Problem- And Solution-Based Leadership Styles: A Study Of Collaborative Design Workshops For A Diagnostic Center

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PROBLEM- AND SOLUTION-BASED LEADERSHIP: A STUDY OF COLLABORATIVE DESIGN WORKSHOPS FOR A DIAGNOSTIC CENTER

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ABSTRACT
Although general project management literature abounds with references to leadership styles and project outcomes, the existing studies have, by and large, disregarded the dynamics of leadership that is often evidenced in practice of collaborative design workshops. By drawing from the fields of design studies and leadership literature, in this paper we derive a theoretical framework for micro-level leadership in the context of collaborative design workshops. The framework distinguishes between the two fundamental design tasks of problem formulation and problem solving and sets out the problem- and solution-based leadership styles to accomplish these tasks. The paper illustrates the descriptive value of the framework by providing empirical evidence from an interpretive study that encapsulates three months of extensive involvement with the management team for a building design reconstruction project of a medical diagnostic center in the Netherlands. The interpretive study elaborates two collaborative design workshops that employed different leadership strategies leading to different patterns of interaction and outcomes. The findings suggest that the workshops featured problem-based leadership to facilitate the process of problem formulation and solution-based leadership to achieve convergence in the problem-solving stage subsequently. The relevance of the findings to the EPO domain pertains particularly to the notion of problem-based leadership that is normally not taken into account as a management strategy. Consequently, the study argues for soft skilled project management that employs different leadership styles to accommodate different emergent circumstances in EPOs.

KEYWORDS: collaborative design, design management, leadership, ethnographic study, interpretive analysis.

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INTRODUCTION

Due to the high complexity of an increasing number of projects delivered in various sectors worldwide, the efficiency of the design organization in such projects is becoming a subject of interest among both academicians and practitioners alike. This is even more the case for projects in the architecture, engineering and construction (AEC) sector that in many cases epitomize the complex social settings in which interdisciplinary design is produced. The implementation of collaborative design concepts is becoming increasingly commonplace in a variety of projects that involve numerous stakeholders and fields of design expertise. During the collaborative design effort, the solutions are jointly negotiated by the participating parties with the intention of coming up with a solution that meets the objectives of all the stakeholders.

The implementation of collaborative design is, however, a particularly challenging effort as the contributions of different participants are numerous and often interdependent. One of the main consequences is the development of the design management role with the responsibility of leading and managing the execution of the interdisciplinary process (Gray and Hughes 2001). The collaborative design is then implemented in the form of workshops where the participants work towards the solutions under the project manager’s supervision. Although the above described approach is used in practice relatively often, relatively little theoretical knowledge exists on how the effort of collaborative design is and should be organized. We further introduce an overview of selected studies in the area of design organization.

Studies of the Design in AEC

Within the domain of design studies, a long-standing stream of inquiry exists that aims to explain the design process from the perspective of the individual designer’s thinking (see, for example, Lawson 2005; Cross 2007). This stream of design research addresses the tasks of creative problem-solving by using concepts from the domain of interdisciplinary cognition research. Some of the more recent developments from this camp point towards the concept of design as a co-evolving problem-solution. This specific concept was firstly put forth by Maher and Poon (1996) and subsequently elaborated in a study involving industrial designers by Dorst and Cross (2001). The concept of problem-solution co-evolution acknowledges that both problem formulation and problem solving are inherent parts of the design process, albeit of largely different nature.

Some of the more recent design-related studies in the AEC domain focused on, for example, constructability (Fischer and Tatum 1997; Arditi et al. 2002; Pulaski and Horman 2005) design-build delivery methods (Xia et al. 2011), design errors (Lee et al. 2006; Han et al. 2011; Lopez and Love 2011), methods of concurrent design (Bogus et al. 2006; Bogus et al. 2011), sustainable design (Swarup et al. 2011; Kovacic and Sreckovic 2013), and the application of lean concepts (Aquere et al. 2012; Ballard and Tommelein 2012).

