduce a selected body of leadership studies in the domain of AEC projects to identify the need for the leadership-as-practice perspective deployed in this study. We then construct the case for studying leadership through emergent interactive practices, as a distinct analytical angle in which the focus on human agency precedes the focus on the individual actor, as in the bulk of existing leadership literature. Subsequently, we introduce the research setting, in which this study was conducted: a collaborative design workshop for a medical imaging centre (MIC) in the Netherlands. Based on an in-depth analysis of interactions that occurred in the workshop, we discuss domain knowledge ownership, frequency of interactions, actor responsiveness and cross-disciplinary knowledge brokering as important aspects through which leadership practices unfolded in the analysed workshop. After discussing the findings, we lay out some implications of this study for theory and practice and conclude with some possible directions for future work in this domain.

Leadership in projects

Project studies have, by and large, dealt with leadership by setting the unit of analysis to projects as distinct chunks of work that an organization performs over time and by using project characteristics as contextual variables in which effective leadership occurs. These studies focus on, for instance, the relationship between project characteristics and leadership styles (Müller and Turner, 2007) to conclude that different leadership styles are more likely to lead to successful outcomes on different types of projects such as telecommunications, construction, information and communications technology, etc. In the context of AEC projects, a similar volume of literature is dedicated to leadership. The main contextual variable here is operationalized as a cultural boundary between different countries (Fellows *et al.*, 2003; Ofori and Toor, 2009) or the difference between firm, project and portfolio levels (Cheung *et al.*, 2001; Kissi *et al.*, 2013). While these studies take a macro-level view of the construction industry that arguably also includes the design phase of projects, the leadership of design processes in AEC project organizations has thus far not been thoroughly explored. Besides two questionnaire studies that identify the behaviours that employees in architectural offices prefer from their leaders (Kasapoğlu, 2010, 2014), no other studies have

been found that deal specifically with design leadership in AEC project organizations.

Moreover, the existing body of leadership studies adopts the underlying assumption that a strong link exists between the leader's personality and diverse project situations translated into contextual variables. Due to this assumption, the dominant discourse has been revolving around the leader as opposed to leadership (Crevani *et al.*, 2010). This notion has led to the leadership-as-practice perspective that begins to study leadership as a phenomenon that emerges through particular interactive practices rather than as a consequence of personality traits possessed by the supposedly effective leader-individuals (Wood, 2005; Alvesson and Spicer, 2012).

The main topic of concern of the leadership-as-practice stream of studies is to construct an alternative theoretical position that calls for a fine-grained approach to studying leadership as it is manifested in different situated contexts. More specifically, this perspective advises a shift in the unit of analysis from the individual leader towards leadership practices as they occur in organizational reality. In this setting, leadership is considered as a practice rather than a leader-focused instrumental strategy (Crevani *et al.*, 2010). In summary, critical leadership studies emphasize the need to develop process ontologies that are able to represent leadership as an activity rather than analyse it as a static set of properties that is possessed by heroic individual actors (Crevani *et al.*, 2010; Raelin, 2011). The call for process ontologies of leadership as an activity has implications for research methodology that includes conversation analysis, phenomenology and discourse analysis as appropriate tools to capture manifestations of leadership as it is practiced in mundane routines and interactions (Holmes and Marra, 2010; Larsson and Lundholm, 2010; Küpers, 2013).

Despite the striking resemblance of the methodological stance adopted by AEC design process-level studies—on the one hand—and leadership-as-practice research—on the other—we could not find any studies that explicitly connect them. Consequently, very little is known about the emergence of leadership in interactive practices of collaborative design for AEC projects. Due to the focus of most existing leadership studies on individuals rather than practices, such knowledge would provide a novel perspective to the body of leadership practices and methods. Driven by this motivation, we next present the research setup and approach for this study.

Research design

Given that leadership-as-practice of AEC design is a largely unexplored organizational phenomenon, we chose a research strategy that best addresses the 'how' and the 'why' questions concerning the subject matter as opposed to large-scale deductive theory-testing research that is more appropriate to address questions concerning the relative empirical importance of constructs (Eisenhardt and Graebner, 2007). To this end, we designed the research as context-driven interpretive inquiry (Walsham, 2006) that implements video-based interaction analysis (Jordan and Henderson, 1995) as an interdisciplinary method drawing broadly from more fundamental discursive methods such as ethnomethodology and conversation analysis. The aim of using video-based interaction analysis was to set up the inquiry in a way that would allow theory to emerge from rich interaction data broadly in line with guidelines for grounded theory building (Corbin and Strauss, 2008).

