COMMUNICATION RISK IN CONTRUCTION PROJECTS: APPLICATION OF PRINCIPAL-AGENT THEORY

Prof. Anita Ceric, Ph.D.
Department of Construction Management and Economics
Faculty of Civil Engineering
University of Zagreb

anita@grad.hr

PREFACE

The four papers that follow were presented at the Engineering Project Organizations Conferences at South Lake Tahoe, California, Estes Park, Colorado, and Rheden, The Netherlands, in 2010, 2011, and 2012, as well at the International Building Council's (CIB) Conference at Montreal, Canada, in 2012. The research underlying the four papers was conducted in three stages, each of which was separated by several months. It evolved organically through the interaction with many people involved, and especially the project managers who participated in all the stages of the research itself.

Throughout, the principal-agent theory formed the basis of the research project. The relationship between the project owner and contractor was extended to include their respective project managers. The project owner is the overall principal and all the others are agents. The contractor is the principal with respect to the contractor's project manager. These four participants are crucial in every construction project. However, it is important to note that the project owner's and contractor's project managers are not in a contractual relationship with each other.

As the principal-agent theory shows, the asymmetry of information exchanged between the agents and their principals may lead to significant problems in the construction phase of major projects. The main finding of the four papers that follow is that the relationship between the two project managers is central to the construction phase itself, which is characterized by risk minimization. During this phase, the project owner and contractor play subsidiary roles. This is an important finding that should inform further research in this field. Another key research finding is that trust is the main risk-minimization strategy in the construction phase.

A previous version of this paper was presented as a plenary talk at the Engineering Project Organizations Conference at South Lake Tahoe, California, November 4-7, 2010 (Working Paper Proceedings)

THE IMPACT OF ASYMMETRIC INFORMATION ON COMMUNICATION RISK IN CONSTRUCTION PROJECTS: PROJECT MANAGERS' PERCEPTIONS

Prof. Anita Ceric, Ph.D.
Department of Construction Management and Economics
Faculty of Civil Engineering
University of Zagreb

ABSTRACT

The impact of a multiple principal-agent problem on communication risk in construction projects is addressed. The focus here is on communication issues between the project owner, the contractor, and their project managers, as well as between the two project managers working for them. These are the key four parties in any construction project. In construction projects, the principal-agent problem is even more pronounced than is usually the case because of their short-term employment relationship. This problem is characterized by three issues concerning the relationship between the principal and the agent: adverse selection, moral hazard, and hold-up. Asymmetric information is common to all three. An exploratory survey was conducted in order to establish an understanding of the relative importance of the relationships between the key project parties in terms of the above communication risks. The respondents were project managers with considerable experience in the construction field. They agree that the main relationship in a construction project before the contract is signed is that between the project owner and contractor. However, they suggest that the main relationship after the contract is signed is that between the project owner's and contractor's project managers, both of whom are agents, which points to new and promising areas for further research.

KEYWORDS: principal-agent theory, asymmetric information, communication risk, construction projects, project management

INTRODUCTION

Good communication between project participants is crucial for project success. Poor communication is one of the most common project risks (Ceric, 2003; Zerjav and Ceric, 2009). Communication within construction projects is a multifaceted phenomenon spanning multiple disciplinary fields, multiple organizational levels, as well as multiple perspectives and interpretations. Participants need to collaborate, share, collate, and integrate significant amounts of information to realize project objectives (Emmitt and Gorse, 2007; Emmitt 2010).

Information asymmetry is the situation in which one of the two parties is better informed than the other. One of the best known applications of information asymmetry in economics is the *principal-agent problem* (*e.g.*, Jäger, 2008). Either buyers or sellers do not have reliable information about a particular product or service. For example, a project owner as buyer is less well informed about the quality of a constructed facility than a contractor as seller. Similarly, a contractor as buyer is better informed about the key characteristics of a construction project—such as time, cost, and quality—than an insurance company as seller of project insurance, for instance.

The project owner and the contractor form the key relationship in construction projects (Turner and Müller, 2004). Delegation of tasks establishes a principal-agent relationship between the project owner and contractor, where the principal (project owner) depends on the agent (contractor) to undertake a task on the principal's behalf (Müller and Turner, 2005). One can act on assumption that agents will try to maximize their own benefit even when that may involve a higher damage to the client (Schieg, 2008). This problem is characterized by three issues of risk concerning the relationship between the principal and the agent: adverse selection, moral hazard, and hold-up. Briefly, adverse selection occurs when the principal does not have the exact qualifications of the agent before the contract is signed. In the case of moral hazard, the principal cannot be sure that the agent will fully act on the principal's behalf after the contract is signed. Hold-up occurs when the principal has invested some resources in the belief that the agent will behave appropriately, but the agent acts opportunistically after the contract is signed (Jäger, 2008; Schieg, 2008).

In this paper, the multiple principal-agent problem in construction projects is addressed. The three issues mentioned above are central to the argument. What makes this paper different from those published so far is that the focus here will be on communication issues between four parties involved in construction projects: project owner, contractor, and their project managers. In the literature we can find "classical" principal-agent theory applied to construction projects that discusses issues between the project owner and the project manager working on the project owner's behalf, as well as the contractor and the contractor's suppliers, but none have discussed the relationships and communication risks of all four parties mentioned above, who perforce play the most important role in every construction project.

Of course, other participants may play important roles in construction projects. These include consultants, such as designers, and sub-contractors. However, the four parties discussed here play key roles in all construction projects, as project owners and contractors typically engage project managers. Moreover, project managers involved in construction projects are typically professionals concerned with a wide variety of construction-related disciplines, most often based in civil engineering. This is why they have been selected for special attention in this research.

It should be mentioned that many papers using the principal-agent framework can be found in the construction literature. They cover a wide spectrum of issues, which do not warrant detailed analysis here because they do not address the four key parties discussed in this paper, but the most important among these papers have been classified by the key principal-agent theory issues—adverse selection, moral hazard, and hold-up. Potentially useful to future researchers in the field, the classification is presented in Table 1. It offers an indication of the relative importance of the key issues covered by the construction literature. To date, moral hazard has attracted most attention in the construction field, followed by adverse selection. The hold-up issue has attracted least attention so far.

Table 1: Key construction-related literature by main issues in principal-agent theory

ADVERSE SELECTION	MORAL HAZARD	HOLD-UP
Adriaanse, A., and Voordijk, H. (2005) Bajari, P., *et al*. (2008) Brockmann, C. (2009) Floricel, S., and Lampel, J. (1998) Holt, G., *et al*. (1995) Ive, G., and Chang, C.Y. (2007) Lampel, J., *et al*. (1996a, 1996b) Lützendorf, T., and Speer, T.M. (2005) Love, P.E.D., *et al*. (2008) Müller, R., and Turner, J.R., (2005) Ong, S. (1999) Rosenfeld, Y., and Geltner, Z. (1991) Turner, J.R., and Müller, R. (2004) Ward, S., and Chapman, C. (2008) Winch, G. (2010) Yiu, C.Y., *et al*. (2002)	Atkinson, R., *et al*. (2006) Bajari, P., and Tadelis, S. (2001) Berends, K. (2007) Corvellec, H., and Macheridis, N. (2010) Demski, J., and Dye, R. (1999) Farrell, L.M. (2003) Gonzales, M. (1998) Lampel, J., *et al*. (1996a, 1996b) Mang, P. (1998) McAfee, R., and McMillan, J. (1986). Missbauer, H., and Hauber, W. (2006) Müller, R., and Turner, J.R., (2005) Schieg, M. (2008) Sorrell, S. (2003) Turner, J.R., and Müller, R. (2004) Walker, A., and Wing, C. (1999) Ward, S., and Chapman, C. (1994) Ward, S., *et al*. (1991) Winch, G. (2010)	Bajari, P., and Tadelis, S. (2001) Chang, C.Y., and Ive, G. (2007a, 2007b) Schieg, M. (2008) Tadelis, S. (2002) Unsal, H.I., and Taylor, J.E. (2010, in press)

In the pages that follow, the principal-agent theory framework in construction projects is first introduced. Special emphasis is placed on the communication risk in connection with asymmetric information. Then an exploratory survey of project managers is presented. Collectively, they bring considerable expertise, and their perceptions of communication risks are central to this paper because they play important roles in all construction projects. A section is thus dedicated to these perceptions. The main findings of the survey follow. They are largely qualitative in nature, but they provide sufficient guidance for future research. In particular, the relationship between project managers as agents in the construction phase of a project deserves greater attention. The paper closes with conclusions that focus on future research.

PRINCIPAL-AGENT THEORY FRAMEWORK FOR CONSTRUCTION PROJECTS

The owner of a project is the person or group that provides the financial resources for its delivery, accepts the project milestones, and project completion (Project Management Institute, 2000). The project owner hires a contractor to perform all the activities required to complete the project. According to the principal-agent theory, the relationship between the two parties also involves self interest of each party, which is also shown in Figure 1.

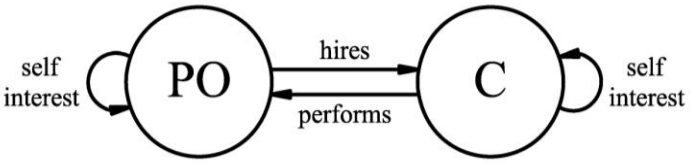


Figure 1: Project Owner - Contractor relationship (PO: Project Owner C: Contractor)

Also, the project owner and the contractor delegate their tasks to their project managers. Therefore, there are four different parties involved in the project even before its execution starts. It should be noted that the contractor's project manager is understood here as the person who is in overall charge of a particular project on contractor's behalf irrespective of the title. Namely, in some business environments this role is played by consultants.

However, it is important to note that project owner's and contractor's project managers play important roles in any construction project even though they are not in a contractual relationship with each other. They can be praised or blamed for success or failure of the project and they thus have a great moral responsibility (Corvellec and Macheridas, 2010). Because they are so important for the success of any project, their perceptions of communication risks between the key participants in construction projects should be explored in greater detail, which has not been done before.

It is commonly assumed that all participants in the project will work smoothly together in order to achieve the same goal. However, there is a potential conflict of interests between the participants because they all have their self interests, too. Extending Figure 1, the relationships between all the above mentioned participants taken together are shown in Figure 2. These are the key parties to any construction project. Considering only pairs of these parties, as is commonly the case in the existing literature, obscures the complexity of these relationships. The relationship between project managers, which has been neglected so far, is thus set in its proper context.