While the above studies focus on the macro-level organization of design, a separate stream of research has been dealing with the micro-level design organization. This particular stream is undergoing a rapid development with an increasing number of studies that provide rich descriptions of design from a social perspective (Luck 2012). Some of the examples of these studies include an explication of design interactions through boundary spanning practices (Di Marco et al. 2010; Di Marco et al. 2012; Iorio et al. 2012), as well as the use of boundary objects
that enable both structured and unstructured interactions labeled as hybrid practices (Whyte 2011) and messy talk (Dossick and Neff 2011).

These studies provide valuable insights about the knowledge organization at the micro-level of the design process, where a number of specialists needs to interact across boundaries of disciplinary knowledge domains. Furthermore, the above studies share a fundamentally descriptive character in that they aim to demystify the phenomenology of the design process, rather than to provide explicit guidance on how to manage and lead the collaborative design in organizations. This is most likely the case due to the entangled nature of the design process that does not lend itself to sparse normative concepts.

There is, nevertheless, a high demand for managerial concepts that can be implemented in the context of collaborative design. This particularly refers to the so-called soft skills of management of which leadership is a prime example.

Leadership Studies

The current body of leadership literature can be labeled as a nuanced field of inquiry that examines the relationships between leadership styles and various situational variables. These studies include, to name a few, the relationship between project characteristics and leadership styles (Müller and Turner 2007) or the competences needed for successful projects (Müller and Turner 2010). A meta-analysis by Burke et al. (2006), moreover, delineates between transactional, structure-initiating and boundary-spanning behaviors in the task-focused leadership.

Of particular relevance for collaborative design is the study where Davis and Eisenhardt (2011) address the issue of revolving leadership roles that occur in the context of innovation projects. In this study, they contend that innovative collaborations employ a rotating leadership process, in which various collaborating organizations assume leadership roles in various phases of these projects. This implies that the task at hand will determine the conditions for the leadership role.

Construction literature similarly abounds with leadership-focused studies. Although most of them have an intercultural focus (Fellows et al. 2003; Giritli and Oraz 2004; Ofori and Toor 2009), there is an emerging research stream that transposes the macro-level leadership studies to the firm or project level (Cheung et al. 2001; Kasapoğlu 2010). These studies focus on the acceptance of different leadership styles, most notably: participative and charismatic, by the team members. Other research is focused on the influence of emotional intelligence in relation to team performance (Leicht et al. 2012; Skipper and Brandenburg 2013).

Although both the design studies and leadership-focused studies form a significant body of knowledge, the overlaps between the two fields are very seldom. In particular, no studies could be identified that address the features of leadership at the process-level collaborative design of construction projects. Consequently, very little is known about the role of leadership in mobilizing the participants’ contributions to the design decision-making process and reaching consensus about the developed solutions.

This paper aims to address this gap by integrating some of the recent developments in design research with leadership studies. To this purpose, the paper will develop a theoretical framework that draws from general design research as well as team-level leadership studies to substantiate a descriptive framework for leadership in the collaborative design process. The explanatory usefulness of the derived theoretical framework will be illustrated subsequently with findings from an interpretive study involving two collaborative design workshops in the context
of a building design and reconstruction project in the Netherlands. The paper concludes by discussing the findings and suggesting avenues for further research.

DEVELOPMENT OF THE ANALYTICAL FRAMEWORK

To develop an analytical framework for leadership in collaborative design, we substantiate the notion of design as problem-solution co-evolution (Dorst and Cross 2001) and the notion of situational leadership based on the task at hand (Müller and Turner 2007; Davis and Eisenhardt 2010). The notion of design as a problem-solution co-evolution concept sets forth that the two fundamental design tasks are problem formulation and problem solving. Each of these tasks occurs in its own domain but they are interconnected and thus indivisible at the level of cognition. Because the tasks in the co-evolution concept are mutually supportive, this representation of the design process also explains its iterative nature as well as the leaps between the problem and solution domains during the problem-solving effort.

