UTS ePRESS

Construction Economics and Building

Vol. 19, No. 2
December 2019

RESEARCH ARTICLE

Incentivising innovation in the construction sector: the role of consulting contracts

Jonas Anund Vogel[1*], Hans Lind[2], Cyril Holm[3]

[1] Department of Energy Technology, Royal Institute of Technology, Brinellvägen 68, SE-10044 Stockholm, Sweden, javogel@kth.se, +46 708 23 37 26
[2] Department of Real Estate and Construction Management, Teknikringen 74 D, SE-10044 Stockholm, Sweden, hans.lind@abe.kth.se
[3] Faculty of Law, University of Oxford, St Cross Building, St Cross Road, Oxford OX1 3UL, cyril.holm@law.ox.ac.uk

***Corresponding author:** Jonas Anund Vogel, Department of Energy Technology, Royal Institute of Technology, Brinellvägen 68, SE-10044 Stockholm, Sweden, javogel@kth.se, +46 708 23 37 26

DOI: 10.5130/AJCEB.v19i2.6613
Article history: Received 23/05/2019; Revised 04/10/2019; Accepted 15/10/2019; Published 02/12/2019

Citation: Vogel, J.A., Lind, H., Holm, C. 2019. Incentivising innovation in the construction sector: the role of consulting contracts. *Construction Economics and Building*, 19:2, 181-196. https://doi.org/10.5130/AJCEB.v19i2.6613

ISSN 2204-9029 | Published by UTS ePRESS | https://epress.lib.uts.edu.au/journals/index.php/AJCEB

Abstract

The issue of whether contracts promote innovation and sustainability is an important but overlooked aspect for achieving energy and environmental targets, as well as for creating smart and sustainable cities. In this article, based on the principle/agent problem and Holmström and Milgrom's work on optimal contracts it is argued that the current general conditions of architectural and engineering consulting agreements in Sweden (ABK 09)—a standard type of contract often used in developer/consultant relations—may not incentivize choices that support the long-term goals of society. Furthermore, although this exploratory study specifically analyses a Swedish standard contract, the question of how contractual incentive structures can optimize real-world performance is a general one, and thus the article's findings have general applicability. This exploratory study also points to further research into how contractual structures impact climate-neutral buildings. In this way, Swedish consultants who use ABK 09 are incentivized to include low-risk, well-proven, and widely used technologies in order to minimize risks for themselves. This study contributes to resolving this dilemma by suggesting how ABK 09 could be restructured to change the balance between incentives and risk and incentivize innovation and sustainability. As mentioned above, the current study

DECLARATION OF CONFLICTING INTEREST The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. **FUNDING** The author(s) received no financial support for the research, authorship, and/or publication of this article.

operates at a theoretical level. It discusses six possible changes that would better align the contract with the societal goals of innovation and sustainability.

Keywords

Contracts, incentives for innovation, construction sector, institutional economics, Sweden, buildings.

Introduction

The pace of incorporating new technologies in the residential and construction industry is currently too slow to achieve today's energy-efficiency targets. Buildings are estimated to account for 30-40% of overall energy use in industrialized countries, along with almost 40% of the CO2 emissions (Berardi, 2013). Dynamic, sustainable cities need flexible buildings that will meet user preferences not only today but, in the future, while simultaneously reducing the environmental impacts of building construction and operation.

It is especially crucial to incentivize innovation and sustainability in order to achieve energy and environmental targets and to make smart and sustainable buildings and cities possible. Because novel technology carries risks alongside its advantages, developers, contractors, and consultants must have incentives to fully accept those risks if we are to meet the crucial long-term goals of society for the reduced use of resources and emissions. The design of contracts among the various parties involved is one aspect that merits investigation in order to understand how to incentivize faster adoption of technological innovation.

This paper focuses on an actor that has received limited attention in this context: consultants. The structure of the legal contract between consultants and developers or contractors influences their incentive to recommend new, more sustainable technologies and their actual recommendations to contractors on the use of such technology.

This focus is in keeping with the focus of institutional economics on the law—and contracts in particular—as a crucial element in framing incentive structures for players and in achieving real-world outcomes of those incentive structures (Coase, 1937, 1960; North and Thomas, 1973; North, 1990; Ostrom, 1990, 2005; Holmström and Milgrom, 1991, 1994). More specifically, this study uses Holmström's and Milgrom's theoretical framework on how to optimize incentive structures in the principal/agent relation (Holmström and Milgrom, 1991, 1994) to analyse incentive structures in legal contracts between consultants and contractors. The well-known principal/agent problem is a defining aspect of much of economic activity, but it is a particularly salient feature in the construction industry, which is characterized by complicated networks of players.

The thought here is that while it is relatively straightforward (and obviously necessary) to focus on technological and purely regulatory aspects of the transition to climate-neutral construction and operation, incentive structures laid out in contracts are also an important aspect of this transition, and one that has received little attention in the research. In view of the importance of the institutional economics perspective for solving so-called social dilemmas—that is, situations in which short-term incentives are detrimental to the long-term stability of an asset (such as the stability of the climate) - this perspective can contribute substantially to hastening the shift towards smart and sustainable buildings and cities through climate-neutral construction and operation practices.