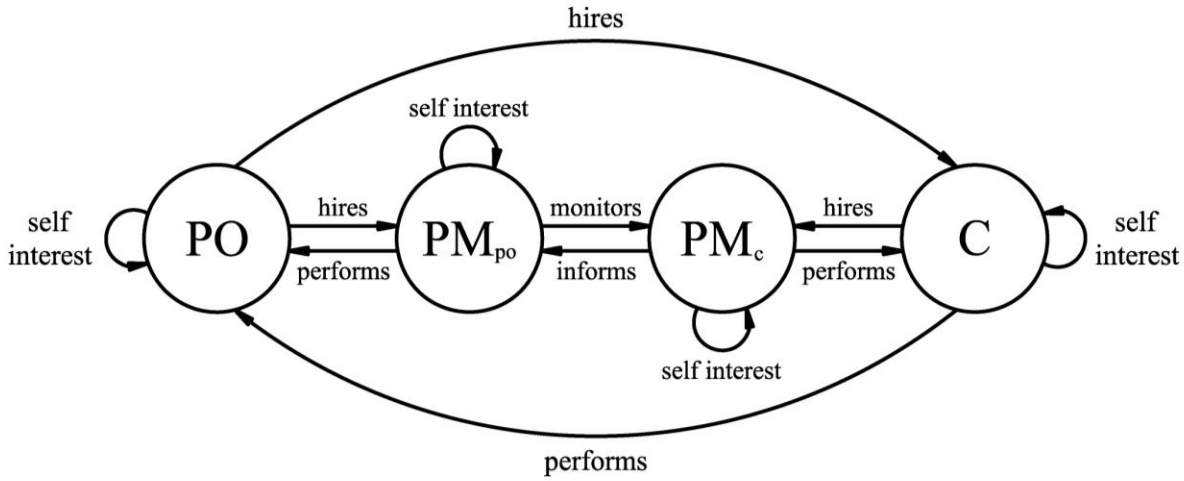


Figure 2: Principal-agent theory framework for construction projects (PO: Project owner, C: Contractor, PM_{po}: Project owner's project manager, PM_c: Contractor's project manager)

As can be seen in Figure 2, the project owner acts as the principal in relation to both the project owner's project manager and contractor as agents, and the contractor acts as the principal in relation to the contractor's project manager. Therefore, there are two principals and three agents involved, where the contractor is both the principal and agent in a project. This is why this complex set of relationships can be called a multiple principal-agent problem that needs to be addressed in the context of human resources management. Again, Figure 2 shows the key relationships that occur in every construction project.

The project owner provides the financial resources and hires the contractor. This is the key relationship in this case. According to Turner and Müller (2004), the owner is particularly interested in the following:

1. the end deliverable will meet their functional requirements
2. the right project process is being followed to successfully deliver the required end deliverables in the optimum way
3. the project will meet the required quality, budget, and schedule requirements
4. appropriate control mechanisms are in place to achieve the above
5. the project manager is behaving in a professional and trustworthy manner

The project owner hires a project manager in order to achieve the goals of the project. The project owner's project manager works closely with the contractor's project manager and monitors all the actions that the contractor's project manager takes to achieve the goals of the project, but also to satisfy the project owner. The project owner and contractor communicate in two ways: directly and indirectly—through their project managers. Although all four parties ostensibly have the same goal, they have their own self interests, as well. Some of the information will be shared only when the participants are willing to do so.

The situation in which one of the two cooperation partners is better informed than the other is characterized by *asymmetric information* (Schieg, 2008). The concept of asymmetric information is of great value to modern economic theory (Stiglitz, 2000). After Akerlof (1970), much has been written on this subject. In 2001, George Akerlof, Michael Spence, and Joseph Stiglitz shared a Nobel prize in economics for this important work.

Asymmetric information and its applications are covered by substantial literature. In the presentation of the theory, this paper relies on Jäger (2008) and Schieg (2008), which provide useful overviews of the theory. The reminder of this section of the paper follows them in the presentation of the key concepts used**.**

Asymmetric Information and Communication Risk

As argued in the Introduction, information asymmetries apply whenever the principal and the agent are not in possession of the same information at the same time. In construction projects, we have four key parties that work together, and it is assumed that they will share important information in order to meet main project's targets: time, cost, and quality. However, because of self interest, they will not be willing to share all the information all of the time. Specifically, the following types of information asymmetries apply for acting parties: *hidden characteristics*, *hidden information*, and *hidden intention.* Respectively, these three types of information asymmetries generate following risks: *adverse selection*, *moral hazard*, and *hold-up*.

Adverse selection describes information asymmetries when the principal does not have the exact qualifications of the agent. It occurs *before* the contract between them is signed. The result can be the wrong choice of the contractual partner. In the case of the moral hazard there are information asymmetries *after* the contract is signed. The principal cannot control all the agent's activities and an information imbalance in favour of the agent can occur. If the agent uses this situation opportunistically, then this type of asymmetric information is called moral hazard. If the principal makes large investments in money or other resources because of the trusty relationship with the agent, and if these investments get lost in the case that the agent acts uncooperatively, these result with the problem called hold-up. The principal has already made an irreversible investment and this enables the agent to confront the principal with excessive demands, for instance.

Asymmetric Information in Construction Projects

Based on the principal-agent theory, relationships between the project owner and contractor, as well as the two project managers are systemized according to related asymmetric information and corresponding types of risk. Hidden characteristics are associated with adverse selection; hidden action and/or hidden information are associated with moral hazard; and hidden intentions are associated with hold-up.

Hidden characteristics cause the adverse selection problem *before* the contract is signed between involved parties. It means that the project owner does not have all the information about the contractor before the contractor is hired. Similarly, the project owner does not have all the information about the project manager before hiring. The same holds for the contractor and the project manager working on the contractor's behalf. Therefore, in the case of adverse selection we have three different parties involved and three information asymmetries. The adverse selection problem occurs in the early phases of the project. Generally, these phases are the most important from the risk point of view. The early phases of a project are of particular interest because the level of influence on total project costs is highest early on, whereas the impact of early decisions on total project costs is the highest (Hendrickson and Au, 1989). The potential influence of stake-holders is also highest in the early project phases,

before a detailed agenda is set and the cost for making changes is low (Kolltveit and Grønhaug, 2004).

Hidden information or hidden action causes the moral hazard risk. This occurs *after* the contract is signed between involved parties. For example, the client cannot be sure that firms, once hired, will fully mobilize their capabilities on the client's behalf or on behalf of other clients of theirs (Winch, 2010). In our case, four parties are potentially involved in the moral hazard problem. After the relevant contracts are signed and the project owner has hired the contractor and the project manager, and after the contractor has hired the project manager, they cannot be sure that all information will be shared in an appropriate way because of their self interest. People will not act in the interest of others, their principals or partners, to the exclusion of their own preferences (Eisenhardt, 1989; Jensen, 2000). The moral hazard problem also occurs between two project managers because they have their self interest, as well.

Hidden intentions can cause hold-up problems. The project owner can invest some money at any stage of the project and trust that the contractor will cooperate, but it can happen that the contractor will act opportunistically. After the project owner realizes that the contractor is behaving opportunistically, it can be too late for the project owner to withdraw investment. The same holds in the opposite direction. The contractor can also invest some money at any stage of the project and trust that the project owner will cooperate, but it can happen that the project owner will act opportunistically.

Risk Minimization

There are several ways to minimize risks that arise from adverse selection, moral hazard, and hold-up problems. These are known as *screening* and *monitoring* (Jäger, 2008; Schieg, 2008). As both screening and monitoring represent costs, they are known in the literature as "agency costs." The purpose of screening is to gather information of use to the principal in an effort to learn more about the agent's qualifications—for instance, references, certificates, work probes, and credit worthiness. It helps reduce the adverse selection risk. Similarly, the purpose of monitoring the agents is to ascertain that they are behaving in accordance with the contract. That is, it helps reduce moral hazard and hold-up risks. In the exploratory survey presented below, monitoring will be shown to be of particular interest in this research.

EXPLORATORY SURVEY

An exploratory survey was used to establish the relative importance of communication risk sources and types of relationship in construction projects (Appendix). Since this research is exploratory in nature, a questionnaire survey was considered an appropriate tool (Bailey *et al*., 1995). The objective was to establish an understanding of the relative importance of a number of communication risks established in the literature. The respondents were project managers with considerable experience and expertise in the field. They were selected for this study because they play central roles in all construction projects. Their perceptions of communication risks are thus important. However, the survey respondents cannot be said to be representative of all project managers, the population of which is beyond the scope of this paper.

Out of thirty-five construction project managers approached, twenty-seven participated in the survey (response rate: 75 percent). Several of them were involved in an initial pilot survey to ensure its comprehensibility. On the average, the respondents had fifteen years of experience on a wide variety of construction projects. The largest projects they had managed had an average value of $1 billion. Many of the largest projects were in infrastructure, but all other types of projects were represented. Collectively, the respondents worked on construction projects in a wide range of countries on most continents. Among more than thirty countries, they worked in Egypt, Hong Kong, India, Iraq, Italy, Pakistan, Poland, Russia, Saudi Arabia, Spain, Switzerland, Turkey, the United Kingdom, and the United States. They can therefore be understood as experts in the field. The respondents were asked to offer their perceptions, and they felt comfortable expressing them.

Following the principal-agent theory, there were five main questions, which were divided into two sections. The first section concerned three issues of information asymmetry (adverse selection, moral hazard, and hold-up), which correspond to their three sources (hidden characteristics, hidden information, and hidden intentions), while the second section concerned two types of communication risk minimization (screening and monitoring). The questions were formulated in such a fashion that the above key concepts were introduced only descriptively, so as to avoid the recognition of these concepts from the literature by the respondents. The respondents were asked to rate the importance of each issue addressed in five questions in terms of the four relationships between the key project parties. The scale used was from one to nine, where the highest value was considered to be the most important.

The scale used here is ostensibly ordinal, and ordinal data do not permit statistical analysis using means and standard deviations, but only medians and ranges instead (Stevens, 1946). However, the scale used here can be meaningfully interpreted as the interval scale, as it involves only levels of importance, from least to most important. Each level of importance can be interpreted as the same as any other, and the scale can thus be interpreted as linear. In such a case, especially if the scale is sufficiently wide, it is permissible to treat the ordinal scale as an interval one (Knapp, 1990). Therefore, means and standard deviations can be used in the statistical analysis applied to the interpretation of the data.

However, this paper does not rely on statistical analysis. The means and standard deviations presented below are used mainly as indicators of the relative importance of various relationships studied. As such, they provide pointers for future research. Given the paucity of research concerning the relationship between the project managers as agents directly involved in the construction phase of a project, the exploratory survey presented here offers suggestions rather than definitive claims, let alone proofs.

