MANAGING RISK AND UNCERTAINTY IN SUSTAINABLE CONSTRUCTION INNOVATION: THE ROLE OF THE PARTNERING CONTRACT

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Drawing upon actor-network theory and the related concepts framing/overflowing by Michel Callon, the present work aims to explore the role of the partnering contract in construction. The method used is a case study of the design and construction of an innovative cross-laminated timber campus building in Inland Norway. The contract unexpectedly became a conduit of overflow as it delimited the action space for joint exploration, undermined trust and collaboration, shaped and triggered guarding behaviors, self-interest, controversy and prolonged negotiations over construction design, responsibility and distribution of unexpected costs. This, in turn, spilled over and challenged the project's innovative sustainability ambition. The conclusion is that the partnering contract did not stay faithful to its expected collaborative and innovative role. When used in practice, the contract also played a more hybrid, surprising and unfaithful role because it added new unexpected uncertainties, risks and costs.

Keywords: partnering contract, trust, risk management, actor-network theory

INTRODUCTION

Partnering has been widely considered as a solution to poor project performance, with expected benefits for efficiency, quality and innovation. Yet, in practice it appears to be a mixed blessing. As Alderman and Ivory (2007) note, although partnering is supposed to be about sharing benefits from joint collaboration, it can also be a "smokescreen" for doing business as usual" (392). In practice, partnering is not without paradoxes, and the construction industry appears to have more than its fair share of mixed experiences (Wood and Ellis, 2005; Bygballe, Jahre and Swärd, 2010; Gadde and Dubois, 2010). Cheung, Ng, Wong and Suen (2003) identified the main problem as the client's unwillingness "to fully commit to the partnering agreement" (255). Partnering is a trust-based contractual relationship, as also pointed out by Wamuziri and Seywright (2005). The authors are also considering risk sharing in such collaborative arrangements, and mention client's use of formal risk register in the bidding process. Larya and Hughes (2008) note a proliferation of such formal analytical risk management models for assessing contractors' risks in pricing bids.

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Yet, the authors also note that these models are rarely used and calls for more ethnographic research into the actual practice of risk management and with what effects for the construction project. According to the authors' own empirical investigations, a range of issues might be at play such as tensions between underestimated costs ex-ante and true costs ex-post, and further issues regarding costing/pricing and trust between client and contractor. The literatures recognize trust building and risk sharing as important aspects of the partnering arrangement (Crespin-Mazet, Havenvid and Linné, 2015; Cheung *et al.*, 2003) and as an important factor in achieving project goals regarding cost efficiency and quality. Although the extant literature report from several cases about partnering in construction, it appears to be relatively few studies that consider the risk management practices as the events of the construction project unfold and the contracting partners interact. How the partnering arrangement translates into management and sharing of risks and benefits is not very well researched. This raises a more general question about the role and usefulness of the partnering contract. More specifically, our research question is: what role does the partnering contract play during a construction project in managing risks and in facilitating or hindering innovation, trust and collaboration?

To address this question we have investigated a case, Evenstad Campus in Hedmark County, Norway. The project used a partnering contract (called 'samspillskontrakt' in Norwegian). The project ambition was high in terms of innovation, i.e. to accomplish "the world's most sustainable building". The project is also knowledge intensive, i.e. being involved in the research effort "Center on Zero Emission Neighborhoods in Smart Cities - ZEN Centers".

The Concepts of Risk, Uncertainty and Trust

The terms risk and uncertainty are often used interchangeably in everyday language, but there is also a debate among scholars regarding their theoretical connotations and whether the two terms should be distinguished from each other or not. Already in 1921, Frank Knight conceptualized the difference between risk and uncertainty by arguing that the former could be calculated while the latter could not. Callon *et al.*, (2009) considered risk as a subset of the broader concept of uncertainty, which concerns the more fundamental condition that we know that we do not know. Both define risk as the factors one can identify and estimate in advance and; a likelihood of occurrence. In short, it means that risks are the factors we know and can make calculations about. Uncertainty, on the other hand, is, accordingly, all outcomes that occur as unexpected in the sense that actors have failed either to calculate the probability of an occurrence or that the outcome itself has not been identified ex ante because it is not known. It also means that uncertainty holds potentially both negative and positive outcomes, a point also emphasized by Chapman and Ward (2011).