This study examines one particular standard contract—ABK 09—used by consultants in the Swedish construction industry. ABK 09 is a widely used standard contract that has been developed on an ongoing basis by the non-profit organization Construction Contracts Committee (Construction Contracts Committee, 2015). The committee is an association that brings together many actors, including government authorities, civil organizations, consulting firms, and contractors. There are similar collaborations around the world that offer widely adopted standard contracts, such as the International Federation of Consulting Engineers (FIDIC) (Ndekugri, Smith and Hughes, 2007).

While this study focuses on ABK 09 and the Swedish context for that contract, such contracts are a feature of any consultant/developer/contractor cooperative undertaking. As a result, although this exploratory study focuses on ABK 09, it has direct relevance for contexts elsewhere in the world. In effect, then, it has implications for such contractual incentive structures anywhere. Importantly, it also points toward further theoretical and empirical studies to investigate the more precise role of these contractual incentive structures in speeding up the transition to smart and sustainable buildings and cities through climate-neutral construction and operation.

This study examines the details of the contract and discusses possible negative effects of the various clauses of ABK 09, as well as possible ways to restructure the contract to better balance risks and incentives: i.e. to incentivize change and innovation so as to achieve long-term sustainability goals. Here, by *change* and *innovation* we mean incentives to propose, invest in, and install technologies that contribute to smart and sustainable buildings and cities through climate-neutral construction and operation.

There are many other aspects that are important for creating the right incentives: for example, tax laws and building codes. In addition, it is suggested that researchers should also consider factors that might be of less importance in general, since secondary factors such as these could possibly disincentivize measures unless they also are adjusted.

The next section of this article describes the research approach used in this study, followed by a section on general theory. Then, after a brief introduction of laws and regulations in the Swedish construction sector, it delves into a detailed examination of the relevant clauses of the ABK. The analytical section discusses more general implications and possible remedies, followed by conclusions.

Research approach

The aim of this case study is primarily to identify problems in the current contract structure, and therefore it was decided that the best method would be an informal deductive approach. Deductive mathematical modelling is common in theoretical economics; although such models are used for different purposes, one task is to find out what *can* happen in certain situations. By making specific assumptions about the situation and the players' motives, one can deduce what will happen. Because the models always include simplifying assumptions, it is not possible to conclude that the model faithfully reflects what would happen in reality; however, if the model describes what Sugden (2000) calls a credible world, the fact that certain things happen in the model does indicate that these same things could happen in reality.

Even though no mathematical models were built in this article, the fundamental methodological idea is the same. What would be expected of a rational individual with a certain level of risk aversion in a specific situation—in this case, when the relationship to the other parties is regulated by a specific type of contract? The implications of each specific

section of the ABK are discussed, on the assumption that the parties involved are partly motivated by self-interest and are risk-averse. The study relies heavily on work from contract theory regarding how to optimize the principal/agent relation (Coase, 1937, 1960; Ostrom, 1990, 2005; Holmström and Milgrom, 1991, 1994) and focuses on what rational, profit-maximizing developers and consultants would do in different institutional environments.

Institutional knowledge is necessary in order to build a good model. Without it, the wrong simplifications might be made, and the conclusions might then not yield credible predictions. The same risk exists when a more informal approach is used. One of the authors has worked in the construction sectors for several years—indeed, this background was what led to the initial observation that the design of the consulting contracts might be problematic. This researcher's knowledge was useful in identifying the possible consequences of the contract design.

This study does not present any new empirical data and should primarily be seen as an exploratory study, in which theoretical exploration is used to fined-tune questions for future empirical studies. The possible solutions discussed here should also be investigated more thoroughly in future studies: for example, empirical studies that compare standard contracts in different countries.

General theoretical framework

Law, rules, and regulations can be effective mechanisms to solve social dilemmas (Ostrom, 1990). A social dilemma is a situation in which short-term incentives for the participants lead to actions with long-term negative consequences for society (Ostrom, 2005). Social dilemmas often occur in situations involving common-pool resources (Ostrom, 2005) such as rainforests, fresh water, clean air, or cooperatively owned buildings (Vogel, Lind and Lundqvist, 2016). Laws can mitigate situations where short-term individual incentives are detrimental to the long-term stability of shared assets (Ostrom, 1990). Broadly accepted rules and regulations accepted can thus serve to solve social dilemmas and secure assets of importance to the long-term welfare of society.

This study argues that the construction industry faces a social dilemma; in this case, the environment is a common-pool resource that is at the mercy of the short-term profit motive of individual players. From a societal perspective, we need a strong desire to construct smart and sustainable buildings with reduced environmental impact to a minimum thus contributing to the long-term survival of the planet and our species.

The questions then become how the principal legal tool for mutual exchange—the contract—(i) is designed, and (ii) could/should be designed to align incentives and risk between the developer, contractor, and consultant.

An important theoretical starting point for this article is the work of Holmström and Milgrom on the optimization of contracts, in view of the ubiquitous principal/agent problem. When a principal contracts an agent (such as when a developer contracts a consultant or a contractor) to undertake some work on the principal´s behalf, there are conflicts of interest: the agent wants to perform the contracted work minimizing its use of resources in relation to the remuneration, while the principal wants the work done on time and at optimal quality. The relationship is also characterized by information asymmetries that adversely influence incentives to allocate resources in such a way as to optimize the enduring quality of what is produced under the contract. That is, in most cases the consultant or contractor has superior first-hand information about what they are producing.