PROJECT MANAGERS' PERCEPTIONS OF COMMUNICATION RISKS

Before turning to the main findings, it is useful to review the responses to the last section of the survey, which elicits the respondents' comments**.** In particular, the respondents were asked to list specific communication risks between the four project parties, as well as the most appropriate risk-minimization approaches in each of the four relationships between them. The most important responses are presented in this section so as to give substance to the argument that follows, which concerns the relative importance of each relationship in different principal-agent contexts.

A significant proportion of pertinent responses refer to the relationship between the project owner and contractor, on the one hand, and the project owner's and contractor's project managers, on the other. The latter relationship deserves special attention, as will be argued in the next section with the main findings. So far, this relationship has not received any attention from the research community concerned with the construction field, but the research reported here shows that it is crucial in the monitoring phase of the project, when construction actually takes place. What follows are pertinent comments regarding all relationships covered by this research.

Project Owner-Contractor

According to one respondent, "there is no direct communication between the project owner and contractor because project managers act as a buffer between parties. Appropriate communication protocol must be set up." Another respondent suggests that "all critical issues should be openly discussed without hidden agendas due to the very complex nature of the construction process." Yet another states that "the highest risk is the inability of the owner to clearly explain what is expected from the contractor—unclear scope definition, vague expectations, etc." Two respondents mention "incomplete progress reports" and "incomplete contract and design documents." What is needed, according to one respondent, is "clear and consistent change-management from the project owner's side." Given that the respondents perceive this relationship as crucial in construction projects before the contract is signed, as will be shown below, there is a need for better communication between them.

Project Owner-Project Owner's Manager

One respondent states that there is a "lack of on-time reports." Another states that "clear definitions of responsibilities" are needed. Clearly, this relationship deserves much more attention in the future.

Contractor-Contractor's Project Manager

According to one respondent, "the project manager should be assigned from the core of the organization, so that he or she would be in position to make better assessment concerning possible conflicts and guide the higher management." Again, much more attention is required here in future research.

Project Owner's Project Manager-Contractor's Project Manager

Six respondents state that "this relationship is the most important" after the contract is signed. According to one of them, "project owners and contractors usually have more than one project, so it is most important for their project managers to work together." Another respondent argues that "this relationship is the most subjective one." According to one respondent, "the social relationship should extend outside of the project—*i.e.* by means of their families." Another respondent suggests that "both project managers should have the same level of authority; if this is not the case, the decision-making process can be negatively affected." One respondent states that "the main risk is that the project owner asks for

improvements that are assumed to be included in the project, but the contractor assumes that they should be paid for on top of the project." As already stated, the two project managers play a key role after the contract is signed. This is especially important in the construction phase of the project.

MAIN FINDINGS

The main findings of the exploratory survey can be presented in two steps. The first concerns the first four questions, whereas the second concerns the fifth and last question, which points to an important finding regarding the relationship between the two project managers.

In the first four questions, the first three of which concern the sources of communication risk and the fourth concerns risk minimization (see Appendix), the responses suggest that the most important relationship in any project is perceived to be that between the project owner and the contractor as principal and agent. This is indicated by the highest mean values of responses and low standard deviations between them (Table 2). The second most important relationship in these four questions was that between the project owner and the project manager working on the behalf of the project owner. Again, means and standard deviations are used here mainly to indicate relative importance of different relationships rather than to demonstrate their relative strength by means of statistical analysis.

Table 2. Results of the explorative survey questionnaire.

Survey Question/Relationship		Project owner – Contractor	Project owner - Project owner's project manager	Contractor - Contractor's project manager	Project owner's project manager - Contractor's project manager
Contract partner's qualifications are not fully known before contract is signed between parties	Mean	7.48	6.85	6.12	5.96
	Standard deviation	2.26	1.93	2.22	2.44
Behavior of contract partner cannot be fully assessed after contract is signed between parties	Mean	7.30	6.96	6.24	6.96
	Standard deviation	1.54	1.48	1.76	1.80
Contract partner's intentions are not fully known after contract is signed between parties	Mean	7.41	6.85	6.48	7.04
	Standard deviation	1.72	1.96	1.44	2.07
Gathering information to learn about partner's behavior before contract is signed between parties	Mean	8.41	7.23	6.68	6.08
	Standard deviation	1.05	1.58	1.93	2.23
Gathering information to learn about partner's behavior after contract is signed between parties	Mean	7.15	6.81	6.56	7.27
	Standard deviation	1.97	1.92	1.94	2.16

The responses to the fifth and last question, which concerns risk minimization after contracts are signed between the main parties, show a novel result: according to the project managers surveyed, the most important relationship appears to be that between the project owner's and contractor's project managers, both of whom are agents. This is shown by the highest mean value, which represents an important finding. In addition, a bar chart showing all responses to this question can be found in Figure 3. It shows that eleven out of twenty-seven respondents (or 42 percent) consider this relationship the most important, as witnessed by the highest mark assigned to it. The distribution of responses is sharply skewed toward this claim. These findings suggest that the relationship between project managers, as shown in Figure 2, has thus far been neglected in the literature. It can be hoped that the diagram will therefore be useful in guiding future research.

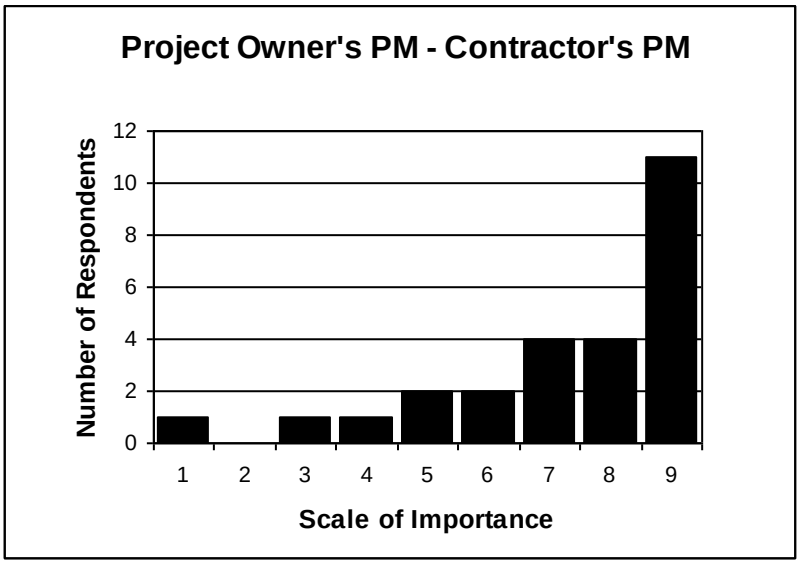


Figure 3: The relationship between the Project Owner's Project Manager and Contractor's Project Manager in the monitoring phase of a project as rated by the survey respondents on the scale from 1 to 9 (where 9 is "most important")

It is interesting to note that the standard deviation of ratings of different relationships in all five questions was highest in the case of the relationship between the project owner's and contractor's project managers. This suggests that respondents were least in agreement concerning their own role in the management of construction projects. However, it should be pointed out that the respondents appear not to have a bias regarding the importance of the relationship between the project owner and contractor, which they consider the most important one in the first four questions.

CONCLUSIONS

The main purpose of this paper was to guide future research. The exploratory survey offers an indication of the relative importance of different relationships between the key participants in construction projects. Although the results cannot be statistically demonstrated due to the

nature of the exploratory survey presented here, they still point to an important area of investigation that deserves greater attention. Future research is needed in several inter-related areas.

The relationships between the four parties shown in Figure 2 have been examined in this paper only from the horizontal axis upwards. This emphasizes the perspective of the principals involved. The lower part of the diagram, which stresses the perspective of the agents, needs to be explored in the future. In terms of the principal-agent theory, this primarily concerns risk minimization strategies by all agents involved. In particular, this involves *signalling* and *reputation*—that is, marketing and good performance (Jäger, 2008).

Future research should also consider more complex relationships between construction project participants, and especially the agents. In particular, this involves consultants, such as designers, as well as sub-contractors, of which there are many in construction projects. The relationships shown in Figure 2 can be widened to better understand the complexities of the construction process beyond the four key participants investigated here.

Of course, the relationships shown in Figure 2 are of great interest to human resource management as a field. The relationship between project owner's and contractor's project managers, as well as their teams, which often include temporary members of other firms, remains an unexplored area within human resource management.

As key agents in every project, experienced project managers can be helpful in finding ways to improve their communication, both formal and informal. The Delphi method can be used to extend this exploratory research and deepen our understanding of possible improvements in communication between project managers involved in the same project. Project managers' perceptions will be crucial in such research, as well. Throughout, the principal-agent theory promises to be most useful in guiding research design.

Akerlof and Shiller (2009) offer useful guidelines for further research into behavioral economics in general. This is a field with many promises in project management as applied to the construction field, as well. They are concerned with notions such as confidence, fairness, corruption and bad faith, and money illusion. All of these notions involve asymmetric information. Assuming such problems away only makes actual problems encountered in the project management practice that much more difficult to resolve.

ACKNOWLEDGMENTS

I would like to begin by thanking several colleagues from the University of Zagreb. Maja Lazic has been helpful in literature search. In addition to literature search, Vedran Zerjav has been helpful with exploratory survey contacts. Mladen Vukomanovic has also helped with survey contacts. Ivica Zavrski and Sinisa Matic have been helpful in the early phase of survey design.

Many people from other universities and other institutions have been helpful with survey contacts: Peter Brandon, Talat Birgönül, Tarek Hassan, George Ofori, Roberto Pietroforte, Rafael Sacks, and Davor Tremac. I am grateful to all.

Also, a number of people have been most helpful with their comments on previous versions of this paper: Syed Ahmed, Ranko Bon, Jan Bröchner, Andy Dainty, Gerard de Valence, Stephen Emmitt, Medhat Etman, Stephen Gruneberg, Will Hughes, Henry Irwig, Kalle Kahkonen, Baris Nazlim, Ralf Müller, George Ofori, Roberto Pietroforte, Les Ruddock, Goran Runeson, Martin Schieg, Alfredo Serpell, Guillem Sivecas, and two anonymous referees for the Engineering Project Organization Conference 2010.