Having no specific hypotheses or research questions in place, we designed the research as a video-based analysis of interactions in the setting of a design workshop, in which leadership was observed to have emerged. This unintended emergence of leadership caught our attention and triggered the interaction analysis in an effort to identify particular patterns through which the phenomenon of emergent leadership could have been explained ex-post. This analysis consisted in a detailed annotation of the turns in which actors interacted with each other during the 52 minutes of the video-recorded workshop. As will be explained in more detail below, the video-based interaction analysis involved a qualitative analysis of the codes for the actor-based turns in the annotation scheme. The incidence of the codes was given a quantitative measure to qualify the relative presence of different types of turns in the overall dataset. Having said that, however, it is important to mention that in line with the positioning of this inquiry as an interpretive and inductive theory building (Walsham, 2006; Eisenhardt and Graebner, 2007), the purpose of the above-mentioned exercise of computing code incidences was not to derive statistically relevant empirical generalizations, but to facilitate the in-depth qualitative exploration of the aspects in which leadership-as-practice occurred in the ongoing setting of the analysed design workshop. Having exposed the approach behind designing this research, we now turn to explaining the context in which the design interactions took place.

Research context

We chose to analyse the multi-stakeholder design process for a project of an MIC located on a University campus in the Netherlands. It was envisioned that the new MIC would host the following groups of medical imaging: non-invasive methods and optics, medical

imaging informatics, computed tomography (CT) and X-ray, magnetic resonance imaging (MRI), and nuclear and molecular imaging. The strategic purpose of the MIC was to become a globally recognizable centre for innovative medical imaging combining research, education and clinical activity. The business case of the MIC was to fulfil the clinical needs of the two local hospitals that agreed to refer a certain number of their patients to the centre to perform different types of diagnostic tests. The scope of the project involved design and renovation of an old university building with the purpose of meeting the functions envisaged for the new diagnostic centre. For this purpose, a number of stakeholders from the sectors of education, research and clinical practice were involved in the design decision-making processes of the project. The project was particularly suitable for studying leadership due to its stakeholder constituencies that involved disparate design specialists as well as groups of clinical, academic and research representatives for all the disciplines represented in the new MIC.

The project manager (PM) was responsible for managing both design as well as the construction stage of the project. The PM, although experienced in a variety of construction projects in a university setting, did not have substantial experience in managing multi-stakeholder design. Personality-oriented leadership literature would label the PM as a 'laissez-faire' leader of the design process. Our involvement in this project began in June 2012 when a leadership problem was identified in the project. At this point, the main architectural drawings for the centre were developed, but the project was stalled as the clinical organizations were delaying their formal approval of the project—a necessary condition to proceed with construction activities. Through discussions with the PM, it was contended that the power of the disparate clinical constituencies in the design process was overriding his management authority in the project. It was therefore decided that there was a need for organizing a collaborative workshop as an alternative method to reach consensus that would enable the project to move ahead. The aim of this effort was to solicit the formal approval from the clinical users and continue with project activities. It was moreover anticipated that this would have occurred seamlessly once the key stakeholder constituencies would have been brought together in a collaborative workshop setting. The participants of the workshop were selected representatives of the healthcare profiles involved in the operations of the centre, operations research optimization consultants, medical equipment representatives and the management team of the project.

This workshop was framed as an exploration of problem space with the goal of identifying the shortcomings of the proposed architectural layout in terms of the medical process. Since the layout was at that time already highly elaborated, this provided the participants with an opportunity to reflect upon the detailed features of the design concept. Besides a number of clinical participants who represented their respective hospitals, an operations research group was invited to attend the workshop and provide expertise in the area of healthcare process logistics. Their involvement was mainly in the context of external consultants as they were not involved in other aspects of the design process, other than on this particular occasion.

The flow of the workshop was planned in a way that, if the participants would have observed any inconsistencies in the layout with respect to the processes of MRI, X-ray CT and PET/MRI hybrid imaging diagnostics, they were asked to suggest changes for the floor plan. Nonetheless, the overall admission parameters of these processes were not clarified to the participants, which caused the discussion to disperse around speculations concerning the assumed number of patients for each diagnostic treatment and the inter-arrival times. This aspect of the workshop is further elaborated upon in the subsequent sections.

Data collection and analysis

We were presented to the participants of the collaborative design as building information modelling specialists who are also researching the process of collaborative design. Within the scope of this role, we were granted permission to video record the ongoing workshop. During the interactive part of the workshop, we did not participate in the discussions or interfere purposefully with the ongoing interactions in any way besides our presence, the use of recording equipment and taking photographs.

We analysed the data in two steps. In the first step, we operationalized the emergence of leadership-as-practice by exploring the context and dynamics of interactions by means of an incidental episode of emergent leadership. In the second step, the video material was imported into ANVIL, a Java-based video annotation research tool (Kipp, 2012) and we annotated the turns in the interaction (Sacks _et al._, 1974). Each turn was defined through a speech act in which language is intentionally used to convey a message or respond to an inquiry. In that way, we coded 52 minutes of the workshop in which most of the interaction relevant to the building layout occurred. This resulted in 48 minutes coded in 405 instances of turns in which participants contributed to the discussion. 4 minutes of the workshop were not coded as these were the interactions that could not have been attributed to any given participant and were thus not considered in the analysis.

lays out the codes used in the data analysis in the context of the workshop composition.