This study has identified three main areas of contract theory in the work of Holmström and Milgrom that impact the social dilemma described above: risk, time, and incentives. These areas must be addressed in order to balance short-term self-interest against long-term societal interests.

RISK

As Holmström and Milgrom (1994) point out, a perception of *shared risk* leads to acting on productive incentives. Agents can be risk-averse or risk-neutral, and contracts need to handle both extremes by properly managing risk versus incentives (Wahlgren, 2013; Holm, 2018). However, research strongly suggests that inexperienced agents are more likely to be risk-averse and tend to provide solutions that adhere to market consensus rather than solutions put forward by more experienced and risk-neutral agents. Inexperienced agents simply have more to lose by being wrong: their capabilities are more uncertainty, and therefore they tend to "play it safe" and seek to avoid "standing out from the crowd" (Scharfstein and Stein, 1990; Hong, Kubik and Solomon, 2000). Studies reveal that less-risk-averse agents prefer riskier crops (Ackerberg and Botticini, 2002)

TIME

Another pivotal problem in any principal/agent relationship is time. Many issues in such relations arise because the risk transfers from one party to the other at a certain stipulated time, eliminating incentives to achieve enduring quality and performance of a product. The issue of time is one overarching issue in the principal/agent relationship.

INCENTIVES

Contracts can be designed to incentivize performance by linking the agent's profit to observable and verifiable performance benchmarks. Performance-benchmarked contracts are often imprecise and have well-known drawbacks insofar as they are dependent on factors that may be beyond the principal's control. This results in a trade-off between offering incentives and sharing risks (Holmström and Milgrom, 1991). To overcome some of these problems, Holmström (1979) developed the *informativeness principle*, which predicts that when an agent's remuneration is linked to a performance benchmark, the contract should be indexed in such a way that exogenous factors do not impact the agent's remuneration.

Most actions in an industry are complex, multidimensional, and involve multiple actors, technologies, and subsystems that can only be partially observed and measured. Only rewarding observable activities might lead agents to focus on activities that are likely to be rewarded (Holmström and Milgrom, 1991). Holmström and Milgrom (1991) developed a model of multitasking that involves substitutes in the design. Different tasks are measured and rewarded differently, depending on factors such as their importance, their amenability to measurement, risk sharing, etc. The *multitasking model* balances the agent's focus among different potential substitutes, weighting incentives and risks so as to achieve optimal outcomes for both parties. The informativeness principle, which calls for a linkage between pay and informative measures, can be applied in simple cases. In more complex situations, where a balance of activities is desirable (such as in construction projects), it might be better to ignore some performance-related information when determining the agent's compensation.

The principal takeaways from Holmström's and Milgrom's body of work is that incentive structures matter hugely in avoiding sub-optimal contract performance. Focusing on

easily measured parameters may distort incentive structures, and so Holmström and Milgrom (Holmström, 1979; Holmström and Milgrom, 1991, 1994) developed a toolbox to fine-tune such contractual incentive structures with a view to optimizing contractual performance.

Brief overview of laws and regulations in the Swedish construction sector

The Swedish construction sector has a few overarching laws, of which the Planning and Building Law (PBL) and the Boverkets Building Regulations (BBR) are the most prominent. The PBL contains provisions regarding the planning of land and water use and construction. Its provisions aim to promote sustainable community development, equitable and satisfactory living conditions, and long-term sustainable development for existing and future generations (Swedish Parliament, 2010). Under the PBL, long-term interests should outweigh short-term interests (Prop. 1985/86:1 pp. 460). The provisions have been revised in order to foster active community participation in decision-making. The BBR, on the other hand, contains mandatory provisions and general recommendations that implement the PBL and the Planning and Building Regulation (PBF). The BBR dictates performance requirements for both residential and non-residential buildings according to geographical location and the selected heating system. The BBR further outlines requirements for the thermal envelope, energy-consuming systems, materials, and products. According to the BBR, regulatory compliance is to be achieved through measurement of actual energy use compared with the stipulated standards (Boverket, 2011).

The construction industry involves many different types of contracts among a variety of different parties, depending on how tasks are allocated. Several studies have analysed these various types of contracts: for example, Nyström, Nilsson and Lind (2016). There is a progressive trend away from Design-Bid-Build (DBB) to Design-Build (DB) contracts (Nyström, Nilsson and Lind, 2016). DB and DBB are the two main forms of contracting in the Swedish construction sector. In DB projects, the contractor has a certain degree of freedom in the design, something that is argued to support increased innovation (Nilsson and Nyström, 2014; Trafikverket, 2018). In DBB projects, the client is responsible for the design. However, case studies on road construction projects in Sweden and the UK have not evidenced a clear relationship between contract type, degrees of freedom, and the achievement of greater innovation (Hall, Holt and Graves, 2000; Nyström, Nilsson and Lind, 2016).

This article focuses on a type of contract that has not been analysed in detail before, namely contracts with technical consultants. The standard template for the Swedish construction industry for procuring services for planning buildings is the "General Conditions of Contract for Consulting Agreements for Architectural and Engineering Assignments" (ABK 09). As noted earlier, ABK 09 is the product of the Construction Contracts Committee, a non-profit organization. Likewise, there are similar collaborative efforts around the world, including the ones developed by the International Federation of Consulting Engineers (FIDIC), which provides widely adopted standard contracts (Ndekugri, Smith and Hughes, 2007).