Of course, I am especially thankful to all project managers who have participated in the exploratory survey: Tarek Bahgat, Steve Burrows, Nicola Costantino, Serap Ciliz, Andy Dainty, Irem Dikmen Toker, Ahmet Erol, Medhat Etman, Gulsah Fidan, Cihat Gurel, Henry Irwig, Ekin İşisağ, Mete Demir, Sinisa Matic, Ferit Oncel Mocan, Baris Nazlim, George Ofori, David Owen, Sinisa Radakovic, Ophir Rozenfeld, Wilhelm Reismann, Aydin Sakin, Rifat Sonmez, Guillem Sivecas, Vladimir Skendrovic, Ertugrul Unluturk, and Ivica Zavrski. Although the survey questionnaire states that all private information will remain confidential, the respondents have seen the last version of the paper and have subsequently agreed to be listed in the Acknowledgments.

Last but not least, I would like to thank the Ministry of Science of the Republic of Croatia for the sponsorship of the five-year research project under my supervision entitled "Human resource management in construction projects" (Project Code Number: 082-0822156-2998).

REFERENCES

Adriaanse, A. and Voordijk, H. (2005), "Interorganizational Communication and ICT in Construction Projects: A Review Using Metatriangulation." *Construction Innovation*, Vol. 5, No. 3, pp. 159-177.

Akerlof, G. (1970), The Market for Lemons: Quality, Uncertainty, and the Market Mechanism, *Quarterly Journal of Economics*, Vol. 84, No. 3, pp. 488-500.

Akerlof, G. and Shiller, R. (2009), *Animal Spirits: How Human Psychology Drives the Economy and Why it Matters for Global Capitalism*, Princeton, New Jersey, Princeton University Press.

Atkinson, R., Crawford, L. and Ward, S. (2006), Fundamental Uncertainties in Projects and the Scope of Project Management, *International Journal of Project Management*, Vol. 24, No. 8, pp. 687-698.

Bajari, P., McMillan, R. and Tadelis, S. (2008), Auctions versus Negotiations in Procurement: An Empirical Analysis, *Journal of Law, Economics, and Organization*, Vol. 25, No. 2, pp. 372-399.

Bajari, P. and Tadelis, S. (2001), Incentives versus Transaction Costs: A Theory of Procurement Contracts, *RAND Journal of Economics*, Vol. 32, No. 3, pp. 387-407.

Berends, K. (2007), Engineering and Construction Projects for Oil and Gas Processing Facilities: Contracting, Uncertainty and the Economics of Information, *Energy Policy*, Vol. 35, No. 8, pp. 4260-4270.

Biley, V., Bemrose, G., Goddard, S., Joslyn, E. and Mackness, J. (1995), *Essential Research Skill*, London, Collins Educational, pp. 60-62.

Brockmann, C. (2009), Global Construction Markets and Contractors, in Ruddock, L. (Ed.), *Economics for the Modern Built Environment*, Oxon, Taylor and Francis, pp. 168-199.

Ceric, A. (2003), *A Framework for Process-Driven Risk Management in Construction Projects*, PhD Thesis, Research Institute for the Built & Human Environment, School of Construction and Property Management, University of Salford, Salford.

Chang, C.Y. and Ive, G. (2007a), The Hold-Up Problem in the Management of Construction Projects: A Case Study of the Channel Tunnel, *International Journal of Project Management*, Vol. 25, No. 4, pp. 394-404.

Chang, C.Y. and Ive, G. (2007b), Reversal of Bargaining Power in Construction Projects: Meaning, Existence, and Implications, *Construction Management and Economics*, Vol. 25, No. 8, pp. 845-855.

Corvellec, H. and Macheridis, N. (2010), The Moral Responsibilities of Project Selectors, *International Journal of Project Management*, Vol. 28, No. 3, pp. 212-219.

Demski, J. and Dye, R. (1999), Risk, Return, and Moral Hazard, *Journal of Accounting Research*, Vol. 37, No. 1, pp. 27-55.

Eisenhardt, M.K. (1989), Agency Theory: An Assessment and Review, *Academy of Management Review*, Vol. 14, No. 1, pp. 57-75.

Emmitt, S. and Gorse, C. (2007), *Communication in Construction Teams*, Oxon, Taylor and Francis.

Emmitt, S. (2010), *Managing Interdisciplinary Projects: A Primer for Architecture, Engineering, and Construction*, Oxon, Spon Press.

Farrell, L. M. (2003), Principal-Agency Risk in Project Finance, *International Journal of Project Management*, Vol. 21, No. 8, pp. 547-561.

Floricel, S. and Lampel, J. (1998), Innovative Contractual Structures for Inter-Organizational Systems, *International Journal of Technology Management*, Vol. 16, No. 1, pp. 193-206.

González, M., Arruñada, B. and Fernández, A. (1998), Regulation as a Cause of Firm Fragmentation: The Case of the Spanish Construction Industry, *International Review of Law and Economics*, Vol. 18, No. 4, pp. 433-450.

Holt, G. D., Olomolaiye, P.O. and Harris, F. C. (1995), A Review of Contractor Selection Practice in the U.K. Construction Industry, *Building and Environment*, Vol. 30, No. 4, pp. 553-561.

Hendrickson, C. and Au, T. (1989), *Project Management for Construction: Fundamental Concepts for Owners, Engineers, Architects and Builders*, Upper Saddle River, New Jersey, Prentice Hall.

Ive, G. and Chang, C.Y. (2007), The Principle of Inconsistent Trinity in the Selection of Procurement Systems, *Construction Management and Economics*, Vol. 25, No. 7, pp. 677-690.

Jäger, C. (2008), *The Principal-Agent—Theory within the Context of Economic Sciences*, Norderstadt, Herstellung und Verlag, Books on Demand GmbH.

Jensen, M.C. (2000), *The Theory of the Firm: Governance, Residual Claims, and Organizational Forms*, Cambridge, Massachusetts, Harvard University Press.

Knapp, T.R. (1990), Treating Ordinal Scales as Interval Scales: An Attempt to Resolve the Controversy, *Nursing Research*, Vol. 39, No. 2, pp. 121-123.

Kolltveit, B.J. and Grønhaug, K. (2004), "The Importance of the Early Phase: The Case of Construction and Building Projects", *International Journal of Project Management*, Vol. 22, pp. 545-551.

Lampel, J, Miller, R. and Floricel, S. (1996a), Information Asymmetries and Technological Innovation in Large Engineering Construction Projects, *R&D Management*, Vol. 26, No. 4, pp. 357-369.

Lampel, J., Miller, R. and Floricel, S. (1996b), Impact of Owner Involvement on Innovation in Large Projects: Lessons from Power Plants Construction, *International Business Review*, Vol. 5, No. 6, pp. 561-578.

Love, P.E.D., Davis, P., London, K. and Jasper, T. (2008), Causal Modeling of Construction Disputes, Dainty, A. (Ed.), *Proceedings of the 24th Annual ARCOM Conference*, pp. 869-878.

Lützendorf, T. and Speer, T.M. (2005), Alleviating Asymmetric Information in Property Market: Building Performance and Product Quality as Signals for Consumers, *Building Research and information*, Vol. 33, No. 2, pp. 182-195.

Mang, P. (1998), Exploiting Innovation Options: An Empirical Analysis of R&D-Intensive Firms, *Journal of Economic Behavior & Organization*, Vol. 35, No. 2, pp. 229-242.

McAfee, R. and J. McMillan (1986), Bidding for Contracts: A Principal-Agent Analysis, *RAND Journal of Economics*, Vol. 17, No. 3, pp. 326-338.

Missbauer, H. and Hauber, W. (2006), Bid Calculation for Construction Projects: Regulations and Incentive Effects of Unit Price Contracts, *European Journal of Operational Research*, Vol. 171, No. 3, pp. 1005-1019.

Müller, R. and Turner, J.R. (2005), The Impact of Principal-Agent Relationship and Contract Type on Communication between Project Owner and Manager, *International Journal of Project Management*, Vol. 23, No. 5, pp. 398-403.

Ong, S. (1999), Caveat emptor: Adverse Selection in Buying Properties under Construction, *Property Management*, Vol. 17, No. 1, pp. 49-64.

Project Management Institute (2000), *A Guide to the Project Management Body of Knowledge*, Newton Square, Pennsylvania.

Rosenfeld, Y. and Geltner, D. (1991), Cost-Plus and Incentive Contracting: Some False Benefits and Inherent Drawbacks, *Construction Management and Economics*, Vol. 9, No. 5, pp. 481-490.

Schieg, M. (2008), Strategies for Avoiding Asymmetric Information in Construction Project Management, *Journal of Business Economics and Management*, Vol. 9, No. 1, pp. 47-51.

Sorrell, S. (2003), Making the Link: Climate Policy and the Reform of the UK Construction Industry, *Energy Policy*, Vol. 31, No. 9, pp. 865-878.

Stevens, S.S. (1946), On the Theory of Scales of Measurement, *Science*, Vol. 103, No. 2684, pp. 677-680.

Stiglitz, J.E. (2000), The Contribution of the Economics of Information to Twentieth Century Economics, *The Quarterly Journal of Economics*, Vol. 115, No. 4, pp. 1441-1478.

Tadelis, S. (2002), Complexity, Flexibility, and the Make-or-Buy Decision, *American Economic Review*; Vol. 92, No. 2, pp. 433-437.

Turner, R. and Müller, R. (2004), Communication and Cooperation on Projects between the Project Owner as Principal and the Project Manager as Agent, *European Management Journal*, Vol. 22, No. 3, pp. 327-336.

Unsal, H.I. and Taylor, J.E. (2010), Modelling Inter-Firm Dependency: A Game-Theoretic Simulation to Examine the Hold-Up Problem in Project Networks, *Journal of Construction Engineering and Management*, in press.

Walker, A. and Wing, C.K. (1999), The Relationship between Construction Project Management Theory and Transaction Cost Economics, *Engineering, Construction and Architectural Management*, Vol. 6, No. 2, pp. 166-176.

Ward, S., Chapman, C. and Curtis, B. (1991), On the Allocation of Risk in Construction Projects, *International Journal of Project Management*, Vol. 9, No. 3, pp. 140-147.

Ward, S. and Chapman, C. (1994), Choosing Contractor Payment Terms, *International Journal of Project Management*, Vol. 12, No. 4, pp. 216-221.

Ward, S. and Chapman, C. (2008), Stakeholders and Uncertainty Management in Projects, *Construction Management and Economics*, Vol. 26, No. 6, pp. 563-577

Winch, G. (2010), *Managing Construction Projects*, Oxford, Blackwell Science.