We continued with an in-depth interaction analysis by analysing the interaction dynamics, transition patterns and knowledge-brokering practices in the turn-based annotation scheme dataset. It should be also mentioned that all the interactions analysed were in Dutch. Text excerpts included in this article are translated into English for presentation purposes. In this process, we tried our best to capture the essence of what is being said without distorting the meaning of the original text. We also used the video recordings to induce meaning of the interactions by drawing on subtle cues in non-verbal interaction as well as the context and tone of voice for the analysed turns. These cues were mostly related to identifying the humorous character in certain sequences of interaction turns. Nonetheless, instead of formally annotating them in the dataset, we chose to address these subtle cues by relying on our intuitive perception of the context in which something was being said to identify the humorous instances.

Findings

Referring to the workshop actors from , we perceived actor L1 as the emergent leader of the discussion.

Table 1 Coding scheme implemented for the workshop participants

Position	Level of seniority/ expertise	Code
University facilities unit		
Project manager	High	PM
Regional hospital group		
Nuclear medicine physician	High	H1
Information analyst	Medium	H2
CT clinician	Medium	H3
Echo specialist	Medium	H4
Stochastic operations research group		
Experienced researcher healthcare logistics	High	L1
Experienced researcher healthcare logistics	Medium	L3
Researcher healthcare logistics	Low	L2

We confirmed this notion independently after the workshop when the PM expressly pinpointed actor L1 as the leader of the first session. More specifically, the PM contended that actor L1 was responsible for extensively shaping the arguments being discussed, thus prominently holding the leadership position. On the one hand, the constructive criticism being exposed by
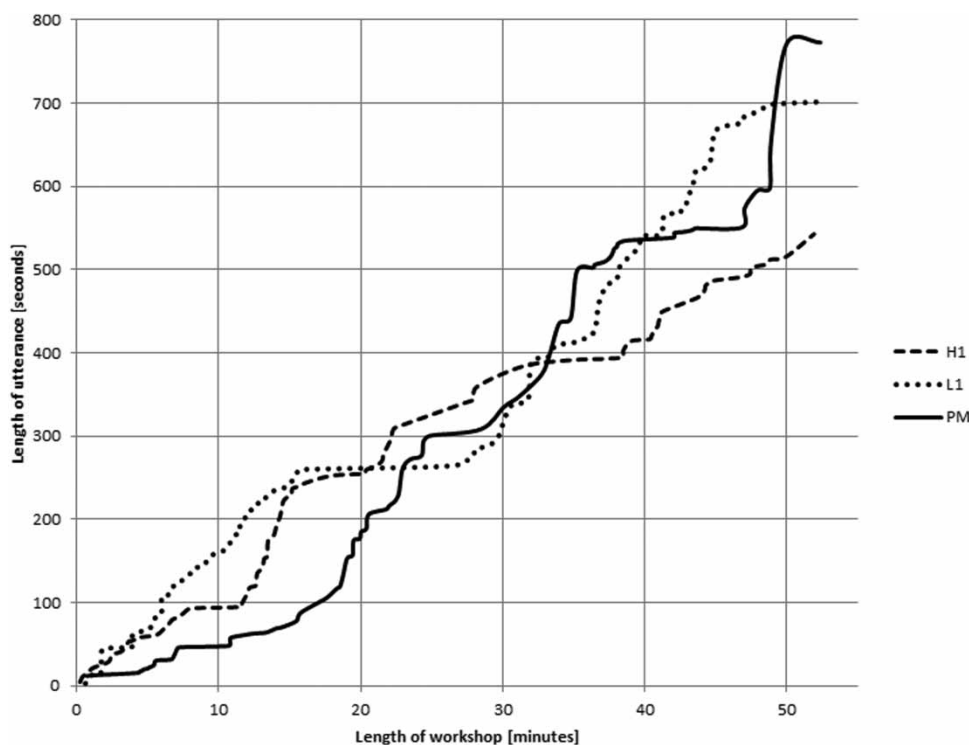
Figure 1 Dynamics of dominance in workshop interactions

actor L1 was seen as an opportunity to improve the layout, but at the same time the PM showed concern that additional work might delay the sign-off of the design documents by the clinicians responsible for the allocation of patients to the new MIC. To shed more light on the phenomenon of emergent leadership across the involved actors, we continued with the video-based interaction analysis of the workshop to identify the patterns that might have helped to explain this emergence. The interactions were analysed across different knowledge domains as well as within them.