The role of the contract as a distributor of risk between two parties is illustrated, inter alia, by the Principal Agent theory and work on transaction costs economics (e.g. Williamson, 1981). The approach is normative, with the aim of finding the optimal contract given the current situation and actors' propensity to act opportunistic. The normative assumption here is that human actors cannot be trusted and that contracts must be designed to mitigate their opportunistic behavior by including appropriate controls and schemes for distributing rewards, risks and sanctions in order to reduce uncertainty and 'getting the risks right' (Flyvbjerg, 2006). According to this conceptualization, uncertainty is but another word for risk. However, risk and uncertainty can also be conceptualized and approached under the assumption that uncertainty is an expected outcome and a consequence of risk management. Callon (1998 and 2009) builds a theoretical framework for this kind of analysis based on the Actor Network Theory (ANT). The ANT approach is not normative, but descriptive and analytic since it provides a socio-technical lens to analyze how the contract can play other and more dynamic roles in addition to the normative and controlling role proposed by standard economics. In the present work we describe and analyze an innovative building project and consider the role of the partnering contract - as a non-human actor/actant - which, through its design frame and affects the interactions of the developer/procurer and the contractor in ways that are perceived as unexpected by them. The client, supplier or sub-supplier may go bankrupt, or a third unexpected stakeholder may protest against the construction project and file a formal legal complaint. While the list of the entities (both humans and nonhumans) that are included in the contract is finite, the list of the excluded entities and events will always remain infinite and incomplete due to lack of knowledge and foresight. The notion of overflowing suggests that attempts to make a complete list of all contingencies and events is bound to fail due to this fundamental uncertainty. Generally, additional important actants to be accounted for could, in our case, be the construction site, the weather, the physical-material elements of the building construction, the drawings, calculations and models that together constitute the project. The ANT approach is relational and does not assume that people have fixed identities with a given set of expectations and interests. Rather, the assumption is that actors' identities are more dynamic and considered as an outcome that is shaped in interaction with non-human entities, such as the partnering contract. It is thus an open empirical question if the contract, in addition to represent human actors' expectations, interests, and responsibilities at the time of contract signing, can also play more active and unexpected roles as the contracting parties interact and the events of the construction project unfolds.

Callon's (1998) notions of framing and overflowing enable us to analyze these dynamics. Callon considers the contract as a socio-technical framing device, i.e., it draws a boundary around actors' interactions by defining through textual inscriptions their roles and responsibilities, their identity for short. Like all framing devices the written contract is imperfect. It cannot take everything and everybody into account. Nevertheless, the notion of framing also suggests that people calculate and mobilize their knowledge and foresight, for example when writing up contracts with price/cost estimations, roles and obligations. As a risk management tool, the contract attempt to regulate the interactions between the contracting parties and to "contain" risk by making them explicit and manageable. Yet, such attempts to install control and predictability will be followed by unexpected events and interactions, which transgresses the boundary of the contract and overflow to the context of the interaction. As suggested, an important element of this context is the written contract. The contract and its inscribed assumptions about price/cost, roles and obligations is challenged by overflowing, for example as unexpected costs and design challenges morph into controversial issues regarding risk assessment and distribution that threatens to undermine actors' trust in each other and the partnering arrangement.

Callon's notion of reframing further denotes the possibility that hitherto uncontained overflows can be taken into account if actors negotiate a new contract. Thus, according to Callon (re)framing and overflowing are not separate processes and phenomenon, but are related and ongoing. In contrast to economics more conventional notion of an externality, Callon considers overflowing to be the norm.

