CAN PROCUREMENT AFFECT DESIGN PERFORMANCE?

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Abstract

There is an emerging view in the construction industry that better performance or better value for money can be achieved by integrating teamwork for planning, design and construction of building projects. There are though, two opposing perspectives regarding how changes in traditional design practices should occur. Advocates of sustainable construction in North America posit that it is a matter of evolving processes, moving from a sequential to an iterative approach to design, whereas the British government supports the view that a change in how projects are procured is required to transform the context that dictates relationships among the members of the team. The objective of the research is to study the influence of procurement on the performance of integrated design teams. It analyses, through case studies representing these two perspectives, the influence of procurement on the performance of integrated teams. The research is conclusive in that it is the context created by contractual relationship, and not the process set up for conducting integrated design, that most influence team efficiency. It demonstrates that traditional procurement processes reinforce socio-cognitive barriers that hinder team efficiency. It also illustrates how new procurement modes can transform the dynamics of relationships between the client and the members of the supply chain, and have a positive impact on team performance.

Keywords: Integrated team, integrated design; Procurement; Team dynamics

Introduction

Problems for productivity, quality and predictability in construction are well documented. Authors (Dupagne, 1991, Huovila *et al.*, 1997) relate these problems with the fragmented and sequential approach to design and delivery of construction projects which leads to sub-optimal solutions, poor constructability and operability, rework in design and construction, and lack of innovation.

Three solutions derived from best practices in manufacturing are suggested to tackle these problems. The first group suggests that it is a process problem that can be solved by redefining the design process from sequential to iterative (Larsson, 2002, Löhnert *et al.*, 2002). The second group argues that the problem is one of context, advocating abandoning fragmented and transactional procurement routes to new ones aimed at encouraging collaboration and innovation of integrated and relational procurement by transforming the relationship between the client and its supply chain (Egan, 1998, Latham, 1994). It advocates the creation of integrated teams. The third group suggests to break geographical and temporal barriers between firms and phases that hinder collaborative work by linking distributed work within an integrated virtual environment (Eastman *et al.*, 2008). However, as demonstrated in theory and research on information technology, technology itself cannot transform practices. Process reengineering leveraged by technology is required both at organizational and at the business network levels to successfully achieve integration of work (Hammer and Champy, 1993; Henderson and Venkatraman, 1999). Recent research on the use of Building Information Modeling in

construction confirms this assertion (Froese and Aranda-Mena, 2008).Therefore, the paper focuses on the two first solutions.

However, the theoretical and empirical foundations of these solutions remain shallow. Koskela's (2000) theory of production was used as a theoretical framework to get a better understanding of the influence of procurement on the performance of integrated design. This theory provides a theoretical framework providing a triangulation of three views – transformation, flow, and value generation to analyze the performance of the proposed solutions. Organization of work in design and construction is not structured around processes, but divided between specialized practices and specialties. As stated by (Huovila *et al.*, 1997) this work structure performs poorly in managing flow, or meeting client requirements. Koskela *et al.* (2006) also contend that the incapacity of the industry to move from sequential to integrated design resides in the adversarial business context created by transactional contracting methods. In a transaction, the seller is bound to delivering to the buyer a specified outcome for an agreed price. Risk and responsibility of results are on the shoulder of the seller, who has no incentive for collaboration with other contract parties in defining the solution that will best meet expected results. Relational contracting is based on recognition and striving for mutual benefits between the parties. This type of contract is usually long-term, develops and changes over time, and involves substantial relationships between the parties.

The aim of the research is to analyze how procurement influences the performance of integrated design in construction. The objectives are first to identify the socio-cognitive factors that affect the performance of integrated design teams, and second to establish the effects of transactional and relational contracting on these socio-cognitive factors. The design process and outcome of two projects - the first using a traditional transactional approach, the second a new relational procurement approach - were investigated. Research results describe how procurement can affect the dynamics of the team by creating a context that encourages or hinders collaboration and innovation.