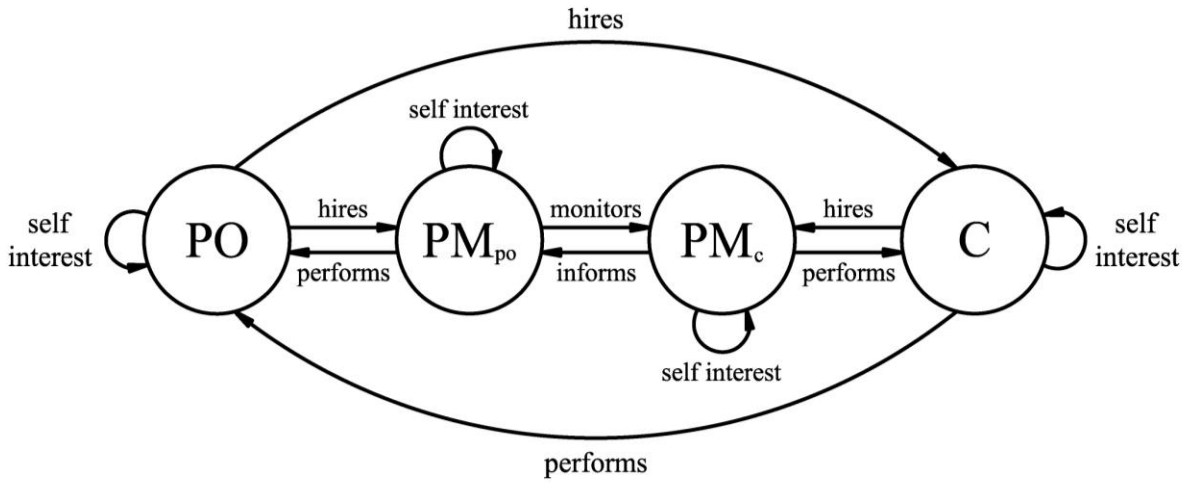
Yiu, C.Y., Lo, S.M., Ng, S.T. and Ng, M.M.F. (2002), Contractor Selection for Small Building Works in Hong Kong, *Structural Survey*, Vol. 20, No. 4, pp. 129-135.

Zerjav, V. and Ceric, A. (2009), Structuring Communication within Construction Projects—A Communication Breakdown Structure, *Proceedings of the 25th Annual Conference*, Dainty A. (Ed.), Nottingham, ARCOM.

APPENDIX: SURVEY QUESTIONNAIRE

COMMUNICATION RISKS IN CONSTRUCTION PROJECTS — INTRODUCTION

This research has to do with the relationship between the project owner, contractor, and their project managers (see diagram below). These four parties are crucial to the success of every project. This research focuses on risks associated with their communication. Research to date has shown that communication is of vital importance to the success of construction projects. The focus here is on information asymmetry in the project-management process. An example of information asymmetry is when one party does not fully know what the other knows or does. It has been shown that this form of asymmetry is central to explaining key problems in many other fields. Extending this research to construction management may in time contribute to its further development.



PO: Project owner
C: Contractor
PM_{po}: Owner's project manager
PM_c: Contractor's project manager

SURVEY QUESTIONS

A. General information

Note that all private information will remain confidential. Only statistical data pertaining to all respondents will be made public.

1. Name:
2. Educational background:
3. Professional qualifications:
4. Current job title:
5. Years of experience in project management:
6. Value of largest project managed in $US:
7. Countries where worked:

B. Information asymmetry – Sources of communication risk

Note that information asymmetry changes once the contracts between different parties involved in a project are signed. Only three contracts are involved in the process as described in the diagram above. These are contracts between the project owner and contractor, as well as contracts between them and their project managers.

Please use the scale from 1 to 9 (where 9 is "most important") to rate the importance of each relationship between project parties in terms of communication risk involved:

From – To	Project owner - Contractor	Project owner - Owner's project manager	Contractor - Contractor's project manager	Owner's project manager - Contractor's project manager
Contract partner's qualifications are not fully known before contract is signed between parties				
Behavior of contract partner cannot be fully assessed after contract is signed between parties				
Contract partner's intentions are not fully known after contract is signed between parties				

Please comment on the communication relationships above that you consider most important:

C. Risk minimization – Ways to reduce information asymmetry

As in Part B above, information asymmetry changes once the contracts between different parties involved in a project are signed. Again, there are only three contracts involved: between the project owner and contractor, as well as contracts between them and their project managers.

Please use the scale from 1 to 9 (where 9 is "most important") to rate the importance of each relationship between project parties in terms of communication-risk minimization:

From – To	Project owner - Contractor	Project owner - Owner's project manager	Contractor - Contractor's project manager	Owner's project manager - Contractor's project manager
Gathering information to learn about partner's behavior before contract is signed between parties				
Gathering information to learn about partner's behavior after contract is signed between parties				

Please comment on the communication relationships above that you consider most important:

D. Communication risks

Please list specific communication risks between the project parties that you consider most important for project success. If possible, also list most appropriate risk-minimization approaches in each case.

Project owner – contractor:
Project owner – Owner's project manager:
Contractor – Contractor's project manager:
Owner's project manager – Contractor's project manager:

A previous version of this paper was presented at the Engineering Project Organizations Conference at Estes Park, Colorado, August 9-11, 2011 (Working Papers Proceedings)

MINIMIZING COMMUNICATION RISK IN CONSTRUCTION: A DELPHI STUDY OF THE KEY ROLE OF PROJECT MANAGERS

Prof. Anita Ceric, Ph.D.
Department of Construction Management and Economics
Faculty of Civil Engineering
University of Zagreb

ABSTRACT

All significant construction projects involve the project owner and the contractor, as well as their project managers. Following upon recent research into the multiple principal-agent problem, which was applied to the minimization of communication risk in construction projects, the focus here is on communication issues between the four project parties. Recent research has shown that the relationship between the project owner and the contractor is paramount for risk minimization *before* the contract between them is signed. However, the relationship between project managers is dominant for risk minimization *after* the contract is signed. To further explore risk minimization at this stage of the project, the Delphi method was employed. A panel of highly-experienced project managers working for both project owners and contractors was asked several rounds of questions in an attempt to arrive to a consensus concerning the most important relationships between project parties in terms of risk minimization after the contract is signed. The relationship between the two project managers tops the ranking, thus focusing further research. As they are both agents, and as there is no contract between them, this offers a fresh challenge for the principal-agent theory.

Keywords: principal-agent theory, communication risk, construction projects, project management, Delphi method

INTRODUCTION

Good communication between key participants is essential for the success of every construction project. Poor communication is one of the most common project risks (Ceric, 2003). Communication involves sharing relevant information between project participants. It is commonly assumed that all participants cooperate and exchange information in order to achieve project's goals. However, there is a potential conflict of interests between project participants because they all have their own interests, as well.

The situation in which one of the two parties is better informed than the other is well known in economics as the *principal-agent problem* (*e.g*., Jäger, 2008). In construction projects, the project owner and contractor as principal and agent form the key relationship (Turner and Müller, 2004). Delegation of tasks establishes a principal-agent relationship between the project owner and manager, where the principal (project owner) depends on the agent (contractor or project manager) to undertake a task on the principal's behalf (Müller and Turner, 2005). One can act on assumption that an agent will try to maximize his or her own benefit even when that may involve a higher damage to the client (Schieg, 2008). According to the principal-agent theory, this problem is characterized by three issues concerning the relationship between the principal and the agent: adverse selection, moral hazard, and hold-up. These three issues will be discussed in the next section.

The literature review shows that the application of the principal-agent problem in construction is extensive. It covers all three issues of risk concerning the relationship between the principal and agent: adverse selection, moral hazard, and hold-up. Analyzing papers that have been published so far, it can be concluded that most authors have researched moral hazard dealing with supply chain management, procurement systems, make-or-buy decisions, and outsourcing (Rosenfeld and Geltner, 1991; Tedelis, 2002; Yiu *et al*., 2002; Ive and Chang, 2007). Some authors have discussed the adverse selection problem and its impact on building performance and building quality (Holt *et al*., 1995; Corvellec and Macheridis, 2010). It should be noted that the hold-up problem dealing with sub-contracting and procurement systems has attracted least attention so far (Chang and Ive, 2007; Unsal and Taylor, 2010). A more detailed analysis of the key construction literature covering all three issues can be found in Ceric (2010). However, the literature does not cover the relationship between project managers in construction projects, which is at the core of the research presented in this paper.

The research presented here was conducted in two phases. In the first phase, an exploratory survey of project managers with considerable experience was used to establish the relative importance of communication risk sources and types of relationship in construction projects. The focus was placed on project managers because they are most intimate with the construction process itself. It was found that the relationship between the project owner and contractor is the most important before the contract is signed between them (Ceric, 2010). It should be pointed out that this finding suggests that there was no bias among the respondents. It was also found that, after the contract is signed between the project owner and contractor, the most important relationship for risk minimization in the process of monitoring is that between the project owner's and contractor's project managers.

In the second phase, the Delphi method was used to investigate this important finding in greater detail. This method can be valuable for developing theory (Okoli and Pawlowski,

2004). The focus was placed on the monitoring process itself, which is central to risk minimization during construction. The exploratory survey was considered to be the first round of the Delphi method, which requires a number of iterations, and two additional rounds were then conducted. The same survey technique was used throughout.

In the pages that follow, asymmetric information and communication risk are first introduced. Next, the principal-agent theory framework in construction projects is presented. Special emphasis is placed on the communication risk in connection with asymmetric information. Then the research method is discussed. The results of the Delphi survey are presented in two sections: first, the respondents' perceptions of risk minimization are discussed; second, the main findings are presented. Then the limitations of the study are briefly discussed. The paper closes with conclusions including ideas for future research.

ASYMMETRIC INFORMATION AND COMMUNICATION RISK

There is a large literature on asymmetric information and its applications. Only a few sources will be used in this section for explanatory purposes. In particular, the presentation relies on Jäger (2008) and Schieg (2008). Again, Ceric (2010) provides a much wider discussion of the relevant literature.

Asymmetric information occurs whenever the principal and the agent are not in possession of the same information at the same time. In construction projects, there are four key parties who work together: the project owner, the contractor, and their project managers. It is customarily assumed that they will share important information in order to meet the main project targets: time, cost, and quality. However, because of self interest, the four parties will not be willing to share all the information all of the time. The following types of information asymmetry apply in cases like this one: *hidden characteristics*, *hidden information*, and *hidden intention.* Respectively, these three types of information asymmetry generate the following risks: *adverse selection, moral hazard*, and *hold-up*.