Drawing upon Callon (1998, 2009), Themsen and Skærbæk (2018), Harty *et al*., (2014) argued that risk management tools can help to create risk and uncertainty between the actors instead of reducing these. In construction management research, several contributions have noted the proliferation of formal risk management tools or models (see Larya and Hughes, 2008, for a comprehensive review), including the contract as a risk management tool. This research points to a need for ethnographic approaches to inquire further into what people are actually doing as they try to figure out the risks and price for a construction contract. It appears to be room for further research into the complex dynamic relation between the contract and price ex-ante and the emergence of new and unexpected risks and uncertainties during a construction project. More specifically, and going along with our ANT approach, it appears to be room for more ethnographic case-based research on what the contract does and its eventual dynamic role in managing risk and uncertainty during an innovative construction project. As regards our case, differing opinions between the public procurer and the private entrepreneur clearly emerged. The controversies concerns supposed water damages inflicted on the innovative massive wood constructions elements, elements that was novel to both key actors in the partnering contract. Framing and overflowing in this case concerns the role of the partnering contract in shaping actions and events, including negotiations between the client and construction management over the target price and risk distribution between the two contracting parties.

METHOD

When researching our case we use ANT and Latour's (1987) 'rules of method' (258) to follow the actors and the unfolding chain of actions and controversies. The ANT approach is processual, case-based and inspired by ethnography and anthropological methods. Translated to our research, we have conducted visits and direct observations on the construction site since spring 2015 during the groundwork and assembly of the building. We have also conducted direct observations during a meeting at the construction management office on the construction site and participated on site during the celebration of the finished building. In order to reconstruct the chain of events and the controversies that emerged after the signing of the partnering contract, we supplemented with document studies and semi-structured interviews with key actors. The collected documents are planning documents from the early phases of developing concepts and project proposals, reports from client advisors prior to project competition, competition brief and contract standards, meeting protocols and a report from the client and its advisors about project outcomes. Semi-structured interviews were conducted with key actors while they were still working with the project and negotiating with each other. Interviews include project- and construction management, the client and user representative at Campus Evenstad, the project owner- and facility management at Statsbygg. In addition, we interviewed the management at Tre Torget, a private-public funded industry research association and a consultant affiliated with "Tredriveren in Hedmark", which are regional key actors within a national network promoting innovation in wood construction. For the purpose of this paper, the focus is on two unexpected and controversial issues that emerged during 2016 and that challenged the partnering agreement. Both controversies concerns moisture in the wood construction material and is accounted for in the vignettes below.

First Case Vignette: Negotiating Re-Design of the Outer Wall

Construction Management (CM) was appointed in December 2015, soon after the contract with the large public client, Statsbygg, had been signed. Previously, the concept and feasibility study had made the case for extensive use of massive wood. Subsequent refinements by the architect and client advisors resulted in a design of a two floors office building, with massive wood prefabricated panels including both the inner and outer walls. The wall panels would be sufficient to carry the weight of the building construction. Together with packed wood fibers in between, the wall's sandwich design would also be able to isolate and regulate temperature and humidity levels, to the benefit users' indoor climate. In addition, and importantly to the project ambition, the massive wood construction would also benefit the outdoor climate, because, it would contain the greenhouse gas C02 while also providing an energy efficient solution due to its material properties in regulating the indoor climate.

These material properties are translated and inscribed into the wall construction design, only to be subjected to further and intense discussion, just after CM was appointed for the job. The project 'clock' started ticking once the client and contractor signed the contract. According to the partnering contract, CM was in principle left with discretion to figure out the best design solution for the client, this then in contrast to a conventional design-build contract. In practice, however, the CM's design discretion was framed by the partnering contract in several ways. There was a time for proposing changes, but only within the timeframe of the contract. Delays was associated with a fine. So the time for change in project plan and design was limited. Still further, with the discretion to propose changes followed also a responsibility. If changes proposed and implemented turned out bad during the first 5 years of operations (another but related timeframe), the client could invoke guarantees and liability clauses. If CM for that or some other reason proposed no further design changes, the client could still invoke guarantees and liability clauses later on if CM failed to recognize the need for such changes during the construction project. In either way, due to these inscriptions, CM's roles was framed by the partnering contract - to propose change or no change became an on-going responsibility, dilemma and concern.