Process versus Context Approach to Integration

Integrated design was devised during the Second World War to speed up the development and construction of new complex weapons. It proved to drastically reduce the time to market and product development costs, while delivering superior products. It is why it was widely adopted by the manufacturing industry in the 1980's. Integrated design was only introduced in construction in the beginning of the 1990's for the design of sustainable buildings to solve problems in the sequential design process, which was generating sub-optimal buildings at higher costs. This proposed new design process shares with sequential design and delivery the breakdown of the project lifecycle into a series of phases marked by milestones, during which interim deliverables (brief, concept, preliminary design, working drawings) are reviewed and approved. It differs in the organization of the work to produce these deliverables. In a sequential process, problems are distributed among people that work and develop systems in isolation. They meet only for coordination purpose. Members of the project teams will change from phase to phase. There is little opportunity for optimization. (Larsson 2002).

Core principles of integrated design include strong client leadership by establishing clear goals and objectives, a multi-disciplinary approach involving active participation of client, builder, operators and users of the future building to the design during the whole project lifecycle, and continual learning to address all design issues flowing from the objectives (Larsson, 2002, Löhnert *et al.*, 2002, Zimmerman, 2006). Whole system thinking and whole lifecycle costing are priorities. The core of the team effort is invested in the early stage of the project. The design process is not linear but utilizes iteration loops for problem-oriented analysis and optimization of design alternatives (Löhnert *et al.*, 2002). The building is first outlined as a holistic system

which is partitioned at each step into finer and finer elements, whilst the sustainability requirements start at a highly abstract level to become more specific for the lower-level elements. A sustainability benchmarking based on sustainability targets is done at the end of each iteration, providing feedback loops to refine the proposed solutions. Integrated design process mapping and tools have been proposed to the industry to support the transition from existing to this desired organization of work.

The British government has adopted a different route to integration. Two seminal reports (Latham 1994, Egan 1998) relate the construction industry's poor performance with adversarial procurement practices. They condemn these practices as creating the context that led to the industry's high fragmentation, lack of quality outputs, and low productivity. They also contend moving forward to new forms of procurement context that encourages continuous improvements waste reduction through the integration of teams and supply chains (StrategicForum, 2003, Comptroller and Auditor General, 2001). It is assumed that the integrated collaborative design that is emerging from this new context will set design as the common thread linking organizations together (Austin, 2001). Procure-21 framework is considered as a model for the construction industry in the application of Egan's key value drivers (NHS, 2005): committed leadership using trained and certified project directors; customer focus through appointed and trained design champions; integrated teams using an integrated process within integrated supply chains; a quality-driven agenda through programme management, benchmarking, and continuous improvement processes; commitment to people by the involvement of stakeholders (staff, users, and patients) throughout the project lifecycle.

These two views converge in their aim to deliver superior value by assembling, integrating, and harnessing all the collective skills and capabilities of clients and their supply chains. Both views, however, fail to consider or address the socio-technical problems affecting the performance of multidisciplinary teams. Integrated teams in construction are usually coalitions of representatives from various organizations that have different cultures and organization of work. They are often brought in together for the first time and are assigned to the project on a temporary basis. In contrast, integrated teams in the manufacturing industry are usually teams that have worked together for a long time on multiple projects. They share the same culture and organization of work and design processes. This is why there is a high risk that design coalitions may not perform as well, or even be dysfunctional. Recent research on intra-teams boundaries within design-build projects (Moore and Dainty, 2001) supports this assertion. There is a need to provide a better empirical and theoretical ground to understand the dynamics of integrated teams in construction and the influence that procurement can have on their performance.

Research Methodology

Choosing the paradigms driving the research is a crucial and difficult question. Patton (2002) describes the research paradigm as a way of making sense of the complexity of the real world. It is considered as being deeply embedded in the researcher or practitioner's social models. Its strength is also its principal weakness; the very reason for action is hidden in the unquestioned assumptions of the paradigm.