Adverse selection describes information asymmetries when the principal does not have the exact qualifications of the agent. It occurs *before* the contract is signed and the result can be the wrong choice of the contractual partner. In the case of moral hazard there are information asymmetries *after* the contract is signed. The principal cannot control all the agent's activities and an information imbalance in favor of the agent can thus occur. If the agent uses this situation opportunistically, then this type of asymmetric information is called moral hazard. If the principal makes large investments in money or other resources because of the trusty relationship with the agent, and if these investments come into jeopardy in the case the agent acts uncooperatively, the resulting problem is called hold-up. The principal has already made an irreversible investment and this enables the agent to confront him with excessive demands, for instance.

Construction Projects

Based on the principal-agent theory, the relationships between the project owner, the contractor, and their project managers are systemized according to the related types of asymmetric information and the corresponding types of risk. Again, hidden characteristics

are associated with adverse selection; hidden action and/or hidden information are associated with moral hazard; and hidden intentions are associated with hold-up.

Hidden characteristics cause the adverse selection problem *before* contracts are signed between the parties involved. The most important among them is the contract between the project owner and the contractor. Adverse selection means that the project owner does not have all the information about the contractor before the contractor is hired. Similarly, the project owner does not have all the information about the project manager before hiring. The same holds for the contractor and the project manager hired. The adverse selection problem occurs in the early phases of the project. Generally, these phases are important from the point of view of risk. The early phases of a project are of particular interest because the level of influence on total project costs is highest early on; also, the impact of early decisions on total project costs is the highest (Hendrickson and Au, 1989). The potential influence of stake-holders is also highest in the early project phases, before a detailed agenda is set and the cost for making changes is relatively low (Kolltveit and Grønhaug, 2004).

Hidden information or hidden action causes the moral hazard risk. This occurs *after* contracts are signed between the parties involved. Again, the contract between the project owner and the contractor is the most important among them. Moral hazard means that the client cannot be sure that the companies, once hired, will fully mobilize their capabilities on the client's behalf or on behalf of other clients of theirs (Winch, 2000). In our case, four parties are potentially involved in the moral hazard problem. After the contract is signed and the project owner has hired the contractor, as well as after the project owner and the contractor have hired their project managers, they cannot be sure that all the relevant information will be shared in an appropriate way because of their self interest. People will not act in the interest of others, their principals or partners, to the exclusion of their own preferences (Eisenhardt, 1989; Jensen, 2000). The moral hazard problem also occurs between two project managers because they have their own self interest, as well.

Hidden intentions can cause hold-up problems. The project owner can invest resources at any stage of the project in trust that the contractor will cooperate, but it can happen that the contractor will act opportunistically. After the project owner realizes that the contractor is behaving opportunistically, it can be too late for the project owner to withdraw the resources already invested.

Risk Minimization

There are several ways to minimize risks that arise from adverse selection, moral hazard, and hold-up problems. These are *screening* and *monitoring*. The former is relevant before the contract is signed, whereas the latter is relevant after signing. The purpose of screening is to gather information of use to the principal in an effort to learn more about the agent's qualifications — for instance, references, certificates, work probes, and credit worthiness. Similarly, the purpose of monitoring is to ascertain that the agent is behaving in accordance with the contract. As both of these are costs, they are known in the literature as "agency costs."

PRINCIPAL-AGENT THEORY FRAMEWORK FOR CONSTRUCTION PROJECTS

The owner of a project is the person or group who provides the financial resources for its delivery, accepts the project milestones, and project completion (Project Management Institute, 2000). The project owner hires a contractor to perform all the activities required to complete the project (Figure 1).

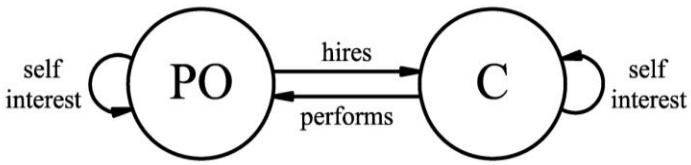


Figure 1: Project Owner - Contractor relationship (PO: Project Owner, C: Contractor)

Both the project owner and contractor in any major project are represented by their project managers, to whom many of their tasks are delegated. Together, they can be considered the four key parties to every major project (Figure 2).

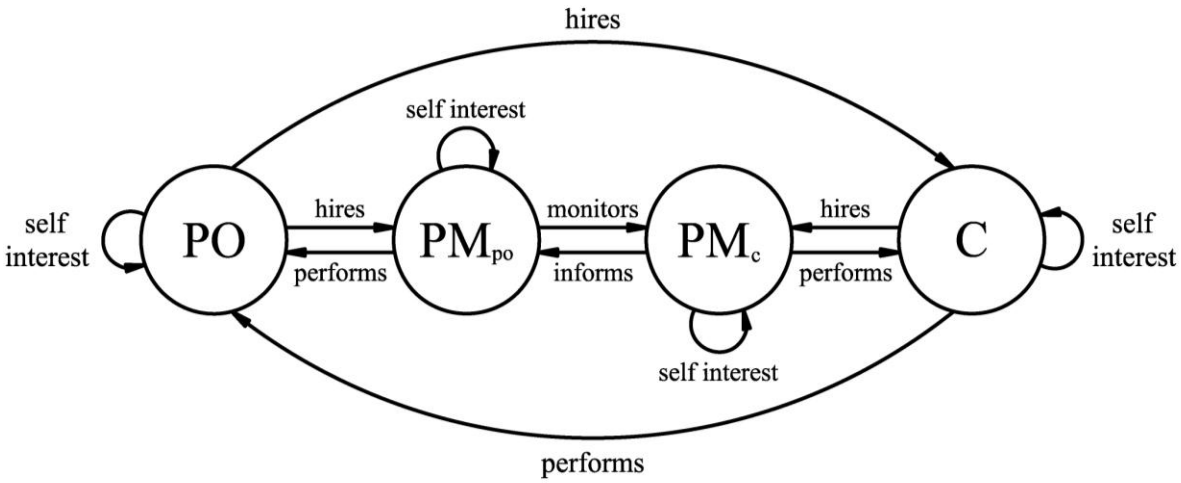


Figure 2: Principal-agent theory framework for construction projects (PO: Project owner, C: Contractor, PM_{po}: Project owner's project manager, PM_c: Contractor's project manager)

From the point of view of risk minimization, monitoring is the key project-management activity after the contract between the project owner and contractor is signed. This suggests that the relationship between the project owner's and contractor's project managers is therefore the key relationship at this stage of the project.

RESEARCH METHOD

At any one time, project managers are geographically spread apart, as well as not available for consultation over lengthy periods of time. Therefore, the Delphi method was chosen as an appropriate approach to survey their opinion. The Delphi method was introduced by the Rand Corporation in the 1950s with the objective of obtaining the most reliable consensus from a group of experts. It is especially effective in difficult areas that can benefit from subjective judgements on a collective basis (Lindeman, 1975). A panel of ten to fifteen experts has proved to be a good guideline (Delbecq *et al*., 1975). The consensus is reached through structured communication involving feedback over several iterations (Linstone and Turoff, 1975). At each iteration, each respondent can see the responses to the previous iterations of all other respondents without knowing who they are. It makes it possible for experts to change their previous assessments in the light of new information provided by their peers (Chan *et al*., 2001). The objective of these iterations is to achieve the desired level of consensus among panellists, for which measures of central tendency and level of dispersion are typically used to present the collective judgement of respondents (see, *e.g.*, Hsu and Sandford, 2007). The method is especially suitable when time and cost constraints make frequent face-to-face meetings difficult to arrange (Ericsson and Henricsson, 2005).

One of the standard problems with the application of the Delphi method is the selection of the experts (Sharkey and Sharples, 2001; Yousuf, 2007; Hsu and Sandford, 2007). This is especially important when it is not possible to ascertain the degree to which the selection is representative of the population in question. In this research, three criteria were used to select the project managers for the study:

1. Level of experience as measured by the years involved in the field;
2. Size of the largest project managed in terms of its monetary value; and
3. Involvement in a variety of projects as measured by the number of countries covered.

There were three Delphi rounds in the research reported here. The first round took two weeks, while the other two took one week each. The results of the first round can be found in Ceric (2010), where it was presented as an exploratory survey. Out of 35 experts in the field of project management originally selected for the exploratory survey in accordance with the three criteria presented above, 27 responded (response rate: 75 percent). They all come from different organizations working in different environments. They have worked both for project owners and contractors. Also, they have worked in more than thirty countries on most continents.

For the second round, 20 of the 27 respondents were selected by sharpening the above criteria for the purposes of the Delphi method. Given the focus on risk minimization in the construction phase, the project managers with greatest experience in the field were selected. All of them were practitioners with considerable expertise, as witnessed by their thirteen years of experience on the average, and the average of the largest project they managed assessed at $1.4 billion, of which the latter was considered more important than the former. Also, they had considerable international experience. Collectively, they had worked on all continents. In the second round, 15 out of 20 selected respondents participated (response rate: 75 percent).

In the third and final Delphi round, 11 out of 15 respondents took part (response rate: 73 percent). Also, 7 out of 15 respondents, or 47 percent, chose to modify their scores in view of the results of the second Delphi round. Survey questions for the last two Delphi rounds can be found in Appendices A and B.

Given that one of the fundamental goals of the Delphi method is the achievement of a satisfactory consensus between panel experts, it is necessary to conduct a quantitative analysis of the consensus by means of a non-parametric statistical test. One of the metrics that is widely recognized as the best is Kendall's coefficient of concordance, W (Okoli and Pawlowski, 1990). Kendall's W takes on values between zero and one (Kendall and Gibbons, 1990). The value of zero means that that there is no agreement between the experts, meaning that the achieved consensus is a matter of chance. The value of one represents full agreement between the experts, meaning that all of them have provided identical answers. Schmidt (1997) proposes that Kendal's W offers the best measure of agreement in the application of the Delphi method. According to him, W = 0.5 represents moderate agreement and a fair confidence in rankings, whereas W = 0.7 represents strong agreement and high confidence in rankings.

RISK MINIMIZATION: RESPONDENTS' PERCEPTIONS

Before moving to the main findings, the results will be presented starting with the last section of the survey, in which the respondents were asked to list specific communication risks between the project parties, as well as to list most appropriate risk-minimization approaches in each case. The most important responses are presented in this section so as to give substance to the argument that follows. The majority of pertinent responses concerns the relationship between the project owner and contractor, on the one hand, and the project owner's and contractor's project managers, on the other. The latter relationship deserves special attention, as will be argued in the next section. So far, this relationship has not received sufficient notice from the research community concerned with the construction field.

Referring to communication in general, three respondents argue that all the relationships addressed in this survey would be much improved by "regular meetings" and "regular reporting," as well as a "greater flow of information" between project parties. As another respondent points out, the main message to project parties is that they should "communicate properly." These are important pointers for future research.