Analysis of the General Conditions of Contract (ABK 09)

This study is concerned with two central actors in Swedish construction projects: *developers* (who manage and monitor the design phase) and *consultants* (who draw up the actual design).

Developers are in charge of locating buildings geographically (in cooperation with municipal governments), setting targets related to cost and performance, hiring consultants and contractors, and in some cases also establishing housing cooperatives for future homeowners. creating the cooperatives that will own and operate multifamily housing (Vogel, Lind and Lundqvist, 2016). The consultant is responsible for translating the developer's ideas into a functioning building, and hence they are also important for the design and performance of the building. The third central player in a building's development is the contractor, who is not considered here. However, the clauses and issues investigated in this study regarding the ABK 09 standard contract also apply to the General Conditions of Contract for Building and Civil Engineering Works and Building Services (AB 04) and General Conditions of Contract for Design and Construction Contracts for Building, Civil Engineering and Installation Works (ABT 06), as well as to any generic principal/agent-type relationships that are formalized in a contract.

Now, the question is: does the current way of organizing collaboration between developers and consultants leads to a social dilemma—that is, is the incentive structure of ABK 09 effective? This section investigates how a rational profit-maximizing consultant might interpret an important aspect of the consultant's institutional context: namely, ABK 09. This section further asks whether ABK 09 adequately addresses the three main areas identified: risk, time, and incentives. This is undertaken by looking at each section and asking the following research questions:

- Does the section in any way lead to uncompensated risks for the consultant?
- Does the section in any way lead to any uncompensated time delays for the consultant?
- Does the section in any way incentivize consultants to propose novel innovative technologies that can be expected to perform better and contribute more to sustainability than commonly used technologies?

Six sections of ABK 09 were identified that could potentially lead to weak and/or negative incentivization of consultants in proposing the best available technologies. However, the possible misalignment between short-term individual interests and long-term societal interests is present even in the very preamble of ABK 09.

PREAMBLE

When negotiating ABK 09, the objective has otherwise been to frame the terms in a manner appropriate in scope, and also from an overall industry perspective, to reconcile the interests of Clients and Consultants in conjunction with the implementation of architectural and engineering consulting assignments. ABK 09 is premised on a reasonable balance between rights and obligations, which aims for the optimal allocation of financial risk between the parties. Therefore, changes to these terms shall be avoided.

Comments

The current contract only includes an aim for optimal allocation of financial risks. This makes the current contract rather narrow since it does not mention building operation and sustainability in the design phase. It is important to include risks other than financial risks, such as technological risks and environmental risks. It is furthermore important to align shared risk over the term of a contract.

CHAPTER 2, SECTION 1

The Consultant shall implement the assignment in a professional manner and with due care, and shall also generally observe sound professional practices. (Construction Contracts Committee, 2009)

Comments

The requirement concerning professionalism and sound professional practice is not troublesome per se and may seem rather sound. However, there is no precise definition or description of the term *professionalism* in the context of planning and constructing buildings. As described in Section 3 above, research reveals that inexperienced agents tend to provide solutions that align more closely with the market consensus compared to solutions that more experienced agents propose. Inexperienced agents have more to lose by being wrong (Scharfstein and Stein, 1990; Hong, Kubik and Solomon, 2000). Without further clarification, this term could therefore result in relatively inexperienced consultants, in particular, being afraid to propose new technologies in light of the risk of being judged "unprofessional" or of having offered something that is not yet "sound professional practice."

CHAPTER 2, SECTION 6

The Client's approval does not discharge the Consultant from liability for data, the result of investigations, or technical solutions. However, the Consultant shall be discharged from liability where the Consultant proposed or presented technical solutions which the Consultant deems to be associated with particular risks and the Client approved the solutions. At the request of the Consultant, the Client shall provide an answer in such matters of approval. (Construction Contracts Committee, 2009)

If the Consultant proposes or presents a technical solution which the Consultant deems to be associated with particular risks, the demand for professionalism requires that the Consultant notify the Client of them and of the advantages and disadvantages that exist. (Construction Contracts Committee, 2009)

Comments

The consultant should, according to Chapter 2, Section 1, implement the assignment in a professional manner with due care and should also generally observe sound professional practices. This means that in order for the consultant to propose a novel innovative technology—one that according to current research can ensure the best technical and economic results for the client—the consultant must be sure that the technology performs well over a relatively long time period (10 years; see Section 2, Chapter 5). Novel innovative technologies are arguably associated with an increased risk compared to older, well-known, but less-efficient technologies. Moreover, the multitasking model reveals that agents will allocate their effort away from uncompensated activities and toward compensated activities. Investigating the exact level of "professionalism" related to a specific measure or technique is arguably an uncompensated activity. Further, the model discusses aggregate output. Proposing a novel innovative technology will most certainly also affect other parts of the building that might be outside of the consultants' control and that would require the cooperation of teams of consultants. If it is only possible to measure aggregate output, it may be difficult to contractually provide optimal incentives for each consultant due to the moral hazard of teams.