Positivism or technical rationality is claimed to be the research paradigm in the design sciences (Schön, 1995). However, an interpretivist perspective was adopted as it is better suited to investigate this complex social phenomenon. Interpretivists see the social world, in contrast to the physical world, as socially constructed. They are more interested in understanding specific cases within a particular context than hypothesizing about generalizations and causes (Patton, 2002). Triangulation of theories, methods, and sources were used to capture and analyze data from multiple perspectives.

Van de Ven (2007) calls for process instead of variance logic to investigate complex organizational phenomena. The phenomenon here, to be studied, is teams' integrated design process. Process data have characteristics that make them difficult to analyze and manipulate: they deal with sequences of "events"; they have multiple levels with ambiguous boundaries; their temporal embedded-ness varies in terms of precision, duration, and relevance; they tend to be eclectic, drawing on phenomena such as changing relationships, thoughts, feelings, and interpretations (Langley, 1999).

A social science process approach has also its limitations. Blackler et al., (1999) argue that social research on teamwork practices does not take into account the rapid pace of changes in the organization of work. It is based on biased assumptions, avoiding featuring elements of context as variables that can impact team effectiveness, such as the hierarchical aspect of group regulation, the politics of relationships between different experts or functional groups, the nature of the broader institutional contexts, and ways in which participants have become socialized to participate within these structures. They advocate instead a context approach to research, using activity theory to explore the dynamics of teams. Activity theory focuses on activities, in which people transform their environment, instead of processes, and provides a much richer framework than traditional variance or process approaches used in social science to investigate complex phenomena (Nardi, 1996). A triangulation of qualitative research methods, based on activity theory and grounded research, were used to investigate the two case studies. Kaptelinin and Nardi (2006) advocate, for research in activity theory, to pay attention to broad patterns of activity rather than narrow episodic fragments that fail to reveal the overall direction and importance of an activity. For analyzing patterns in terms of grounded research, Strauss and Corbin (1998) suggest connecting causal conditions, the phenomenon, the context, the intervening conditions, the actions and interactions, and the consequences as a process structure . Maximum variation and intensity were sought in the choice of the cases.

The first is a longitudinal case conducted in Canada. Documents pertaining to the development of the design, design deliverables, and electronic correspondence were made available for the research. Eight brainstorming and design workshops were conducted in e-collaborative design laboratory of École de technologie Superieure. They were videotaped. Observation strategies derived from Ancona's Team Process Observation Guide (2005) were used to analyze disturbances or contradictions affecting the team dynamics. Ancona proposes seven categories to structure the observation of the team dynamics: task and maintenance functions, decision-making, communication, influence, conflict, atmosphere, and emotional issues. "Task and Maintenance functions" is the glue that holds the team together. Task functions help the team to organize themselves to get the things done. Maintenance functions hold the team together so that the members can continue to get along with one another. It is expected, in a performing team, that its members build together a shared view of the project purpose, agree in the best way to achieve it, and on how they will stay on target. It is also expected that all team members have their "voice" heard and that all ideas are opened to discussion. The observations were triangulated against two rounds of interviews, one with partners/tenants' directors and employees at the end of the first phase to capture the strategic intents, and one with the integrated team after the concept phase. A total of 19 persons were interviewed.

A second case was undertaken to study a new procurement framework put in place in a leading British initiative. Data were collected in three steps. Firstly, a series of interviews with six representatives from Office of Government Commerce, the Department of Trade and Industry, Constructing Excellence and Construction Industry Council were conducted to understand the context surrounding Rethinking Construction related initiatives. Research was narrowed down to Procure 21 and Achieving Excellence initiatives. Secondly, interviews were conducted with 2 Office of Government Commerce representatives, the Department of Health director of Construction, and the Procure 21 program manager. Thirdly, interviews were conducted with personnel from the Hospital planning department, the new unit staff, and the principal supply chain representatives. Twenty persons were interviewed. National Health Procure 21 and

knowledge portals were also explored in detail; Procure 21 tools and process map were downloaded, and analyzed.