To analyse the interactions, the annotation scheme containing codes for each actor's turns was implemented over the 48 minutes of the total of 52 minutes of video-recorded material. In the subsequent sections of the paper, we report detailed findings of this analysis in the following way. We first focus on a 2-minute excerpt from the workshop, which illustrates the details of the knowledge domain in which leadership emerged at the level of interactions on a turn-by-turn basis. The excerpt of workshop interactions is taken between minutes 36 and 38 of the annotated material (for more details, refer to Figure 1). After having exposed the knowledge domain in which the phenomenon of leadership emergence was observed, we then continue with an interaction analysis of the entire 52 minutes of the workshop. This analysis is focused on explicating the patterns through which the turns by the actors contributed to the workshop interactions. To this end, we analysed the dynamics of interactions as well as transition patterns between the various disciplinary groups and individual actors. The aim of the analysis is to explore the relationships between the patterns in interaction and the emergence of leadership.

Incidental episode of emergent leadership: 'Is the waiting room large enough?'

The following transcription illustrates an example of the situation, through which leadership was perceived to have emerged. To set the stage for this 2-minute episode, it should be mentioned that the below reported interactions followed the PM providing an extended clarification of the layout based on the clinical workflows for the PET/MRI and CT scans of the two local hospitals involved in the project. At that point in time, participant L1 turns towards the board with the floor plan and begins.

(1) L1: So the patients come in here [pointing at the floor plan on the wall] … here they come in three per hour [points to the CT room] … and here [points at the MRI room]?

(2) PM: I don't know … I think it should be 3 per hour … MRI? [looks around and asks for reassurance from H1 and H2]

(3) L1: So let's say here we have 4 per hour [points at the CT room], here 3 [points to the MRI room], to be on the safe side and here [points at the PET/MRI room]?

(4) PM: [Turns to H1 and H2 and asks them:] How many? One per hour?

(5) H1: Two per hour.

(6) L1: This is then … there are nine patients per hour walking around this area. [points at the MRI and CT areas]

(7) H3: For the CT it is about forty patients per day.

(8) L1: Then there are 10 patients per hour. This means that, let's say that the patient comes too early [pointing at the areas of the waiting room, CT and MRI]. So for the CT, there will be two or three people waiting here because they might come with their families. For the MRI, there are also two people sitting in the waiting room … Did you then look at what happens in the waiting room? [turns to the PM]

(9) PM: Well, [indistinguishable] … No.

(10) L1: I am thinking, if 30 people are sitting here [points at the waiting room], then it is full. So the people come in from here [points at the entrance of the building] and they go to the dressing rooms [points at 4 dressing rooms adjacent to the lower part of the waiting room] … I think. Is this correct? And what happens here? [points at the upper part of the floor plan adjacent to the waiting room and turns to the participants]

(11) PM: This is the interventions block. We still did not make the arrangements for that part, so we should not plan anything for it now.

(12) L1: Yes, but these people will also wait here? [points at the waiting room]

(13) PM: Yes.

(14) L1: [pointing at the corridors leading to the PET and MRI] If a patient comes here on a stretcher [CT room] and one here [MRI room], do you know this in advance in your planning?

(15) PM: I believe so.

(16) PET/MRI clinician: Yes.

(17) L1: Do you always know this?

(18) H1: Always. We ask this in advance … how mobile the patient is … we know if the patient is sufficiently mobile to come on their own.

(19) L1: [turns back to the floor plan and points at the corridor leading towards the CT and MRI areas]. If there is one patient here on a stretcher

and another one comes in, where do you lay him? Should he wait in the elevator?

(20) [multiple people laughing]

(21) PM: [laughing] No.

(22) L1: Then he should also go here [points at the waiting room]. This part is then really quite dreadful for the patient.

A lot is going on already in this short extract and the analysis focused on several aspects relevant for the emergence of leadership through turn-based inter-actions. First of all, it is clear that actor L1 dominated a substantive portion of the discussion by raising issues such as the size and number of dressing rooms in relation to the needs of the medical process, differences between various patient streams, clean material and waste, and the size of the waiting room. As a result, it was the healthcare logistics expertise that emerged as the domain knowledge in which leadership of the discussion took place. Although active, the role of the PM was relatively marginalized, with his contributions limited to providing arguments for the inquired aspects of the design rationale. It is also interesting to notice that in the above episode the ambiguity concerning the lack of information about the number of admissions for different tracks of medical imaging could be seen as an antecedent for the emergence of leadership through *domain knowledge ownership*. At this level, leadership emerged through scenario-based considerations about flows of patients supported by analytical techniques specific for workflow and logistics planning. At this point, the participants were following L1 in his analysis of a hypothetical scenario in which three patients per hour utilize the MRI device and four per hour for the CT device. The aim of exploring different scenarios was to discuss a space of possible solutions regardless of not knowing the numbers of admitted patients. It was also observed that actor L1 continued to reassure this domain knowledge ownership by making casual jokes in reference to other potential shortcomings of the floor plan.

It is important to note that the above episode illustrates only one incidence of leadership emergence and that we identified a number of other, equally significant instances in the data. Nonetheless, the above episode was chosen as we believe that it captures the phenomenon under study in a detailed, and yet succinct, way. Following on from the above episode, we continue the analysis of the annotation scheme implemented over interactions that took place during the entire workshop.