According to Section 6, Chapter 2, consultants are released from liability if the Client approves of the proposed solution, even if it might be associated with risks. However, there is a risk that the client might still pursue a liability claim against the consultant because they cannot be expected to have adequate knowledge of the proposed new solution. Current trends (Vogel et al., 2015) reveal decreasing technical competence on the developer side, along with increased usage of DB contracts, arguably making it more difficult successfully argue for a transfer of liability (Nyström, Nilsson and Lind, 2016).

This research also question the view of the relationship between client and consultant since the text states that the consultant should ask for permission to use certain kinds of technology instead of seeing it as more of a partnership relationship in which the parties share the upside/downside of riskier technologies. In passing, it is noted that this is in line with seeing the law as a fundamental instrument for lowering transaction costs, thereby leading to a more efficient outcome.

CHAPTER 4, SECTION 2

The Consultant is entitled to an extension of time if the Consultant is delayed due to circumstances which the Consultant has not caused and the effect of which the Consultant could not reasonably have eliminated. (Construction Contracts Committee, 2009)

Comments

Chapter 4, Section 2, entitles the Consultant to an extension of time if the delay is caused by circumstances that the Consultant could not reasonably have eliminated. If the Consultant proposes to use novel technologies without the Client's approval, then the Consultant most probably will not have the right to an extension of time, due to the premise of professionalism stated in Section 1, Chapter 2. This further increases the risk of trying to introduce new technologies, since such cases are likely to require extra time, especially in the case of smart buildings with complex, interacting systems.

In keeping with the comment above, we would call for more emphasis on the partnership aspect between the parties to the contract.

CHAPTER 4, SECTION 6

Liquidated damages may be agreed to for exceeding a specified deadline for delivery of the entire or part of the assignment. Where the Consultant exceeds this deadline and is not entitled to an extension of time, the agreed-to liquidated damages shall be paid. If liquidated damages have not been agreed to, the Consultant may be liable for damages for the delay. (Construction Contracts Committee, 2009)

Comments

If the introduction of novel innovative technologies results in time delays, the Consultant might not be entitled to an extension of time as discussed in Chapter 4, Section 2, and hence will be forced to pay liquidated damages. As argued in the comments of Chapter 2, Section 6, smart and sustainable buildings employ multiple interconnected systems and materials, and if it is only possible to measure aggregate output, it may be difficult to contractually provide optimal incentives for each consultant due to the moral hazard of teams. Single consultants hired using an ABK 09 contract might therefore have weak incentives to propose novel innovative technologies due to the increased risk of having to pay damages.

The issue of damages is a standard remedy for compensating parties in private legal disputes. Historically, damages have been a very successful instrument for handling risks related to long-distance maritime transport (Greif, 2006). However, this model of damages is one of distrust and not of shared risks. With that in mind, damages may be seen as a sign of distrust in the contractual relation, and this exploratory study suggests that contractual measures involving the sharing of risk over time are an important area for follow-up research.

CHAPTER 5, SECTION 1

Subject to the limitations below, the Consultant is liable for damage that the Consultant has caused the Client through lack of professionalism, disregard for customary due care, or other negligence in the implementation of the assignment. Where the Client has shown that damage has occurred and has made likely that the damage is due to an error in the Consultant's documents or an omission by the Consultant, the Consultant must show that the Consultant is not liable for the damage in order to exempt itself from liability. (Construction Contracts Committee, 2009)

The damage covered by the term need not consist of property damage but may also concern, for example, financial damage. (Construction Contracts Committee, 2009)

Comments

Section 1 of Chapter 5 adds another dimension to the problem of liability. In the commentary section, financial damage is also included among the damage that the consultant can be held liable for. This section could be used against consultants that do not propose to use novel innovative technologies that could, for example, lower a client's operation costs. At some point, novel innovative technologies become standard technology and hence the technology that should be used by a consultant acting with the professionalism that is called for in Section 1, Chapter 2. The risk related to omission of new and better technologies is, in reality, small, since it could always be argued that the risk of using new technology is higher and the consultant can thus explain and defend their use of traditional but less efficient technology. These well-established technologies might also be familiar to a client with less technological knowledge, and therefore it is unlikely that they would question it. Using well-established technologies is thus less risky than proposing new technologies, even though the latter are both more sustainable and more profitable.

CHAPTER 5, SECTION 2

The Consultant is liable for damage discovered within ten years of the date on which the Consultant's assignment is completed or otherwise terminated. (Construction Contracts Committee, 2009)

Comments

Section 2, Chapter 5 adds further risk for the Consultant, typically without any upside. When introducing novel innovative technologies, it is the client who will receive the benefits—through decreased operation costs, for example—but the risk remains with the consultant for quite a long time.

The incentive to invest in collaboration depends on the parties´ expectations of how the surplus will be shared. Ownership of assets is rather clear in the construction sector but sharing of future profits related to decreased operating and maintenance costs, as well as future service production in buildings, is typically not included in the consulting contract. This is a further area in which future research may significantly improve the inventive structures for

consultant contracts in order to optimize outcomes in terms of smart, eco-friendly buildings and cities.