Project Owner-Contractor

This is the relationship between the principal and the agent. It is central to the principal-agent theory. However, the project managers surveyed have many critical comments about this relationship. According to one respondent, there is "no direct communication between the project owner and contractor because project managers act as buffers between parties; an appropriate communication protocol must be set up." Another respondent suggests that "all critical issues should be openly discussed without hidden agendas due to the very complex nature of the construction process." Yet another states that "the highest risk is the inability of the owner to clearly explain what is expected from the contractor—unclear scope definition, vague expectations, etc." Two respondents mention "incomplete progress reports" and

"incomplete contract and design documents" as special problems. What is needed, according to one respondent, is "clear and consistent change-management from the project owner's side." Another points out that "there is almost no communication between the project owner and the contractor once the contract is signed." Yet another respondent argues that "the most important thing is to prepare detailed and understandable contracts." One respondent points out that both parties to the contract "should assess the previous experiences, financial ability, and capacity of the opposite side."

Project Owner-Project Owner's Project Manager

This is the relationship between the principal and an agent hired by the principal to monitor another agent, the contractor. Again, the project managers surveyed report a number of problems regarding this relationship. One respondent states that there is a "lack of on-time reports." Another points out that "clear definitions of responsibilities" are needed. According to one respondent, it is essential that the project owner "clearly explains the goals of the project to its project manager in order to avoid confusions." Another states that "the project owner may fail to define the company's strategy to its project manager." One respondent mentions "unclear targets, sometimes close to 'hidden agendas,' from the project owner's side." Another states that "on-time updates regarding decisions by the project owner" are necessary. According to yet another respondent, "a long-term relationship between the project owner and its project manager should be preferred to better understand each other."

Contractor-Contractor's Project Manager

In this case, the contractor acts as the principal in relation to the agent directly involved in a project. The relationship has its own difficulties. One respondent argues that "the project manager should be assigned from the core of organization, so that he/she would be in position to make better assessment concerning possible conflicts and guide the higher management." Another states that "the contractor's project manager cannot be successful without higher management support." According to one respondent, there is "a need for a well-established reporting system and regular site visits to ensure that the contractor's project manager is acting properly." Yet another respondent points out that "the contractor should have follow-up and reporting mechanisms, so as to avoid problems."

Project Owner's Project Manager-Contractor's Project Manager

The two agents, one working for the principal and another for the contractor as an agent, are in most direct relationship during a construction project, and especially in its monitoring phase. Most project managers surveyed consider this relationship crucial during construction itself. Six respondents state that "this relationship is the most important" after the contract is signed. According to one of them, "project owners and contractors usually have more than one project, so it is most important for their project managers to work together." Another respondent argues that "this relationship is the most subjective one." "Informal information flow" between the two project managers is stressed by yet another respondent. One respondent points out that "most projects fail on the personal level." According to one

respondent, "the social relationship should extend outside of the project—i.e. by means of their families." "Some social activities, such as company banquets, may be helpful in providing an informal atmosphere," states one respondent. Another one suggests that "both project managers should have the same level of authority; if this is not the case, the decision-making process can be negatively affected." According to yet another respondent, "the main risk is that the project owner asks for improvements regarding the project that he assumes are included in the project, but the contractor assumes that they should be paid for on top of the project."

MAIN FINDINGS

The previous exploratory survey concerned the relationships between pairs of four key project participants (Ceric, 2010). It focused on the relationships in the upper part of the diagram shown in Figure 2. The relative importance of these pairs in risk minimization *after* the contract is signed is shown below (Table 1). In particular, the relationship between the two project managers was considered by the respondents to the exploratory survey to be most important for risk minimization. The results shown in the table below are those for the twenty practitioners of project management selected for further research. Throughout, the scale from 1 to 9 (where 9 is most important) is used to rate the importance of each relationship between project parties in terms of the communication risk involved.

Table 1: Delphi Round One

Rank	Relationship	Mean	St. Dev.
1	Project owner's project manager → Contractor's project manager	7.70	1.66
2	Project owner → Contractor	7.30	1.63
3	Project owner → Project owner's project manager	6.90	1.65
4	Contractor → Contractor's project manager	6.74	1.66

Round Two of the Delphi method considers all relationships shown by arrows in Figure 2 (Table 2). Several results are noteworthy. First, the relationship between the contractor's project manager and project owner's project manager come on top (8.39). The reverse relationship is not far behind (8.00). Second, the relationship between the project owner and project owner's project manager comes next in terms of risk minimization during the construction phase (7.07). The reverse relationship is some way behind in terms of relative importance (6.61). Third, it should be noted that the same score applies to the relationship between the contractor and project owner. The relationship between the project owner and contractor is close behind (6.57). Fourth, the relationship between the contractor and contractor's project manager, as well as the reverse relationship, come last in terms of importance in risk minimization (6.43 and 6.39).

Following the second Delphi round conducted in the research presented here, the obtained concordance coefficient $W = 0.319$ with the level of significance $\alpha < 0.0001$. This represents a weak agreement between the experts, which necessitates another Delphi round.

Table 2: Delphi Round Two

Rank	Relationship	Mean	St. Dev.
1	Contractor's project manager → Project owner's project manager	8.39	0.74
2	Project owner's project manager → Contractor's project manager	8.00	1.96
3	Project owner → Project owner's project manager	7.07	1.14
4	Project owner's project manager → Project owner	6.61	1.30
5	Contractor → Project owner	6.61	2.08
6	Project owner → Contractor	6.57	2.21
7	Contractor → Contractor's project manager	6.43	1.22
8	Contractor's project manager → Contractor	6.39	1.27

Round Three of the Delphi method provides a wide range of mean scores (Table 3). A number of important results follow. First, the relationship between the two project managers comes on top in terms of the scores. Although the relationship between the project owner's project manager and the contractor's project manager comes on top (8.57), the reverse relationship is not far behind (8.46). It can be concluded that both relationships are similar in terms of their importance in risk minimization in the construction phase of a project. Second, the relationship between the project owner and project owner's project manager comes next in terms of importance (7.07). However, the reverse relationship is considerably less important according to the respondents (6.61). A strong asymmetry can be noted here by comparison with all the other relationships considered in this research. Third, the relationship between the project owner and contractor, as well as the reverse relationship, come next in terms of importance in risk minimization (6.79 and 6.71). The scores suggest that these two relationships are of similar importance to project success. Fourth, the relationship between the contractor and contractor's project manager are considered by the respondents to be least important (6.57 and 6.36). Again, these relationships are quite similar in terms of their relative importance.

Following the third Delphi round, the obtained concordance coefficient $W = 0.430$ with the level of significance $\alpha < 0.0001$. The Kendall's coefficient of concordance has increased by 35 percent, which shows that the agreement between the experts has also increased by the same percentage. Since the achieved value of W is considerably smaller than 0.7, it is necessary to consider the need for the fourth Delphi round. The analysis was performed by using the non-parametric Spearman's rank correlation test (Siegel and Castellan, 1988). The ordered relationships between participating experts in Delphi rounds two and three were correlated. Spearman's rank correlation coefficient rho = 0.905 was calculated. A value so high indicates a strong interdependence of results achieved in the second and third Delphi round. In conclusion, the fourth Delphi round would be unlikely to change the rankings of the relationships between the respondents, as well as Kendall's coefficient of concordance. Therefore the fourth Delphi round was considered unnecessary.

Table 3: Delphi Round Three

Rank	Relationship	Mean	St. Dev.
1	Project owner's project manager → Contractor's project manager	8.57	0.65
2	Contractor's project manager → Project owner's project manager	8.46	0.63
3	Project owner → Project owner's project manager	7.07	1.07
4	Project owner → Contractor	6.79	0.97
5	Contractor → Project owner	6.71	0.99
6	Project owner's project manager → Project owner	6.61	1.18
7	Contractor → Contractor's project manager	6.57	1.16
8	Contractor's project manager → Contractor	6.36	1.15

As can be seen by comparing the results of the three rounds as presented in Tables 1-3, the importance of the project owner's and contractor's project managers grows in importance through the Delphi process. This can be seen through the growing mean values of the scores. It is important to note that the two project managers exchange their places twice over the rounds, which demonstrates that monitoring is a two-way process. The two project managers as agents of the principal and the main agent—that is, the project owner and contractor—dominate the construction process in terms of importance.

However, there is no contract between these two agents. As construction is a crucial stage of any project, this finding requires careful scrutiny in terms of the importance of agents in the principal-agent theoretical framework. In the case of construction, further theoretical development is needed to better understand the best approach to risk minimization in the monitoring process.

LIMITATIONS

The Delphi method is an appropriate tool for investigation of project managers' perceptions. It facilitates reaching a meaningful consensus in these perceptions. However, one of the limitations of the Delphi method is that different panels of experts may come to somewhat different conclusions in terms of specific results. Therefore, the tool can be used to provide a focus for further research rather than to arrive at definite results.

CONCLUSIONS

The research presented here offers new challenges for the principal-agent theory. In construction, the project owner is the principal and contractor is the agent. However, both of them have their own agents. The two project managers play key roles in the construction

phase of every major project, when both the project owner and contractor play subsidiary roles on account of project complexity and duration. This is when project managers, although agents, play key roles in construction projects.

Although project managers may act cooperatively with their principals, they may also act opportunistically, as the principal-agent theory points out. Therefore, the theoretical framework needs to be extended to encompass the interaction between the key agents involved in construction projects, especially when there are no contracts between the agents. A better understanding of that interaction is likely to be of value to other fields in which project managers play key roles in the execution of complex projects.

The intricacies of the monitoring process, which is at the focus of the research presented here, will require much more detailed investigation of project managers and their interaction to arrive at the most promising interplay between formal and informal communication during construction. For instance, communication protocols defined in contracts may help improve the monitoring process. Such an investigation could be best achieved by means of interviews and/or focus groups. Many pointers for further study can be found in the above section outlining the respondents' perceptions. They offer a useful guidance for further research.

ACKNOWLEDGMENTS

I would like to thank four anonymous referees for the Engineering Project Organization Conference 2011.

I very much appreciate the contribution of the respondents to the last two rounds of the survey: Stephen Burrows, Mete Demir, Ahmet Erol, Medhat Etman, Gulsah Fidan, Cihat Gurel, Sinisa Matic, Ferit Oncel Mocan, Baris Nazlim, Sinisa Radakovic, Wilhelm Reismann, Ophir Rozenfeld, Aydin Sakin, Gullem Sivecas Gibert, and Ertugrul Unluturk. I would like to thank them all.