Interaction analysis

At the level of the entire workshop, it was interesting to notice that the actors coded with L1, H1 and PM executed the bulk of turns with a total representation in the overall interactions of 26.88%, 18.90% and 24.44%, respectively. Consequently, it was through these interactions that the main arguments of the workshop were shaped. A more comprehensive account of this annotation scheme for the entire workshop is given in Table 2.

The turn-based analysis of the annotation scheme also revealed that some actors were contributing shorter speech-acts than others. This situation was particularly pronounced with actor L1 whose frequency of turns was the highest among all the other participants as he was persistent in giving short comments, making jokes and posing questions regarding the medical processes. Longer duration of an average turn, on the other hand, was an indication that a participant was predominantly addressing issues that required an in-depth clarification. This was most evident with actors PM and H2 who were engaged in extended explanations of the issues concerning the layout of the building as well as planning features of the PET/MRI process for which the information analyst was in charge.

Table 2 Analysis of the overall annotation scheme

Participant	Interactions coded (N)	Total duration of turn (s)	Average duration of turn (s)	Self-reference ratio (%)
PM	76	771.86	10.15	
Medical practitioner group				33
H1	82	542.82	6.61	
H2	34	342.50	10.07	
H3	36	176.82	4.91	
H4	13	48.07	3.69	
Logistics experts group				27
L1	118	701.70	5.94	
L3	34	190.29	5.59	
L2	12	97.25	8.10	

We also noticed significant interaction occurring amongst participants of the same group. These domain self-referential interactions occurred either within the hospital practitioners group or within the healthcare logistics group. One such example was when multiple participants from the hospital group discussed the duration of detailed steps in a specific diagnostic protocol. Another example was when healthcare logistics experts discussed advantages and disadvantages of combining the sequences of steps into a specific process. About one-third of all the interactions in these two groups were domain self-referential. To further explore the phenomenon of leadership emergence, we next present a turn-based analysis of the dynamics between the key actors that shaped the interactions.

Analysis of interaction dynamics

At the overall level the interaction analysis points towards the actor L1 as the most highly engaged in terms of total duration of turns and their relative frequency. The interaction dynamics can be represented as a triadic structure of relationships where three clusters of actors were observable, based on their knowledge domain. As a result of different contributions by actors from different domains, substantial revisions of the floor plan were being negotiated. The revisions were coming from the healthcare disciplinary domain and entailed requests for increasing the number of dressing rooms and conducting further inquiry into the capacity of the waiting room. The following diagram depicts the dynamics of interactions between L1, H1 and PM as the most prominent actors (Figure 1).

Each curve in the above diagram represents the summative length of turns for each of the three actors in a way that shows how much they contributed to the interactions per unit of time. The slope of the curve thus indicates the level of activity for any given actor in

such a way that the steeper the slope, the higher is the level of activity recorded. It is interesting to notice the similar levels of activity for the three actors at the end of the 52 minutes of the workshop. It is also interesting to notice the irregularities from minutes 33 of the workshop till its end. On this segment, actor L1 was not as active as before and actors PM and H1 increased their levels of activity. In the above diagram, moreover, the initially introduced 2-minute excerpt can be found between minutes 36 and 38, which corresponds to a very high level of activity for L1, accompanied by PM. Arguably, the requests for revisions of the floor plan were a result of the logistics disciplinary domain in general, and actor L1, in particular, being perceived as the leaders of the discussion.

Transition analysis

We further analysed patterns of transition between turns attributed to different participants. The transition analysis is shown in Table 3. The matrix gives the number of instances where actors in the first row follow turns by actors in the first column. Reading the PM column, for instance, one can induce that the PM spoke 31 times after L1, 15 times after H1, 10 times after L3 and so on. The purpose of the matrix is to isolate (1) the dyads in which specific interaction transitions occurred and (2) the actor-based frequencies of inward-facing transitions. The former identifies the relative presence of any given transition sequence in the annotated dataset. The latter, by contrast, can be interpreted as a proxy to argue how responsive actors were to the ongoing interactions. The actor-based frequencies are shown in the bottom row of the transition matrix in Table 3.

Interpreting Table 3 from the two above-mentioned angles suggests that the high-frequency transitions emerged between actors L1, H1 and PM, who at the

Table 3   Transition matrix highlighting high-frequency dyads and high-response actors

Follows/followed by	H1	H2	H3	H4	L1	L2	L3	PM
L1	**31**	13	10	6	11	5	10	**31**
H1	6	3	8	2	**44**	0	4	15
L3	7	4	3	0	6	3	1	10
H2	7	2	3	0	10	1	3	8
PM	20	4	9	1	**28**	1	7	6
H3	10	5	0	2	9	1	5	4
L2	1	1	0	0	4	1	4	1
H4	0	1	3	2	6	0	0	1
Total responsiveness	**82**	33	36	13	**118**	12	34	**76**