General analysis and recommendations

By looking at the current industry practice for collaboration (ABK 09) through the lens of relevant parts of contract theory, this study pinpoints areas where ABK 09 theoretically could lead to misalignment between short-term incentives for individual agents and the long-term goals of both companies and society, thus contributing to a social dilemma in which the climate is the asset that is sacrificed (Ostrom, 1990).

RISK AND INCENTIVES

The consultant risks being held liable for damage connected to novel innovative technologies, while the client reaps the benefits of installing such technologies. The consultant risks

- being held liable for damage connected to proposed novel innovative technologies,
- forfeiting the possibility of time extension, and
- being forced to pay penalties if the assignment is delayed due to the introduction of novel innovative technologies.

The client, on the other hand, risks missing the opportunity to get the best available technology installed. This can lead to increased operating costs and to missed opportunities and/or future additional costs to reap the benefits of future interconnected smart cities.

The current trend of using DB contracts instead of DBB contracts is supposed to lead to increased levels of freedom for contractors and consultants and thereby stimulate innovation. However, assigning too much risk to the consultant (or the contractor) might be one reason why there have been no clear signs of increased innovation under these contracts in Sweden (see Lind and Borg, 2010; Nyström, Nilsson and Lind, 2016).

TIME

ABK 09 describes the apportionment of liabilities between the parties, but only focuses on the deadlines and scope of the current collaboration. The actual outcome of the process (how the building works during the operation stage) is not part of the collaboration. Hence, the incentive to focus on long-term sustainability is weak. To stimulate the parties to use contracts that contribute to solving a social dilemma it is important to discuss the sharing of risks over time. It is also important to include risks other than financial risks, such as technology risks, emissions risks, etc. Finally, this research seeks to challenge the recommendation that "changes to these terms shall be avoided." Instead, it is considered important that the contract structure a process for changing contractual terms, should such a change improve the balance of risks and incentives for implementing new technologies that reduce emissions and the climate impact of a building.

TERM OF LIABILITY

In ABK 09 the same liability period applies to beams and pillars and to HVAC systems and information and communication technologies (ICT), even though the long-run consequences of new technologies are more difficult to predict. Moreover, due to rapid technological development, the turnover of modern ICT systems is probably actually shorter than the term

of liability. Different terms of liability for different systems could incentivize the use of newer technologies.

THE CONCEPT OF *PROFESSIONALISM*

The use of the concept of *professionalism* in ABK 09 is a potential problem. Professionalism could be interpreted as the use of the latest technology in order to reduce resource usage and emissions, but it could also be understood as the use of proven technologies that are less efficient. Professionalism could be interpreted as performing a lifecycle analysis of the building as a system, but it could also be interpreted as calculating the direct costs for implementing a specific measure. New technology carries a risk as the downside of its advantages and finding measures that fall on the right side of risk/reward line that divides risk-free technologies from unproven, risky technologies, means looking into the past. Products and methods eventually shift from new and risky to well-proven and risk-free, but never without testing the technologies in real-world environments (Borg, 2015). Novel energy-saving technologies cannot be implemented today without adding risk to the actors who introduce them.

Moreover, younger, inexperienced consultants might not dare to propose novel technologies and their associated risks due to the possibility of damaging their reputation (Scharfstein and Stein, 1990; Hong, Kubik and Solomon, 2000). Research has also found that so-called "dominant shareholders" are better clients/principals (Bertrand and Mullainathan, 2001) and also that less-risk-averse consultants/agents prefer riskier crops, the so-called selection bias (Ackerberg and Botticini, 2002). However, teams of experienced developers with extensive knowledge of both details and operation, or developers with teams of experienced and trusted consultants, can make efficient choices under today's standard contracts. The problems discussed above are heightened when inexperienced or risk-averse consultants work together with poorly informed clients. In such a constellation there will be weak incentives for either party to prioritize sustainability and the long-term environmental impact of a building.

POSSIBLE REMEDIES

In order to achieve innovation and sustainability and to make smart and sustainable buildings and cities possible, contracts should be designed to capitalize on the full potential of the consultants' and contractors' technical knowledge, as well as the developers' operational knowledge. The four areas described above must be handled and/or investigated in order to incentivize all parties to the contract to promote and invest in smart, ecofriendly technology and climate-neutral construction and operation.

To balance the incentives and risks among the principals and agents (in this study, developers and consultants), this research proposes that the following points be considered in a future revision of the general contract terms in ABK 09 and other construction-related standard contracts in other countries:

- **Differentiate liability periods** between systems that are necessary for operation (framing, vapor barriers, roofing, etc.) and systems that are optional and continually undergoing changes and upgrades (ICT systems).
- **Incentivize consultants and contractors through the sharing of future profits**, allocating responsibilities and rewards not only during planning and construction but also operational benefits and responsibilities. This is often referred to as a performance contract. The multitasking model (Holmström and Milgrom, 1994) indicates that

agents (consultants) will redirect their efforts away from uncompensated activities and toward compensated activities. There are a number of problems with long-term incentive contracts, but it would at a minimum be possible to have a five-year bonus system for consultants related to benchmarks for certain specific costs.