A semi-structured interview protocol and long interview technique were used in both cases. The interviews lasted between 40 and 120 minutes. All interviews were recorded and fully transcribed. A debrief memo was written after each interview. Interviews were also conducted with subject matter experts in project and value management. Client representatives, project managers, design professionals, and construction managers were invited in focus groups to discuss and comment on the research findings at each step of the process. Data was coded using NVivo 7 software.

Research Results

The intent in both case projects was to demonstrate the superior performance of integrated teams. The first aims to deliver more sustainable buildings, the second to drastically improve the quality and efficiency of care within a mental health rehabilitation unit. In the first case, a sustainability roadmap was devised to reengineer traditional design processes. In the second case, a revolutionary relational procurement framework, Procure-21, was implemented to transform the context in which projects are planned, designed, and built, whereas in the first case, traditional transactional procurement route was utilized.

The focus of the research in the Canadian case was to explore further problems of efficiency in adopting a process approach to the integrated team. In the British case, which is considered a model of best practices in integrated teams, the research concentrates on the influence of new procurement routes on the efficiency of these teams by transforming the context of the relationship between the client and the supply chain.

The Canadian Case

This case describes the context and dynamics of a project coalition whose mandate was to innovate not only by delivering an outstanding demonstration project for sustainable construction, but also in the process of designing it. The project was an opportunity for the project client, a non-profit activist organization in sustainable development, to position the organization as the "Voice of Sustainable Development". A sustainability adviser was appointed by the client to structure the integrated design process. The integrated team was composed of three representatives from the architect firm, four representatives from the engineering firms, the sustainability adviser, three client's representatives, and various experts.

Results from observations suggest the team to be dysfunctional. The design team formed an in-group and views of the client, the consultant, and other experts remained fragmented regarding the project objectives and the design process. Surprisingly, interviews and focus groups with design professionals and facilitators confirmed that the dynamics of this team was not uncommon in construction. Explanation for this anomaly could be found in research in team performance and in organizational learning.

A core principle of integrated design is the ability of team members to share knowledge for continuous learning. Scholars (Druskat, 2002, Weick and Roberts, 1993) identify continuous learning – with psychological ownership and heedful interrelating – as one of the conditions for performing integrated teams. It is acknowledged, from recent ethnographic research on team dynamics, that there could be multiple barriers – cognitive inertia, lack of self-regulation, knowledge boundaries – hindering integrated teams ability to perform.

The first problem, cognitive inertia, plays against psychological ownership and heedful interrelating. It is associated with two typical behaviors amongst experts of different disciplines: "groupthink" and "compartmentalization". "Groupthink" is a mode of thinking that people engage in when they are deeply involved in a cohesive in-group. "Groupthink" typically leads to an overestimation of the in-group, closed-mindedness, and stereotypes of out-groups; and "compartmentalization," a fragmentation of viewpoints and a lack of shared mental models. Groups tend towards the opposite of sharing the unique information or knowledge held by individuals, preferring to jointly discuss held information or knowledge (Stasser and Titus, 1987). Fragmentation may make it impossible for experts from different contexts to "speak the same language" and exchange ideas about a problem (Engeström *et al.*, 1995).

In this case, contractual agreements formalized one-to-one relationship between the client and each of his suppliers. *"I don't want a middleman between me and the decision-maker, if not it makes a terrible mess..."* [Project architect]. There were two parallel contractual work agreements that were made by the client, splitting the coalition in three groups: the design team, the sustainability adviser, and the client representatives and experts. A first contract was formalized between the client and the sustainability adviser's firm, a second one between the client and the architect firm, and the engineering firms were subcontractors by the later. The engineers' interventions were tightly controlled by the architect and limited to technical insights and specifications regarding the building systems and structure. Terms and conditions of these contracts were kept confidential. Therefore, these working arrangements remain unknown to the other members of the coalition. Contracts increased fragmentation between experts, encouraging groupthink and the creation of parallel communication and decision-making outside of the team boundaries.