It is, however, precisely because it describes cognition, and not action, that the concept of co-evolution has thus far received relatively little empirical support. Since collaborative design is an interactive activity that can be observed in reality, the goal of the analytical framework in this study is to translate the co-evolution concept at the level of observable action that can be analyzed and steered. The framework will, therefore, seek to substantiate the problem-solution co-evolution concept at the level of collaborative design. The purpose of this level of analysis is to substantiate the basic leadership concepts into the theoretical description of the design effort.

This framework hypothesizes that, to bring the collaborative design process to an end, a leadership strategy needs to take into account the basic tasks of the design process. We propose the following leadership strategies to achieve this.

- Problem-based leadership is used when the design process is in the problem formulation domain. The goal is to solicit the contributions that will provide a broad context of the problem to be solved. In collaborative design, this means encouraging a critical reflection on the problems. Multiple perspectives on the problem should be sought by mobilizing the stakeholders who have their unique perspectives of the problem.
- Solution-based leadership is used when a transition is sought between the problem and the solution. To guide the collaborative design process through its problem solving activities, a structure of tasks should be put into place to achieve the convergence of the process.

According to this representation, collaborative design employs a combination of problem- and solution-based leadership in the form of discrete steps.
Figure 1: The hypothetical framework for collaborative design leadership modes

Figure 1 depicts how the hypothetical framework operates in a collaborative setting. The process begins with a problem that leads to the first instance of problem solving, which reaches a first solution. After the first solution is reached, additional insights into the evolving design become available. These insights will warrant another instance of problem formulation, which will, finally, conclude the design decision-making cycle with the last instance of problem solving.

The tasks of problem solving and formulation are central to this representation. Correspondingly, these two tasks will warrant a leadership strategy on both sides of the framework. Consequently, the two types of leadership occur interchangeably in the design process. As a result of this interplay, design eventually converges towards its final solution.

The goal of the analytical framework in Fig 1 is to facilitate the understanding of the leadership behavior that occurs in the context of collaborative design. The aim of the following sections is to illustrate the analytical framework by using empirical data from an ethnographic study of collaborative design.

**RESEARCH METHODOLOGY**

We conducted a grounded research study on a project involving design and construction of a medical diagnostic center located on a campus of a Dutch University. The strategic purpose of the project is to become a globally recognizable center for innovative medical imaging combining research, education and clinical activity. The scope of the project involved a redesign and renovation of an old university building and adapting it to the functions of the new center. For this purpose, a number of stakeholders from the sectors of education, research, and clinical practice were involved directly in the design decision-making processes of the project. These decisions were, in turn, based around the main disciplines of medical imaging represented in the building: non-invasive methods and optics, medical imaging informatics, computed tomography and X-ray, magnetic resonance imaging, and nuclear and molecular imaging.

This setup made the design effort particularly challenging due to the different interests of the involved stakeholders. The project management (PM) organization had two permanent
members, responsible for both the design as well as the construction stage of the project. Due to
the complex setup of the design organization, the PM team organized regular meetings with
clinical, academic, and research representatives of all the represented disciplines to discuss
various issues regarding the new facility. One of the most important of these issues was how to
address the business strategy in which the center will be used for clinical purposes of the two
local hospitals that agreed to refer a certain number of their patients to the center to perform
different types of diagnostic tests in the future. In this context, the meetings were focused on the
fit between the architectural layout of the facility and the medical process which the building
should host. Since different hospitals did not have the exact same process, negotiating the
common solution was a challenging task. The case study presented in this paper will be focused
on this issue.

The data was gathered during a close involvement of the researchers with the project
management team in a time span of three months. The goal of this intervention was to support
the design process for the new facility with innovative modeling approaches and workshop
design in the context of collaborative decision-making. Two researchers were involved with the
design team of which one was responsible for the modeling, and one for workshop design. Most
of the researchers’ involvement with the PM team was in the capacity of analyzing the
architectural layout of the building in the context of the processes and supporting the interactions
during the collaborative meetings.