- **Formalize the procedure for identifying specific technologies and systems as professionally prudent to use**. Standardize the methods for testing and evaluation, possibly also including suppliers. This change would preferably be implemented on a national level, in order to comply with national building regulations and other framework regulations, such as the municipal planning monopoly.
- **Incentivize knowledge transfer**: The study indicates that it would also be desirable to see some kind of process that mitigates risk aversion among less experienced consultants, so that there are incentives for exchange on these matters between client and consultant, and so that the process of exchange in the contract inherently incentivizes new technology and apportions the associated risks. New technologies might also be evaluated by academic committees or government authorities, as Borg (2015) discusses.
- **Include building performance or building operation into the overall objective**. The contract could be changed to include not only an aim for optimal allocation of financial risks but also long-term building performance and sustainability.
- **Damages should be limited to extreme cases of distrust in the contractual relationship, and in other cases should be replaced by a model of risk sharing.** The sharing of risks should be tied to relevant criteria, so that the parties to the contract are incentivized to spend time on work that actual contributes to partnership and risk sharing, possibly a model that builds on Holmström's multitasking model (Holmström and Milgrom, 1991). The model of damages is one of distrust and not necessarily one of shared risk.

Conclusion

In this study it has been argued that the construction industry faces a social dilemma; in this case, the environment is the common-pool resource that is at the mercy of individual players' short-term incentives for profit. From a societal perspective, strong incentives are needed to construct smart and sustainable buildings that minimize environmental impacts and that contribute to the survival of the planet and our species over the long term.

Here the study has sought to contribute ideas on how to incentivize the construction of smart and sustainable buildings, by identifying misalignments related to risk and incentives in a Swedish standardized contract, ABK 09, which is often used in developer/consultant relationships. This paper also proposes how the standard contract could be restructured to make it attractive for developers to pursue climate-neutral building construction and operation and ultimately resolve the social dilemma described above.

This study first asks how the contract is designed, then asks how it might be redesigned to align incentives and risk among developer, contractor, and consultant. Three main areas have been identified in contract theory that could impact the social dilemma described above. These areas—risk, time, and incentives—are vital to manage in order to balance short-term self-interest against long-term societal interests.

By looking at the current industry practices for collaboration (ABK 09) through the lens of the relevant parts of contract theory—in particular the work of Holmström and Milgrom on optimal contracts—six sections in ABK 09 were identified that contain weak or negative

incentives for consultants to propose the best available technologies that would favour climate-neutral construction and building operation. These sections and the misalignments they contain mostly concern risks versus incentives, deadlines, and liabilities.

Based on the misalignments that were identified, six possible structural changes to standard contracts as instruments for optimized distribution of risk and incentives were put forward that, in turn, are conducive to bridging the social dilemma of ultimate concern.

The general terms of ABK 09 function well and are widely used. The vast majority of planning processes in Sweden use the standard agreement "General Conditions of Contract for consulting Agreements for Architectural and Engineering Assignments" (ABK 09) as the basis for collaboration between developers and consultants. The document is vital for the process of planning buildings in Sweden and assures stability. However, in order to make smart and sustainable buildings an achievable reality, no matter their origin, contracts must encourage consultants and contractors to use their full technical and operational potential starting in the design phase. Risks and incentives must be balanced so as to involve all parties in investigating, promoting, and investing in innovative sustainable solutions. Undoubtedly the knowledge, technologies, and materials are available to drastically improve building performance and service production, while at the same time lowering the associated resource usage. However, the processes to actually identify and implement these technologies are not aligned with current technological development.

Even though this study focuses on ABK 09 and the Swedish context for that contract, similar contracts are a feature of any consultant/contractor cooperation. As such, this exploratory study has direct relevance for contexts other than Sweden and has implications for such contractual incentive structures anywhere. It is hoped that this study encourages others to investigate the role of incentive structures in locally used standard contracts as a means to hasten the transition to smart and sustainable buildings and cities, and climate-neutral construction and operation. The results of this study indicate a need for others to initiate similar attempts at optimizing standard contracts in the construction industry as a means to achieve societal climate goals.

If existing structures are left unchanged, there is a risk of ending up in a situation where society desires innovation and sustainability but does not incentivize these goals. The misaligned incentives, the demand for professionalism, and the asymmetrical distribution of knowledge in the construction sector create a risk of stagnation in building innovation. If clients do not take responsibility for demanding novel innovative technologies (which is not a reasonable expectation if they have less information concerning such technologies), consultants need to be incentivized to propose the use of such technologies, making smart and sustainable buildings the norm instead of something for the dedicated few.

References

Ackerberg, D. A. and Botticini, M., 2002. Endogenous Matching and the Empirical Determinants of Contract Form Endogenous Matching and the Empirical Determinants of Contract Form Maristella Botticini. *Journal of Political Economy*, 110(3), pp. 564–591. https://doi.org/10.1086/339712

Berardi, U., 2013. Clarifying the new interpretations of the concept of sustainable building. *Sustainable Cities and Society*. Elsevier B.V., 8(2013), pp. 72–78. doi: 10.1016/j.scs.2013.01.008.

Bertrand, M. and Mullainathan, S., 2001. Are CEOS Rewarded for Luck ? The Ones without Principals Are. *The Quarterly Journal of Economics*, 116(3), pp. 901–932.

Borg, L., 2015. *Procurement Contracts, Innovation and Productivity in the Construction Sector: Five Studies*.