Within the project team different views soon emerged among advisors regarding the massive wood wall sandwich design. Proponents of the design, the chief architect and a technical advisor on wood construction, both with many years of experience with wood, and even massive wood constructions, maintained that the wood wall design was feasible and sustainable; economically, socially and environmentally. By contrast, other advisors, among them, specialists in heat, mechanical ventilation, electricity, energy efficiency and construction engineering raised concerns about the indoor climate. The key argument was that the proposed design, due to its novelty, could prove prone to water leakage and the accumulation of too high moisture levels in the walls. This, in turn, could damage the construction and generate risks in the form of a microclimate for fungi and spores, with further unwanted ramifications for the indoor climate for end-users.

The debate intensified across the members of the advisor group, and caught up in between was a client and a construction company that had little or no experience with such massive and innovative wood construction designs. The situation could grow into an impasse and potentially put a halt to project progress. Yet, the partnering contract stipulated that progress had to be made. It appears that the conflict could not be resolved through further project meetings and discussions. In a joint agreement with members of the project team, the CM and the client therefore decided to put the design to a test in the laboratory of a well-reputed Norwegian consultancy firm within construction materials and design. A noted by Callon (1998) external expertise and scientific instruments are often called upon to settle controversy. In January 2016 a physical mockup of a wall element with a full size window fitted was tested in the laboratory. The mockup was exposed to water and measurements of moisture was taken along with observations of the movements of water on the mockup. Pictures were taken to document the test. According to the expertise from the consultancy firm, the design posed a risk due to water seeping in between elements in the wall, implying increased risks for accumulation of moisture and damaged construction.

CM and the client could now either choose to accept the risk and move on according to the joint agreement in the partnering contract, or decide to re-do the design. From the point of view of CM, the project was interesting because it featured this innovative sandwich design based on massive wood. Yet, it would also put a high risk on the part of the contractor if they stayed faithful to that design - if it turned out to be a problem with the indoor climate during the first 5 years of use. The client was clearly also interested in this novel massive wood design since they included such deliberations in their competition brief. However, as owner and facility manager of the building, they were also interested in providing a good indoor climate for their tenants and users. During the negotiations between CM and the client, it became clear to both parties that neither of them were willing to accept the risk and uncertainty implicated in this design option. It was decided to re-do the design by opting for a more simple and “safe” solution that replaced the outer massive wood element with ordinary thin wood panels.

The new design appeared to look like the massive wood panel, but due to its thinness, the outer wall would perform differently. The capacity of the outer walls to contain CO_2 would be reduced along with the building’s sustainability performance vis-à-vis its external environment. But then again, the laboratory test proved decisive in closing this debate about the design options. It appears that the closure implies a stronger focus on reducing risks inside the building, especially concerning the indoor climate. By reframing the contract according to the thinner wall design, a new negotiated boundary between the building’s outside and its ‘safer’ inside environment is settled. Simultaneously, the new boundary become an unexpected conduit of CO_2 overflowing, generating new uncertainties and risks in relation to the building’s outside environment, ‘the world’ in short. However, it also appears that the stronger focus on the inside environment also paved the way for further design issues regarding the overall design concept for the heating, ventilation and air-conditioning (HVAC). What was originally a quite simple mechanical concept of indoor climate based on natural ventilation (opening windows) turned into a more complex mechanical design concept requiring more energy to operate. The project plan and the contract’s target price needed revisions due to these design changes. CM and the client sat down to renegotiate a new and higher target price. The lower cost of thinner outer walls could not offset the extra time and costs for test and changes to the construction- and HVAC design, additional planning and assembly work on site.