The second type of problem is related to the nature of project coalitions. There is a lack of self-regulation of typical collaborations in coalitions, where team members coordinate their activities through talking to one another in addition to interacting with their tools. Participants duplicate each other's efforts and many problems often fail to resolve quickly or to anyone's satisfaction (Zager, 2006). The model relationship between client and design professionals carried in transactional procurement defines a problem-solving process that depends on agreement on ends: only experts (professionals) practice the rigorously technical problem-solving based on specialized scientific knowledge (Schön, 1995). Clients and users are expected to provide inputs – clear problems and requirements – for which the experts will provide outputs, e.g. design solutions. Therefore, without clear rules, contractual agreements become the rules that determine the relationships among actors in the case observed. Design professionals therefore repeated the traditional design process described in their code of practice, hampering the development of shared ownership:

> *"The architects went into a corner and came back with a concept. I can understand that it is the way they work, but I have a problem with this because we did not have the chance to build the ownership of the concept..."*
>
> [Client representative]

The third type of problem relates to the "knowledge boundaries" that specialized knowledge creates and which hinder mutual learning. The characteristics of knowledge that drive innovative problem-solving within a function actually hinder problem-solving and knowledge creation across functions (Carlisle, 2002). There is also the aspect of "knowledge at stake". There is stickiness with the common knowledge used by practitioners. Power and influence of dominating actors are often revealed, which create barriers to developing shared meanings by refusing to change the knowledge and interests from their own domain (Carlisle, 2002). As argued by the project architect:

> *"At one moment there are design professionals that are trained to do work. We cannot design in teams. If we design a horse in a team around a table, we will end up with a camel".*

[Project architect]

The architect used the power provided by his ownership of the design knowledge and the cohesiveness created by his binding contractual relationship with the rest of the design team to take control of the process that was outlined by the sustainability adviser, breaking the team cohesion and imposing his rules. Moreover, the architect forced the creation of a parallel process for decision-making; demanding separate meetings with the client's executive for dealing with this task, creating a parallel communication network. This generated conflicts and emotional issues between suppliers, due to the gain of privileged access to the decision-maker.

In summary, it was acknowledged that the fragmented transactional agreements had a negative impact on the team dynamics, fragmenting and polarizing the work between the signatories of the agreement, and channelling team effort to meet contractual deliverables instead of defining optimal solutions.

The British Case

Procure-21 is one of the new procurement routes adopted by the British Department of Health. The aim was to improve performance in delivering better buildings and to develop a design process that is centred on the patient and healthcare staff. Procure-21 distinguishes itself from other initiatives by taking a context instead of a process approach to transform existing design practices. The change in context is imposed by the relational contracting framework, which dictates new rules and division of labour within the team, while redefining the roles of key stakeholders. It is structured on the following principles: to change culture and process through senior level determination to change, the redesign of activities to support the change, training in the skill for collaborative working, and the creation of an environment in which people can expect support rather than blame; to pre-qualify a small group of principal supply chain partners that has demonstrated a specified set of capabilities to form an integrated team at the outset of project planning and maintain it throughout delivery; to promote the implementation of collaborative work by the adoption of a coherent cost management approach built around "Target Costing".

An innovative element of the framework is its reframing of the design and delivery lifecycle into a definition and a delivery phase. In the first phase, the supply chain works on an agreed cost-plus basis to accompany the client in the different stages of planning and design. The goal is to maximize value through the definition of the best fit for purpose at a lesser price. When the project definition achieves an acceptable level of certainty, the supply chain can make a firm commitment to a guaranteed maximum price and a schedule. This price includes provision for risks agreed by both parties. The goal of the second phase is to achieve cost reduction through innovation, standardization, value engineering, and process improvement. Cost savings are equally shared between the client and the supply chain. Cost overruns are absorbed by the principal supply chain.

One of the key characteristics of Procure-21 is that it is no more the design professional but the client who is leading project definition. The framework imposes changes to traditional design practices by redefining the relationship between the client and its suppliers. It achieves this by encouraging fruitful exchanges through partnering, and building trust amongst the integrated team members and between the team and their related organizations, addressing the design problems related to flow and value generation.