Note: Bold value indicates high frequency dyads (L1-H1 and PM-L1) as well as high response actors (last row of the table).
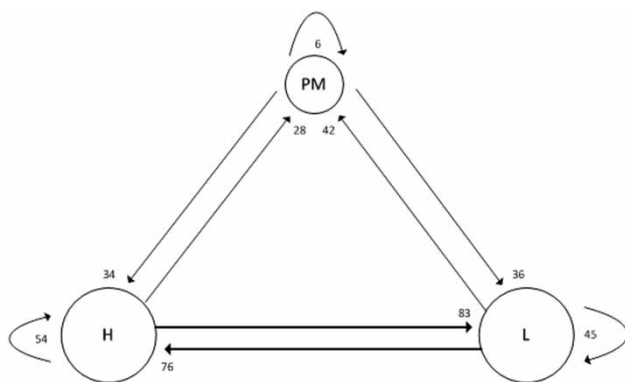
Figure 2 Transition analysis at the level of disciplinary groups

same time exhibited the highest overall levels of responsiveness. More specifically, the high-frequency pairwise dyads comprise actors H1 and L1 as well as PM and L1. The H1–L1 transition occurred as many as 44 times accompanied with 31 occurrences of the L1–H1 transition. Similarly, there are 31 registered occurrences of the L1–PM transition and 28 of the PM–L1 transition. These four most frequent transitions are highlighted in Table 3.

Looking at the actor-based summative frequencies of transition patterns, one can observe that actors L1, H1 and PM are represented with a total of 117, 82 and 76 transition occurrences coded in the annotation scheme. Consequently, the summative frequencies clearly point to actor L1 as the most responsive contributor to the interactions. After analysing the transitions from the perspective of high-frequency dyads and responsiveness of individual actors, we next analyse the patterns on the basis of disciplinary domains.

Figure 2 demonstrates the interactions between the three disciplinary clusters: PM, logistics group and the medical practitioners group. The PM directed 34 annotated interactions towards the healthcare practitioners (H) group, 36 towards the logistics (L) group and 6 annotated interactions were self-referential. Interactions in the logistics group, by contrast, were predominantly directed towards the medical practitioners group, namely 76 annotated instances, in comparison to only 42 annotated instances of interaction towards

the PM and 45 instances of self-referential interactions. Similarly, the medical practitioners group invested a bulk of their interactions towards the logistics group (83) and considerably less towards the PM (28) with a significant number of self-referential interactions (54).

From the above transition analysis, it can be deduced that the bulk of the arguments formed a triadic structure of interactions between the groups of PM, medical practitioners and logistics experts. These groups were, in turn, represented through their respective participants: L1, H1 and PM. The width of the lines in Figure 2 is calibrated to correspond to the frequency of transitions between the three domains. At the level of disciplinary groups, it is visible that the interactions between the medical protocol and process logistics were more intense in comparison with those between any of these two groups and PM. As such, the transition analysis contributes additional insights into leadership as an interactive practice as opposed to an individual achievement attributed exclusively to actor L1. We next elaborate this aspect in more detail in the light of knowledge-brokering practices.

Knowledge-brokering analysis

To analyse the knowledge-brokering interactions in the workshop, we compared the amount of peer interaction of each actor with the amount of interactions across disciplines. To this end, we implemented two analytical codes: one for domain self-referential and one for cross-disciplinary interactions. While the domain self-referential code symbolizes instances in which the actors would interact with their peers (i.e. medical protocols and logistics processes), the cross-disciplinary interactions occurred whenever actors would interact to a person outside their own domain. This analysis is summarized in Table 4.

From this analysis it is visible that PM was in the knowledge-brokering position from the outset of the meeting as his role was to address the interface between the domains of medical protocols and process logistics. However, the knowledge-brokering analysis also reveals that actors L1 and H1 took up the role of knowledge brokers on behalf of their respective

Table 4 Knowledge-brokering interactions

Knowledge-brokering mode	H1	H2	H3	H4	L1	L2	L3	PM
Domain self-referential (N)	23	11	14	6	21	9	15	23
Cross-disciplinary (N)	**59**	22	22	7	**97**	3	19	**70**
Domain self-referential (%)	28	33	39	46	18	75	44	8
Cross-disciplinary (%)	**72**	67	61	54	**82**	25	56	**92**

Note: Bold values indicate high activity actors.

domain teams. In this role, L1 and H1 provided a substantial amount of responding to their group peers and liaised between their respective groups and their counterparts in the workshop.

Moreover, since one person was representing the PM knowledge domain, the self-referential turns were observed as instances where the PM would finish explaining a particular point and then immediately continue with another one. Thus, the interactions were taking place at the interface between the knowledge domains, enacted by the knowledge-brokering roles of H1, L1 and PM. These actors contributed to the workshop with 59, 97 and 70 coded incidences of knowledge-brokering interactions, respectively. In relative terms, H1 spent 72%, L1 spent 82% and the PM as much as 92% of their activity on knowledge-brokering interactions.