Boverket, 2011. *Boverkets building regulations*. [online] Available at: <http://www.boverket.se/sv/lag--ratt/forfattningssamling/gallande/bbr---bfs-20116/> [Accessed 19 January 2019].

Coase, R. H., 1937. The Nature of the Firm. *Economica*, 4(16), pp. 386–405. https://doi.org/10.1111/j.1468-0335.1937.tb00002.x

Coase, R. H., 1960. The Problem of Social Cost. *The Journal of Law & Economics*, 56(4), pp. 837–877. https://doi.org/10.1086/674872

Construction Contracts Committee, 2009. *General conditions of contract, for consulting agreements for architectural and engineering assignments for the year 2009*. Stockholm: AB Svensk Byggtjänst.

Construction Contracts Committee, 2015. *Construction Contracts Committee*. AB Svensk Byggtjänst. [online] Available at: <http://www.foreningenbkk.org/index.php/the-construction-contracts-committe/> [Accessed: 7 January 2015].

Greif, A., 2006. *Institutions and the Path to the Modern Economy: Lessons from Medieval Trade*. Cambridge: Cambridge University Press.

Hall, M., Holt, R. and Graves, A., 2000. Private finance, public roads: Configuring the supply chain in PFI highway construction. *European Journal of Purchasing and Supply Management*, 6(3–4), pp. 227–235. doi: 10.1016/S0969-7012(00)00018-6.

Holm, C., 2018. Bearing and Sharing Risk in the Swedish Welfare State. in Dyson, M. (ed.) *Regulating Risk through Private Law*. Cambridge: Intersentia.

Holmström, B., 1979. Moral Hazard and Observability. *The Bell Journal of Economics*, 10(1), pp. 74–91. https://doi.org/10.2307/3003320

Holmström, B. and Milgrom, P., 1991. Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design. *Journal of Law, Economics, & Organization*, 7, pp. 24–52. doi/10.1108/ilds.2002.12230dab.004.

Holmström, B. and Milgrom, P., 1994. The Firm as an Incentive System. *The American Economic Review*, 84(4), pp. 972–991. [online] Available at: <http://www.jstor.org/stable/2646959> [Accessed 19 January 2019].

Hong, H., Kubik, J. D. and Solomon, A., 2000. Security Analysts' Career Concerns and Herding of Earnings Forecasts. *The RAND Journal of Economics*, 31(1), pp. 121–144. [online] Available at: <http://www.jstor.org/stable/2601032> [Accessed 7 January 2019].

Lind, H. and Borg, L., 2010. Service-led construction: Is it really the future?. *Construction Management and Economics*, 28(11), pp. 1145–1153. doi: 10.1080/01446193.2010.529452.

Ndekugri, I., Smith, N. and Hughes, W., 2007. The engineer under FIDIC's conditions of contract for construction. *Construction Management and Economics*, 25(7), pp. 791–799. doi: 10.1080/01446190701411216.

Nilsson, J. and Nyström, J., 2014. *Mapping railways maintenance contracts – the case of Netherlands, Finland and UK*. [online] Available at: <http://vti.diva-portal.org/smash/get/diva2:771921/FULLTEXT01.pdf> [Accessed 25 January 2019].

North, D. C., 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

North, D. C. and Thomas, R. P., 1973. *The Rise of the Western World: A New Economic History*. Cambridge: Cambridge University Press.

Nyström, J., Nilsson, J. E. and Lind, H., 2016. Degrees of freedom and innovations in construction contracts. *Transport Policy*. Elsevier, 47, pp. 119–126. doi: 10.1016/j.tranpol.2016.01.004.

Ostrom, E., 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press.

Ostrom, E., 2005. *Understanding institutional diversity*. Princeton University Press.

Scharfstein, D. S. and Stein, J. C., 1990. American Economic Association Herd Behavior and Investment. *The American Economic Review*, 80(3), pp. 465–479. [online] Available at: <https://www.jstor.org/stable/2006678> [Accessed 7 January 2019].

Sugden, R., 2000. Credible worlds : the status of theoretical models in economics. *Journal of Economic Methodology*, 7(1), pp. 1–31. doi: 10.1080/135017800362220.

Swedish Parliament, 2010. *Planning and building act*. [online] Available at: <http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Plan--och-bygglag-2010900_sfs-2010-900/>, [Accessed 19 January 2019].

Trafikverket, 2018. *Trafikverkets arbete med produktivitet och innovation i anläggningsbranschen*. [online] Available at: <https://www.trafikverket.se/contentassets/faf06a1e99bf4024ab4e8680e9ed59aa/trafikverkets-produktivitetsarbete_slutversion.pdf> [Accessed 6 January 2019].

Vogel, A.J., Lundqvist, P., Blomkvist, P. and Arias, J., 2015. Problem areas related to energy efficiency implementation in Swedish multifamily buildings. *Energy Efficiency*, 9(1), pp. 109–127. doi: 10.1007/s12053-015-9352-4.

Vogel, J., Lind, H. and Lundqvist, P., 2016. Who is Governing the Commons: Studying Swedish Housing Cooperatives. *Housing, Theory and Society*, 6096(May), pp. 1–21. doi: 10.1080/14036096.2016.1186730.

Wahlgren, P., 2013. *Legal Risk Analysis: A Proactive Legal Method*. Stockholm: Facutly of Law Book Series.