The theory behind the concept of partnering is that removing the adversarial relationship generated by transactional contracting and establishing long-term relationships eliminate industry barriers to collaboration and stimulates value generation. Building trust is also an essential component in building the team dynamics. As asserted by the Director of construction of the Department of health in the UK, changing the procurement process is not sufficient to

change people's mental models, which are deeply embedded in decades of adversarial relationships. There is also the issue of breaking down barriers built around specialized expertise:

> *"You then, of course, need trust between all these parties. That is not an automatic thing. It has to be earned, in many ways the hard way. Trust, then brings respect. Once trust creates respect, you are able to remove large chunks of wastage, because if one says to the other, "I cannot do it differently," the other will trust and respect their expertise and will not challenge them. It is therefore done quicker and more directly. Ever time that it is successful, more trust and respect is generated to the point where it becomes cognitive. The time one lets the other down is the time where the whole thing falls apart. One knows the other does not want that, so they work hard to maintain that situation. I think a very powerful bond is created, because the onus is on both sides to not let the other down, both professionally and personally. Neither wants to be thought of as incompetent."*
>
> [Director of construction]

Waste reduction (flow) is central to the framework. It is achieved at two levels: at the project definition level, by eliminating the multi-level hierarchical decision process and by avoiding duplication of roles; and at the supply chain level, through process improvements and value engineering. To achieve this, the power structure of the traditional work configuration in construction is reshuffled. New players are introduced – the project director, the design champion and facilitators. The role of the quantity surveyor is evolved to include quality assurance and quality control. The hierarchy of relationships (structure of power and influences) is redefined between the client, the design professionals and the builder. Finally, a clear divide between the roles, responsibilities, and hierarchy of interactions is established between the client and the supply chain. The responsibility for defining the "why" and the "what" is placed under the leadership of the client: in this case the project director and the design champion. The project director is the one having the final say on all decisions regarding the scope of work of the project:

> *"The role of Project Director was something that we created. There was no such thing at the time and we drew the distinction between Project Management and Project Directorship. The latter is more strategic and involved with the operational side of the hospital in order to better understand what the solution is supposed to deliver. Therefore, what we tried to promote was a better understanding of some of the techniques that are associated with health care planning, rather than health care construction."*
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> [Director of construction]

Therefore a shared leadership is established, the project director ensuring the project governance and orchestrating the interplay between the client organization and the supply chain, the design champion leading the group of users and patients in establishing client requirements, and the project manager leads the supply chain in articulating the optimal way to meet these requirements. The role of the design champion is central to break knowledge boundaries, group thinking, and compartmentalization:

> *"We have moved around to put the patient and the patient needs in the centre. It's not as powerful as it can be, because the stakeholders are not as informed as the professionals, so they can't really chance... So it's a bit of tokenism. Tokenism can be destroying if the person who is contributing doesn't feel strong enough to challenge the professionals and when that person or that group doesn't have its roots in a community or in a group of staff or whatever, so selecting people to be involved in stakeholders is also important, in the sense of who you get buy-in to a project...It is not about knowing construction or anything like that, it's about knowing how to manage, or what I call 'project champions.' You work with a doctor or nurse in order that they may understand the process. [You are] cascading information and gaining*

ownership in the sense that, hearing the process from someone whom they can identify more easily with, is a supplementary process, rather than hearing it entirely from me."

[Project Director]

Weick and Robert (1993) argue that in a highly differentiated and complex context, a group could function as a highly integrated and effective team through the vigilant collaboration of key stakeholders. In this case, the project director's main role is to ensure vertical and horizontal integration. He has executive power and answers directly to the project owner within the Board of the Trust. He also deals directly with the project manager, who has a similar role within the integrated supply chain regarding the management of the scope boundaries. These two ensure an efficient management of the flow.