Second Case Vignette: Negotiating Re-Doing of the Floors

In the summer of 2016, in the middle of the construction phase, comprising the erection of the frame and inner walls of massive wood panels, the construction crew also installed oriented stranded floor boards (OSB). Just after the installation an unusual heavy rainfall occurred. The mounted floor slabs were under water for about 2 days as the contractor struggled with pumping out and draining the water. After the crew erected the roof, CM and the crew initiated a drying process. They made careful and repeated moisture level measurements of the supporting floor structure in order to ensure that the drying progressed satisfactory. It took some time, because the floor slabs made up about half of the total floor area of 1300 square meter of floor surface.

The client's representative arrived at the building site for regular meetings and inspections during the construction process. When arriving in the aftermath of the 'rain-and-floor' incident the client expressed concerns over the quality of the floors. Through an ocular inspection on site, the client pointed out that the floors was discolored, with further complex ramifications for the collaborative spirit between the partners. The client considered that this OSB floor was damaged and that the OSB floor could create issues with sponges and bad indoor climate. They could also prove to be too weak to carry the overlaying floor. This overlaying floor was a particularly durable and expensive oak floor consisting of short rods glued together from the fiber direction. Thus, according to the client representative, the underlying OSB floor was damaged and a clear case of a construction management error.

The construction manager, in turn, pointed out that the discoloration created by the water standing on the OSB floor could in no way affect the quality of the further construction; it was not a problem to lay the overlaying oak floor; nor could this incident affect the indoor environment negatively by creating a microclimate for the spreading of mold spores. Measurements of the moisture level confirmed that it was below the technical threshold value implicated by the contract and quality standards. However, at the subsequent building meeting, the client representative maintained the view that the discolored floor was an unacceptable deviance from quality standard and a construction error and demanded the contractor to replace the floor structure completely. CM then made the assessment that it was not meaningful to refuse this requirement since the client would otherwise report the resulting damage as a general construction defect after the completion of the construction. Thus, the decision to replace the floor material was taken by the client, unilaterally. In practice it took considerable time to re-do several hundred square meter of floors. Materials and the restoration costs for the entire operation was approximately 5 million NOK, or more than 10% of the contract sum. Once again, the project plan was up for negotiation due to unexpected costs and demands related to moisture and water on wood construction elements. Although CM and the client representative sat down, from CM's point of view, to renegotiate a new and higher target price, the client did not accept this. The cost of tearing out the already mounted floor construction elements, buying the new material and reinstalling that in the building, all these extra costs had, according to the client, to be carried by the contractor.

The post-project evaluation report (Statsbygg, 2017) used the benefit of hindsight to allude to the project team's lack of knowledge and failure to reduce risk and uncertainty. For example, regarding the wall design, it was noted that "Testing of new solutions should take place in the development phase, the pre-project phase, in order to reduce risk and uncertainty with regards to quality, progression and economy." (65) Translated from Norwegian).

DISCUSSION

The case vignettes show examples of controversy related to water and moisture in wood. It appears that wood containing moisture can become both a benefit and upside risk in regulating a good indoor climate and a liability if it grow mold spores. These micro observations of the dynamic tensions between upside and downside risks also makes them useful in furthering our discussion of the role of the partnering contract in managing innovation and risks in construction. Larya and Hughes (2008) called for more empirical research into actual risk management practices and Wamuziri and Seywright (2005) pointed to the partnering contract and target price as a way to share risks. The notion of risk and uncertainty reduction is integral to the partnering contract as it inscribes roles and obligations for the client and the construction firm by specifying in writing a shared risk and incentive scheme vis-a-vis the target price. The parties will share 50/50 of savings below the target price and budget or the extra costs above. The two parties are supposed to be, "in the same boat"; Since it is not an ordinary design-and-build contract with a fixed price the innovative ambition is higher and translates into a target price that can be renegotiated during the project by using the contract's 'change request' mechanism. However, for this mechanism to be mobilized and have effect, it requires a joint agreement about setting a new target price, as it also turned out in our first case vignette. Costing and the new higher target price is thus a negotiated settlement of an emergent set of unexpected issues and concerns with the wall design.