Discussion

The findings point towards several specific features that arguably contributed to the observed emergence of leadership-as-practice. These features include (1) *domain knowledge ownership*, (2) *frequency of interactions*, (3) *actor responsiveness and* (4) *cross-disciplinary knowledge brokering*. The present section will further discuss each of these features.

First of all, it can be argued that the enactment of leadership corresponded to (1) *domain knowledge ownership* both at the inter- and intra-disciplinary levels. Leadership at the interdisciplinary level could be interpreted as an interplay between three main threads of discussion running in parallel. The regional hospital group was leading the discussion on the medical protocol for the diagnostic procedures, the process logistics research group was leading the discussion about the process workflows for each track of patients and the PM was engaged whenever an argument was needed for the rationale behind the floor plan. Not surprisingly, disciplinary domain knowledge can be considered as the equivalent of expert knowledge necessary for shaping as well as defending the arguments, around which the debate takes place.0

The link between leadership and domain knowledge ownership was also evident at the intra-disciplinary domain level. In particular, although all the actors were experts in their fields, actors L1, H1 and PM could be labelled as senior experts, being the most experienced in their respective groups (Table 1). Coincidentally, these three actors alone contributed to 70% of the workshop interactions. As a result, it can be argued that at the intra-disciplinary level, the thread of discussion was being 'owned' on the basis of actors' experience and seniority. Translated into leadership terms, one can

argue that strong domain knowledge ownership enabled actors L1, H1 and PM to take up leadership roles in their respective domains during this workshop.

Although leadership practices emerged at the level of the knowledge domains as well as across them, it is also interesting to examine the specific patterns in the dynamics of activity that can be attributed to the emergence of leadership. As a result of this analysis, we found that, regardless of the overall length of activity for specific actors, it was the (2) *highly frequent interactions* that shaped the arguments more prominently than prolonged and much less frequent turns. Translated into the workshop setting, this can be illustrated by comparing overall levels of activity and relative frequencies across actors PM and L1. Even though the overall amount of activity was higher for actor PM, L1 was much more frequent in his interactions, arguably contributing to the emergence of the perceived leadership more extensively. Similarly interesting is the notion of *high-frequency dyads* that embody a significant part of the overall transitions. More specifically, we found that these dyads comprise actors H1 and L1 as well as PM and L1. Given that a substantial amount of interaction occurred within high-frequency dyads, it is next worthwhile discussing how the individual actors contributed to these transitions.

To this end, we devised the construct of (3) *actor responsiveness*, as an interpretation for the level of inward-facing transition sequences attributed to an actor. Interpreting the workshop in light of the above construct, it becomes clear that actor L1 is represented in both identified high-frequency dyads with a level of responsiveness higher than that of H1 and PM. This, furthermore, suggests the potential existence of a link between actor responsiveness as a behavioural pattern and the phenomenon of emergent leadership under study. This, we believe, is an interesting finding that should be the focus of further research.

Finally, we also found a striking correlation between the (4) *cross-disciplinary knowledge-brokering* activity and the emergence of leadership perceived after the event. Disregarding the actor PM due to the fact that he was the only person in his knowledge domain, actors L1 and H1 were performing a bulk of the interactions in the knowledge-brokering mode, communicating either from their domain towards another one or responding to requests from different domains. We consider this finding particularly interesting and suggest that the relation between knowledge-brokering practices and leadership behaviour warrants further investigation.

In relation with the above findings, a number of further points for a productive discussion can be brought up. We would nonetheless like to single out two additional points: the emergence of *domain-specific leadership styles* and the *role of the architect* in the

leadership-as-practice analysis of the workshop. The reason to focus on these specific points is their undisputed centrality to interdisciplinary design in the AEC context and the fact that they did not emerge as a result of the formal coding scheme implemented for the video-based interaction analysis.

First, during our observations of the workshop and the subsequent interaction analysis we noticed a difference in the way the groups of medical diagnostics practitioners and process logistics researchers approached their critical evaluation of the layout. Arguably, this difference relates to the conceptual divide between the practical and academic ways of thinking and courses of action. This leads us to suggest that *domain-specific leadership styles* were enacted during the workshop. Along these lines, it can be argued that the process logistics leadership was *problem-based* in that the layout was critically examined every step along the way with the goal of identifying its shortcomings. This argument can be partially reinforced by examining the frequency, average duration and transitions-coded interactions all of which suggests that actors from this domain posed frequent questions about the diagnostic protocols and challenged the assumptions behind the design rationale. By contrast, leadership styles exhibited by healthcare practitioners as well as the PM can be more plausibly described as *solution-based*. Similarly, this argument can be partially reinforced by examining the frequency, average duration and transition codes for actors H1, H2 and PM. The analysis suggests that these actors were more prominently engaged in clarifications for various features of the medical protocol as well as the floor plan, rather than raising specific issues or shortcomings.