As part of the design process, the PM team organized and conducted two collaborative
design workshops with the purpose of adjusting the architectural layout of the future health-care
facility with the envisaged medical processes. The participants of the workshops were selected
representatives of the health-care profiles involved in the operations of the center, operations
research optimization consultants, medical equipment representatives, and the management team
of the project. The two workshops were organized in a time span of three months and the final
goal was to reach a decision about the final layout of the facility. The task of the researchers was
to observe the interactions occurring in the workshops in a non-intrusive ethnographic manner.
To achieve this, the researchers setup video recording equipment in the meeting room and
passively listened to the discussions while taking notes. The goal of this approach was to achieve
conformance with methodological guidelines for conducting ethnographic research in the context
of grounded theory building (Strauss and Corbin 2007).

Between the two workshops, the researchers worked closely with the PM team to address
the issues raised during the first workshop. This collaboration took place in the form of multiple
meetings with the managers who, concurrently, were interviewing other workshop participants
individually to better understand their requirements. Furthermore, a change request was issued to
the responsible architectural office that, as a response, implemented a number of changes into the
current version of the layout.

After the second workshop, the video material was analyzed through a preliminary open
coding of emerging categories. The categories were extensively discussed internally within the
research group to scrutinize the interpretation of the data as much as possible. The subsequent
parts of the paper present the findings of the open coding session. In presenting the findings, we
will implement principles of interpretive research to accomplish the best consistency between the
narrative and the previously derived theoretical framework (Walsham 2006).
KEY FINDINGS

The preliminary findings of this research suggest different outcomes or the two observed workshops. Although both workshops formed part of the same stream of design decisions, their social setting was different and, as this study hypothesizes, this led to different outcomes in the workshops. More specifically, we set forth the argument that the first workshop escalated into a problem-based leadership mode, while the second one was kept solution-based. Although the interactions in both workshops were oscillating between problem and solution domains, the leadership of the process determined the outcomes of the workshops.

1st Collaborative Design Workshop

The idea that the PM envisaged for the first workshop was to gather the representatives of the involved clinical disciplines and to solicit their feedback on the existing version of the design solution. In particular, the goal was to enable the interaction between the participants in such a way that they would point to the possible shortcomings of the established architectural layout in terms of the medical process and, if needed, come up with creative suggestions for a better alignment between the two. Since the design concept 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 facilitate the discussions by providing expertise in the area of health-care processes. 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 went as follows. After the participants introduced themselves, the PM explained that the purpose of the workshop was to align the process workflow with the architectural layout of the building. More specifically, if the participants would have observed any inconsistencies in the layout with respect to the processes, they were asked to suggest changes for the floor plan.

The participants were then given the task to discuss the workflows for the MRI, CT, and PET/MRI devices, while the PMs discussed the details of the procedures for each of the devices with a member of hospital personnel separately. This created two parallel streams of discussion in this workshop. The main group was discussing the floor plan standing up in front of a large board with a copy of the floor plan attached to it.

*Escalation of Problem-based Leadership*

The flow of the main discussion was difficult to follow as participants were posing questions in multiple threads and on very different levels of analysis. The basic parameters of the processes were not clarified to the participants, which caused the discussion to disperse around speculations concerning the assumed number of patients per track and the inter-arrival times.

This lack of clarity was the reason for the emergence of the health-care logistics expertise to assume the leadership role in most of the workshop discussions. The role of the PM was for this purpose relatively marginalized, with their contributions limited to providing arguments for the given aspects of the design rationale. Some of the key issues raised in this manner concerned the estimated number of patients to be treated in the facility, the size and number of the 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 (Figure 1).
The PM was providing input on these issues without taking active control of the flow of discussion. The following is an excerpt of the discussion that demonstrates the escalation of the problem-based leadership embodied in role of the health care logistics expert.

*Logistics expert*: 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]*?
*PM*: I don’t know… I think it should be 3 per hour… MRI? *[looks around and asks for reassurance from the assistant PM and hospital specialists]*
*Logistics expert*: 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]*?
*PM*: [Turns to the specialists from the hospital and asks them: ], How many? One per hour?