That reframing was possible to negotiate after the wall design controversy reached a closure due to the new knowledge produced in the laboratory test. The costs and risks for the construction work and the indoor climate could be re-estimated and a new agreement could be reached. However, this revised contract and context of the partnering project appears to be focused on the downside risks; the new knowledge obtained from the test was not used to negotiate further resources to continue the exploration of the novel design, but used as a way to stop these explorations. The downside risks for the indoor climate appears to count more than the upside risks. Wood and Ellis (2005, 324) notes the emergence of "hush realities" further into the project processes, which tends to reduce the initial optimism in the partnering arrangement. Our case vignettes seems to indicate a similar trajectory. As the subsequent rain-and-floor incident also shows, new uncertainties emerge and prevails further into the construction processes when parties are judging on site the quality and performance of the OSB floor; what might appear to be a quite basic and simple construction element. However, this incident also shows that there is little left of the notion of a partnering contract when the key parties are negotiating the meaning and significance of the incident for further project and construction work. It appears, that the partnering contract can be used, not only as a device to negotiate and share unexpected costs and downside risk, as in the case of the wall design issue, but that it can also be used as a device for constructing quality error and allocate downside risk, as the floor issue illustrate. This finding supplement Wood and Ellis (2005) in drawing attention to the unexpected role of the partnering contract in undermining optimism and trust and in triggering guarding behaviors, self-interest and controversy. Finally yet importantly, the contract along with other planning documents such as time schedules and design- and feasibility studies, can also frame project evaluation and be used to allocate success and failure ex-post (Statsbygg 2017). However, as argued by Kreiner (2014) the realism alluded to by Statsbygg (2017) when pressing for more upfront planning could actually undermine the optimistic spirit that animates project parties to carry it through the unexpected challenges and events. If and when the optimism is undermined, the project can run an increased risk of failure, including a failure to innovate, learn and produce new knowledge. We contribute to this discussion by drawing attention to the ambiguous and dynamic role of the contract as a framing device and mechanism for both supporting and undermining optimism, innovation, trust and collaboration. When in use, the partnering contract appears to play several such more or less hybrid roles. This then in contrast to Gadde and Dubois' (2010) typology of relationships which posit that partnering in construction "cannot evolve" (p.258) since mutual orientation and adaptations are avoided. While our second vignette would agree with their claim, our first vignette does not, because it involved mutual adaptations and a joint agreement of a new target price. Trust breaks down during the events captured by the two vignettes, and the contract play a role in both supporting and undermine trust and collaboration. While Cheung *et al.*, (2003) note that trust is always a dynamic and dependent variable our case analysis of the dynamic and hybrid role of the contract also adds to the explanation of why this is so. While Bygballe *et al.*, (2010) suggest the need to consider relations outside the project and its dyadic relationship between contracting partners, our findings suggest that this social 'dyadic' relation is better conceptualized with an ANT lens as a complex and dynamic unfolding socio-technical network in which the contract also plays important roles. There is a need for further studies of the roles of the contract.

CONCLUSIONS

Our conclusion is that the partnering contract can play unexpected dynamic and hybrid roles. The 'change request' mechanism implies that the contract is inscribed with uncertainty as a prevailing condition, which appears to be useful in innovative projects with extraordinary demands for new knowledge. But it is also inscribed with guarantees in the form of liability clauses.What makes a practical difference is how project stakeholders then use or do not use the elements inscribed into the contract. Instead of attempting to eliminate uncertainty and risk by using the contract as a conventional risk management tool, it might be more useful for stakeholders if they could use the contract as a device for knowledge production and in doing so cultivate the ambition and imagination of an upside risk to partnering and innovation in sustainable construction.

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