Second, we contend that any analysis of a design workshop in an AEC industry context would be incomplete, and potentially even flawed, without a discussion on the role of the architect. The final point, therefore, refers to the *role of architectural design activity* in the conception of leadership-as-practice that this study puts forth. Most importantly, we would like to clarify that the interaction-based concept of leadership-as-practice did not capture the role of architectural design given the absence of actors that would represent this knowledge domain in the workshop. It is, nonetheless, intuitively clear that architectural design played a key role in the workshop interactions and decision-making. In particular, even though the architect herself was absent—and therefore not included in the interaction analysis—the entire workshop was framed as a critical evaluation of the architectural layout for the facility. This would suggest that the architect was setting the context of the interactions, mediated by means of a drawing as a representation of the spatial layout for the facility. The architect's role in this specific workshop can, as a result, be formulated as the activity of setting the decision-making frame for

subsequent critical evaluation and problem-solving (Zerjav *et al.*, 2013).We moreover suggest that the interplay between cognitive framing and leadership-as-practice is yet another notion that arises from this study and deserves further conceptual and empirical work.

Conclusion

An increasing amount of research addresses various social phenomena in collaborative design of AEC project organizations (Harty and Whyte, 2009; Di Marco and Taylor, 2011; Dossick and Neff, 2011; Iorio *et al.*, 2012; Luck, 2012). Despite its importance, the role of leadership in collaborative design of AEC projects, however, remains a by and large unexplored area. In line with the some of the recent developments in leadership literature (Raelin, 2011; Alvesson and Spicer, 2012; Tyssen *et al.*, 2013; Brown, 2014), this study proposed a leadership-as-practice view on design in AEC project organizations. This view considers leadership as an emergent phenomenon that occurs through practices of interaction and relationships between diverse actors as opposed to an achievement by the supposedly successful leader-individual.

Overall, the interaction analysis suggests that leadership evolved as a set of interactive practices across multiple domains of expert knowledge. The main findings arising from the incidental episode of emergent leadership, analysis of interaction dynamics, transition analysis and knowledge-brokering analysis suggest that several factors arguably contributed to the observed emergence of leadership through interactive practices: (1) *domain knowledge ownership*, (2) *frequency of interactions*, (3) *actor responsiveness* and (4) *cross-disciplinary knowledge brokering*.

Overall, the analysis reinforces the idea that, indeed, leadership can and should be viewed as an opportunity, a situated and emergent interactive phenomenon rather than an inherent characteristic of invariably charismatic individuals and their supposedly heroic achievements (Brown, 2014). When defined in such a multifaceted way, we believe that the emergence of leadership-as-practice as it occurs in project organizations becomes one step closer to our understanding. This, in turn, has the potential to greatly enrich the existing leadership studies in engineering and construction project organizations (Fellows *et al.*, 2003; Giritli and Oraz, 2004; Ofori and Toor, 2009; Kasapoğlu, 2010; Müller and Turner, 2010; Leicht *et al.*, 2012; Skipper and Brandenburg, 2013). Having said that, however, it should be mentioned that positioning this study in contrast with the personality-based leadership studies does not imply that the aim of the study was to dismiss either the personality-based or any other stream of inquiry

into leadership. On the contrary, it is to complement and enrich existing knowledge with an alternative perspective that provides useful descriptive and explanatory insights into the phenomenon under study. As a result, a pragmatic perspective that focuses on advancing project practices, even at the expense of losing a degree of construct formality in the sense of the traditional scientific inquiry, is the best-suited lens for interpreting the findings of this study.

Having discussed the contributions, it is also important to contend that the theoretical and practical implications of this interpretive and inductive study have technical limitations in terms of their generalizability. One example of such an issue is the question whether the 52-minute long snapshot of the analysed workshop could be considered a representative sample of the interactions over the entire life of the project. To answer this question, we would like to reemphasize our interpretive angle for this inquiry and clarify that achieving statistical generalizability was never the intention of the study. By contrast, the purpose was to begin developing and to present a novel interpretive framework for leadership in design of AEC projects.

As a result, we contend that the findings of this study warrant further empirical treatment, which should be the role of future studies in this domain. Of the findings directly arising from this research, particularly interesting would be to pursue follow-up inquiry into the relation between leadership-as-practice and behavioural patterns of responsiveness, cross-disciplinary knowledge-brokering activity and cognitive practices of framing.

More broadly, we would like to acknowledge the need to perform empirical studies on the emergence of leadership-as-practice in a wide variety of settings, of which collaborative design AEC is only one case. Given that the subject matter is in its infancy, we suggest that future studies should attempt to achieve more robust, generalizable and testable theory through multiple cases and, eventually, large-scale hypothesis testing studies to examine relative empirical importance of the theoretical constructs that began emerging in this study. Insights from this line of inquiry should eventually lead towards a more profound understanding of the collaborative decision-making in complex social settings that are epitomized in many engineering project organizations.

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