*Healthcare specialist 1*: Two per hour.
*Logistics expert*: This is then… there are nine patients per hour walking around this area *[points at the MRI and CT area]*
*Healthcare specialist 2*: For the CT it is about forty patients per day.
*Logistics expert*: 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]*
*PM*: Well, *[indistinguishable]…* No.
*Logistics expert*: I am thinking, if 30 people are sitting here *[points to the waiting room]*, then it is full. So the people come in from here *[points to the entrance of the building]* and they go to the dressing rooms *[points to 4 dressing rooms adjacent to the lower part of the waiting*
...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]

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

Logistics expert: Yes, but these people will also wait here? [points at the waiting room]

PM: Yes.

Logistics expert: [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?

PM: I believe so.

Healthcare specialist 1: Yes

Logistics expert: Do you always know this?

Healthcare specialist 1: Always. We ask this in advance… how mobile the patient is… we know if the patient is sufficiently mobile to come on their own.

Logistics expert: [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?

[multiple people laughing]

PM: [laughing] No.

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

We found it interesting to notice that all of the issues raised in the workshop concerned different perspectives of the problem which was, consequently, perceived as vague in this context. Along the lines of the theoretical framework presented previously, we label this as a case of problem-based leadership. The problem-based leadership emerged during the workshop, contrary to the initial intention of the PM, which was to essentially reach consensus on the solution being presented.

Since no conclusion was reached about the issues raised during the session, the PM decided to organize a second workshop session. The second session, however, was decided to be carefully planned and managed to achieve the closure of the discussion initiated with the first collaborative session. As a result, the researchers worked closely with the project management team to prepare a solid basis for conducting the second workshop session. During this effort, the researchers developed a simulation model of the diagnostic center as well as a collaborative game that were designed as tasks to focus the forthcoming discussion on. The development of the solution-oriented tasks is described in the subsequent subsection.

**Process Analysis and Workshop Design**

The design changes to be addressed concerned the number of the dressing rooms as well as with an altered arrangement of the imaging functions in the floor plan. The two researchers assisted the PMs with estimating the capacity of the facility to accommodate the processes and the structure of the workshop to be held subsequently. With the input from the business plan and information that the PMs obtained from the medical personnel, the researchers assembled a deterministic model of the medical processes in the center. The purpose of the model was to help validate the architectural layout of the facility against the medical workflows. The model implies that during a regular working day, the capacity of the facility is able to accommodate the
processes. The model also provides insights about several scenarios for the utilization of the center. These scenarios cover different combinations of 2 compared to 3 working days per week on the one hand, and 8 vs. 12 working hours, on the other. This analysis provided information about the utilization rates for the various groups of dressing rooms utilized for different devices (PET, MRI, CT). The recommendations from the process analysis are:

- The number of dressing rooms could have been reduced
- MRI device has been shown to work with more capacity than other devices
- ECHO devices has been shown to work with less capacity than other devices

As further support for the solution-focused process, the researchers also developed a simple tool – *the knitting game* - that consists of the floor-plan attached to a soft-board with colored pins and strings. The idea behind this tool was to attach the pins in the specific points of the floor-plan to represent the physical flow in the facility. The participants would then use the string to connect the path between the fixed points and analyze the workflow in the facility. The different flows are represented with different colors of the string: patients, staff, clean material, and waste.

With the help of the developed models and tools, the PMs had the idea of guiding the subsequent workshop in a more focused (i.e. solution-based) way than the experience of the first workshop. More specifically, the explicit intention of the PM was to conclude the participatory decision-making with the second workshop.

**2nd Collaborative Design Workshop**

The second workshop was hosting a total of 18 participants who represented both clinical user organizations, the architectural firm responsible for the design and the medical equipment organization. The workshop also hosted the process logistics consultant and the researchers of the current study.