The project manager and the design champion work together in the definition and management of stakeholders' wants and expectations. The result of these new rules and division of work is the efficient development of shared ownership, continuous learning, and heedful interrelating between users and supply chain. Analysis of the case clearly demonstrated the positive impact of the procurement framework on the dynamics of the integrated team. Users were allowed full participation in the design process, generating most of the innovations. As asserted by staff and psychologist, their participation in the design process not only permitted to integrate innovative solutions for improving the rehabilitation of the patients but also allowed for building buy-in and co-ownership of the design process. As a result, drastic changes in patient behaviours, including an important reduction of aggressions, much faster reintegration of patients into the community, and much better retention of staff were observed. The project was delivered within time and budget.

Discussion

The results from case studies confirm the influence of procurement routes on the performance of integrated teams. These results, on one hand, describe the socio-cognitive problems related to integrated teams in transactional contractual arrangements of design-bid-build, and on the other hand illustrate how an innovative procurement approach can help to resolve some of these problems and improve team performance. The findings indicate, first that problems with integrated design team efficiency are related to context and not process: they are not technical but socio-cognitive, second that fragmented transactional contracting increases socio-cognitive barriers that hinder integrated design team performance, third that new forms of relational contracting may help to mitigate socio-cognitive barriers and improve integrated design team performance.

The Canadian case illustrated the limitations of a process approach to change practices in design. It also illustrated how transactional and fragmented procurement generates an adversarial context that increases the intensity of socio-cognitive barriers. As demonstrated in an empirical research on intra-team boundaries within a design-build process (Moore and Dainty, 2001), a transactional contract favouring integration, while providing a more collaborative context, is not enough to break these barriers, the team repeating patterns of behaviours inherited from fragmented practices. Practices create epistemic barriers among the different communities within organisations which compromise the successful resolution of conflicts and contradictions within multidisciplinary teams (Brown and Duguid, 2001), Professional practices also build their power and influence over the team by their ownership of unique skills and knowledge . For example, the perception of design being the result of a creative act of one individual is rooted in architecture training and deeply embedded in their tools (Lawson, 2006).

In contrast, the new context of relationships created by the Procure-21 framework helped to mitigate the socio-cognitive barriers identified in the Canadian case. One of the key features within the Procure-21 framework was to reconfigure the traditional patterns of power and influence within fragmented teams, around new actors – the project director and the design champion – to drive the planning and design processes. However, changing the context through procurement does not address the problem of obsolete design practices. There is a need to address socio-cognitive barriers that are the result of professional training.

Conclusions and Future Research

The research is a first exploration of the influence of procurement on team performance taking a socio-constructivist perspective. Because of the fragmented and temporary nature of project coalitions in construction, contracts have played a role of stabilizer, formalizing the patterns of relationships between the client and the supply chain. Moving from fragmented to integrated design requires changes to these patterns of relationships. As demonstrated in the case studies, the nature of the contractual arrangements can create an adversarial context to collaboration that may hinder team performance, or can help create a new context that will facilitate the transition to collaborative work.

The research opens new grounds for future research both for building recognition of research methodology, methods and approaches pertaining to theories of practice, and for building propositions and theories regarding the relationship of procurement with team performance.

One promising ground is the exploration of the influence of contract as a boundary object between the members of the integrated teams. Boundary objects are mediating artefacts (tools, technology, and symbols) that help to cross boundaries between specialized knowledge, facilitating the sharing and generation of knowledge. Recent research in construction on contract as a boundary object (Koskinen, 2009), on the impact of boundary objects on collaborative design (Smulders *et al.*, 2008), or on the use of representational artefacts to coordinate the design of the building (Tory *et al.*, 2008) are providing a fertile directions for further research.

More empirical research is also needed to better understand the dynamics of integrated team and how procurement could be tailored to leverage the team ability to perform. Moreover, while new forms of procurement can create a better context to integrated teamwork, there are still fundamental problems that remain unanswered regarding design professionals' ability to perform in this new context. Existing bodies of knowledge and training curricula of design professionals are ill-adapted to integrated teams. Future investigations should explore how to best realize the necessary transformations of design practices.

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