The goal of the workshop was to achieve consensus among the participants regarding the changes implemented in design to address the issues identified in the first workshop. Due to the importance of reaching a common agreement by the end of the workshop, the second workshop was organized in a more formal setting than the first one. The flow of the workshop was such that the PM specifically enumerated each issue raised in the previous workshop and elaborated how it was addressed in the current version of design. Furthermore, the process model was introduced in the beginning of the workshop to set the stage for the upcoming solution-based session. To conclude the introductory session of the workshop, the researchers explained the reasoning behind the boundary object to support the collaborative session.

The PM subsequently divided the workshop participants into two groups and assigned each group a different task: one to discuss the patient flows for the MRI and one for the CT device. In the remaining part of the workshop the two groups were given the toolkit for the knitting game, but only one group actually used it. The group that used the knitting game was discussing the workflow, while keeping the floor plan as given. The group that did not use the knitting game was focused on the layout and they suggested a number of change requests. The two groups then jointly negotiated a number of change requests for the current version of the layout.

*Implementation of Solution-based Leadership*

During the discussions with the designers a host of new issues were being reopened, but the PMs directed the discussion to only the aspects addressed in the first part of the workshop.
This allowed the designers to come up with some quick fixes by directly sketching changes in the floor plan and taking notes of how to address these issues in detail (Fig 2).

In one instance, an issue was raised about patients who undergo a particular type of CT examinations. One of the consequences of this issue is an insufficient number and a suboptimal arrangement of dressing rooms. The issue was raised by a healthcare specialist who participated in the workshop and the following is an excerpt of the interactions around this issue.

_Healthcare specialist 1:_ It is enough to have 4 dressing rooms, there is also enough space.

_PM:_ If you need more, we can make the consultation room smaller.

_Logistics expert:_ If somebody comes here on a stretcher _[points at one of the dressing rooms]_, if you make here two short and one long and here three short and one long _[points at the area with the dressing rooms]_, than if one stretcher goes through and another one comes in, there should be no problem.

_Healthcare specialist 1:_ This is not likely to happen.

_Logistics expert:_ But it is not a problem for the space to make the two _[dressing rooms]_ longer. So if you shorten this one, this one and these three… and lengthen this one and this one _[shows them on the floor plan]_, then you create two sections.

_Healthcare specialist 1:_ But then if these two long ones are next to each other… if you need more space to make the turn… then you need more space here to move _[points at the area adjacent to the dressing rooms in question]_.

[at that point, of the discussion, they discovered that the process that requires the stretchers would block the movement around the corridor. Everybody seemed to have agreed that this was a problem and that they needed to keep the passage clear.]

_PM:_ So what do we do then?

_Healthcare specialist 1:_ _[takes a piece of paper and a pen and starts sketching]_ The idea was to place the technical room like this, the CT scanner like this, and the lab assistants’ room,
here is the lift, and the dressing rooms like this. The small ones are 1.5 times 2 [dimensions in meters] and broader ones 2.5 times 2.

Architect 1: And where should we put the toilet?
[Indistinguishable - multiple people commenting]

Healthcare specialist 1: [continues drawing] So here we put two longer dressing rooms with the room for the bed in front, and here another two. So it will be two small dressing rooms with a toilet, two dressing rooms with the beds, and another two small dressing rooms here. [Points at the lower part of the drawing with a row of the dressing rooms next to each other]. Here you have the CT, MRI, the technical room, maintenance room [points at the upper part of the drawing with the rooms being addressing in a row next to each other]. There is enough space to move around [draws the moving lines from the dressing rooms to the rooms with devices].

Healthcare specialist 2: It is also safe for the lab assistants because they have a shorter path.

Healthcare specialist 1: Yes.
Healthcare specialist 2: Where is the technical part for the CT?
Healthcare specialist 1: Comes from this side.
Healthcare specialist 2: But where do you keep it?
Healthcare specialist 1: This is up to [the equipment manufacturer firm name].

[The interactions at this point evolved in the direction of solving the technical setup of the CT device. Several medical practitioners are involved in this interaction together with the representative of the equipment manufacturer.]

Once the PMs assessed that all the issues have been sufficiently discussed, the PM brought the discussion to a close by asking the participants directly to point out any additional requests besides the ones being already addressed. This approach, finally, allowed the project manager to conclude the meeting with a consensus on the final design solution.

What was specifically interesting to observe in the second workshop was that, when the PM would notice that a problem was being pointed out and that the discussion was sinking into a reflective silence, he would call for a resolution by posing the question similar to “So, what should we do about it?” The question was always posed in a tone that requests a prompt answer rather than reflection. We noticed that every time this happened, it introduced a spin in the discussion and turned it towards the solution rather than problem domain. In conclusion, and along the lines of the theoretical framework presented previously, the second workshop was led in a solution-focused way. We continue the paper with further discussing the implications of the preliminary findings.

**DISCUSSION AND CONCLUSION**

Although their nature is preliminary, the findings of this study point to several implications. Most importantly, the study provided an illustration of the impact of leadership on decision-making in collaborative design, an area thus far not represented in engineering project organization literature. Existing leadership studies in the context of project management have either focused on leadership characteristics of successful managers or on the required leadership skills given the project characteristics. None of these studies focused on the micro-level dynamics of leadership in the context of collaborative decision-making. This study achieved this by using the setting of collaborative design to set out a micro-level concept of leadership in collaborative decision-making. The framework posits that, given the dual nature of design
activity, problem- and solution-based leadership can and should be observed in the context of collaborative design.

The most surprising finding of the study appears to be that, besides the intuitively accepted notion of solution-based leadership, a problem-based type of leadership emerged in the interpretive case study. Although unintentionally, the problem-based leadership role formed an inherent part of the process and contributed to the formation of the final collaborative solution. As such, the main practical contribution of the study is that, instead of invariably going for the solution-based leadership style, managers should balance between the two types of leadership in collaborative design. By providing additional leadership in the domain of problem formulation, we suggest that the likelihood of creative solutions will increase as will the likelihood of achieving a consensus about the final design. We, nevertheless contend that the theoretical and practical implications of the study warrant further empirical treatment due to a relatively conceptual nature of this study.

We, furthermore, would like to discuss several issues that might have appeared throughout the presentation of this study. The first such issue pertains to the different theoretical levels, which the theories of leadership and design as problem-solution co-evolution focus on. We acknowledge that the concept of co-evolution is not a reductionist one and, as a consequence, that separating the tasks of problem formulation and problem solving in a clear-cut manner is not possible. We, nonetheless, assert that in a collaborative setting, the design process warrants a reasonable amount of leadership and management that should have a sound theoretical basis. Since we believe that the co-evolution concept has such properties, we decided to implement it to argue for the dynamics of leadership at the level of collaborative design.

As a corollary of the previous issue, we acknowledge that, although the first workshop was presented in light of the problem- and the second one in light of solution-based leadership, the two workshops obviously contained instances of both styles. However, for the sake of presentation fluency, we chose to use the workshops as units to attribute to the leadership styles in the theoretical framework. We did, indeed, find that the data from the first workshop abounded with references to problem-based leadership, as much as the second one did with references to solution-based leadership.

Future studies should address these issues in more detail. We particularly acknowledge the need to perform empirical studies on the emergence of leadership styles in a wide variety of collaborative decision-making settings, of which collaborative design in EPO is only one case. Given that the subject matter is in its infancy, we suggest that future studies should first implement interpretive phenomenology, followed by more in-depth quantitative and computational studies of decision-making behavior. An example of future studies would be to study the role of problem- and solution-based tasks in collaborative design interactions and derive an in-depth model of the dynamics between the leadership styles in the on-going effort.

In conclusion, we believe that leadership in collaborative design is an important and valuable path of inquiry worth pursuing in the context of EPO and beyond. Insights from this line of inquiry should eventually lead towards not only a more profound understanding of the collaborative decision-making in complex social settings that are epitomized in many infrastructure projects, but they should also help in streamlining the collaborative design processes for a more socially-sustainable built environment globally.
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