Last but not least, I would like to thank the Ministry of Science of the Republic of Croatia for the sponsorship of the five-year research project under my supervision entitled "Human resource management in construction projects" (Project Code Number: 082-0822156-2998).

REFERENCES

Ceric, A. (2003), *A Framework for Process-Driven Risk Management in Construction Projects*, PhD Thesis, Research Institute for the Built & Human Environment, School of Construction and Property Management, University of Salford, Salford.

Ceric, A. (2010), The Impact of Asymmetric Information on Communication in Construction Projects, Working Paper Proceedings, Engineering Projects Organizations Conference, South Lake Tahoe, California, November 4-7.

Chan, A.P.C., Yung, E.H.K., Lam, P.T.I., Tam, C.M. and Cheung, S.O. (2001), Application of Delphi Method in Selection of Procurement Systems for Construction Projects, *Construction Management and Economics*, Vol. 19, pp. 699-718.

Chang, C.Y. and Ive, G. (2007), The Hold-Up Problem in the Management of Construction Projects: A Case Study of the Channel Tunnel, *International Journal of Project Management*, Vol. 25, No. 4, pp. 394-404.

Corvellec, H. and Macheridis, N. (2010), The Moral Responsibilities of Project Selectors, *International Journal of Project Management*, Vol. 28, No. 3, pp. 212-219.

Delbecq, A.L., Van de Ven, A.H. and Gustafsson, D.H. (1975), *Group Techniques for Program Planning: A Guide to Nominal Group and Delphi Processes*, Glenview, Illinois: Scott-Foreman and Co.

Eisenhardt, M.K. (1989), Agency theory: An assessment and Review, *Academy of Management Review*, Vol. 14, No. 1, pp. 57-75.

Ericsson, S. and Henricsson, J.P.E. (2005), Deconstructing Construction Competitiveness—The Initial Results of a Delphi Survey in Finland, Sweden and the UK, In: Sidwell, A.C. (Ed.), *Proceedings of Construction and Building Research (COBRA) Conference*, 4-8 July, Queensland University of Technology, Brisbane, Australia. RICS Foundation.

Hasson, F., Keeney, S. and McKenna, H. (2000), Research Guidlines for the Delphi Survey Technique, *Journal of Advanced Nursing*, Vol. 32, No. 4, pp. 1008-1015.

Hendrickson, C. and Au, T. (1989), *Project Management for Construction: Fundamental Concepts for Owners, Engineers, Architects, and Builders*, Upper Saddle River, New Jersey, Prentice Hall.

Holt, G. D., Olomolaiye, P.O. and Harris, F. C. (1995), A Review of Contractor Selection Practice in the U.K. Construction Industry, *Building and Environment*, Vol. 30, No. 4, pp. 553-561.

Hsu, C.C. and Sandford, B.A. (2007), The Delphi Technique: Making Sense of Consensus, *Practical Assessment, Research & Evaluation*, Vol. 12, No. 10, pp. 1-8.

Ive, G. and Chang, C.Y. (2007), The Principle of Inconsistent Trinity in the Selection of Procurement Systems, *Construction Management and Economics*, Vol. 25, No. 7, pp. 677-690.

Jäger, C. (2008), *The Principal-Agent Theory within the Context of Economic Sciences*, Norderstadt, Herstellung und Verlag, Books on Demand GmbH.

Jensen, M.C. (2000), *The Theory of the Firm: Governance, Residual Claims, and Organizational Forms*, Cambridge, Massachusetts, Harvard University Press.

Kendall, M. G. and Gibbons, J. D. (1990), *Rank correlation methods*, London: Edward Arnold.

Kolltveit, B.J. and Grønhaug, K. (2004), "The Importance of the Early Phase: The Case of Construction and Building Projects", *International Journal of Project Management*, Vol. 22, pp. 545-551.

Lindeman, C.A. (1975), Delphi-Survey of Priorities in Clinical Nursing Research, *Nursing Research*, Vol. 24, No. 6, pp. 434-441.

Linstone, H.A. and Turoff, M. (1975), *The Delphi Method: Techniques and Applications*, Reading, Mass., Addison-Wesley.

Müller, R. and Turner, J.R. (2005), The Impact of Principal-Agent Relationship and Contract Type on Communication between Project Owner and Manager, *International Journal of Project Management*, Vol. 23, pp. 398-403.

Okoli, C. and Pawlowski, S.D. (2004), The Delphi Method as a Research Tool: An Example, Design Considerations and Applications, *Information & Management*, Vol. 42, pp. 15-29.

Project Management Institute (2000), *A Guide to the Project Management Body of Knowledge*, Newton Square, Pennsylvania.

Rosenfeld, Y. and Geltner, D. (1991), Cost-Plus and Incentive Contracting: Some False Benefits and Inherent Drawbacks, *Construction Management and Economics*, Vol. 9, No. 5, pp. 481-490.

Schieg, M. (2008), Strategies for Avoiding Asymmetric Information in Construction Project Management, *Journal of Business Economics and Management*, Vol. 9, No. 1, pp. 47-51.

Sharkey, S.B. and Sharples, A.Y. (2001), An Approach to Consensus Building Using the Delphi Technique: Developing a Learning Resource in Mental Health, *Nurse Education Today*, Vol. 21, pp. 398-408.

Siegel, S. and Castellan, N. (1988) *Nonparametric Statistics for the Behavioural Sciences*, McGraw-Hill, New York.

Schmidt, R.C. (1997), Managing Delphi Surveys Using Nonparametric Statistical Techniques. *Decision Sciences*,Vol. 28, No 3, pp. 763-774.

Tadelis, S. (2002), Complexity, Flexibility, and the Make-or-Buy Decision, *American Economic Review*, Vol. 92, No. 2, pp. 433-437.

Turner, R. and Müller, R. (2004), Communication and Co-operation on Projects between the Project Owner as Principal and the Project Manager as Agent, *European Management Journal*, Vol. 22, No. 3, pp. 327-336.

Unsal, H.I. and Taylor, J.E. (2010), Modelling Inter-Firm Dependency: A Game-Theoretic Simulation to Examine the Hold-Up Problem in Project Networks, *Journal of Construction Engineering and Management*, in press.

Winch, G. (2002), *Managing Construction Projects*, Oxford, Blackwell Science.

Yiu, C.Y., Lo, S.M., Ng, S.T. and Ng, M.M.F. (2002), Contractor Selection for Small Building Works in Hong Kong, *Structural Survey*, Vol. 20, No. 4, pp. 129-135.

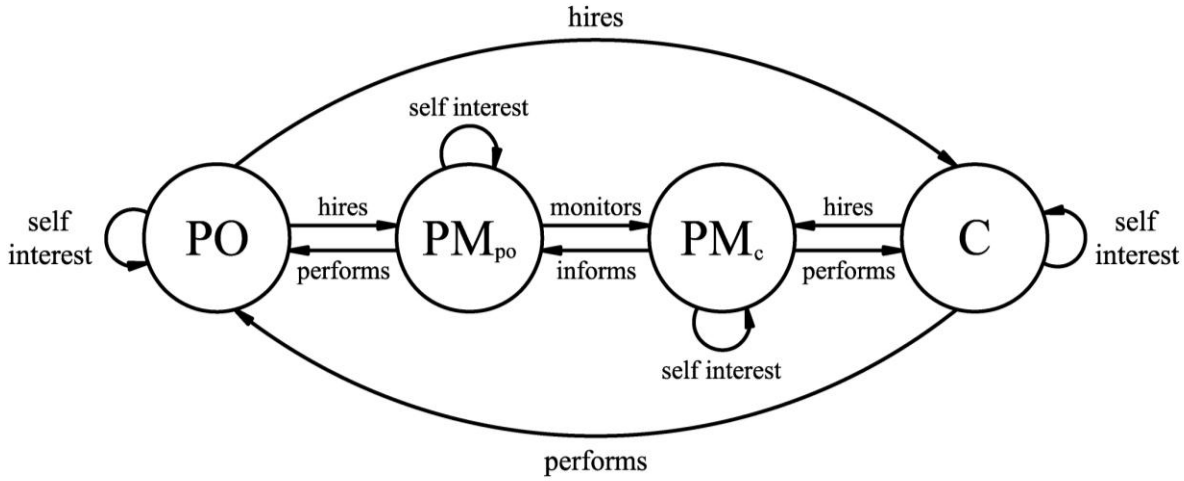
Yousuf, M.I. (2007), Using Experts' Opinion Through Delphi Technique, *Practical Assessment, Research & Evaluation*, Vol. 12, No. 4, pp. 1-8.

APPENDIX A: SECOND DELPHI ROUND

SURVEY QUESTIONNAIRE

COMMUNICATION RISKS IN CONSTRUCTION PROJECTS — INTRODUCTION

This research concerns the relationship between the project owner, contractor, and their project managers (see diagram below). These four parties are crucial to the success of every project. This research focuses on risks associated with their communication. The focus here is on information asymmetry in the project-management process. An example of information asymmetry is when one party does not fully know what the other knows or does.



PO: Project owner
C: Contractor
PM_{po}: Project owner's project manager
PM_c: Contractor's project manager

This survey follows upon the previous one, which can be thought of as its first round. Twenty practitioners of project management have been selected for the next two rounds. Both in terms of years of experience and of project size managed, they can be considered experts in the field.

The previous survey concerned the relationships between pairs of four key project participants. It focused on the relationships in the upper part of the diagram above. The relative importance of these pairs in risk minimization *after* the contract is signed is shown in the table below. In particular, the relationship between the two project managers was considered by the respondents to the previous survey to be most important for risk minimization. The results shown in the table below are those for the twenty practitioners of project management selected for further research.

Note that the means represent the level of importance on the scale from 1 to 9 (where 9 is "most important"). Also note that all standard deviations between the twenty respondents selected for further research were quite low and uniform across the four pairs. That means that there was little disagreement between the respondents.

Survey question/Relationship		Project owner → Contractor	Project owner → Project owner's project manager	Contractor → Contractor's project manager	Project owner's project manager → Contractor's project manager
Gathering information to learn about partner's behavior after contract is signed between parties	Mean	7.30	6.90	6.74	7.70
	Standard deviation	1.63	1.65	1.66	1.66

SURVEY QUESTIONS

A. General information

Note that personal information will remain private.

Name:

B. Risk minimization – Relative importance of relationships between project parties

In this round of the research all relationships between the four key parties to a project are considered. These are shown on both upper and lower sides of the diagram above. This involves all relationships between all parties involved.

Note that information asymmetry changes once the contracts between different parties involved in a project are signed. Only three contracts are involved in the process. These are contracts between the project owner and contractor, as well as contracts between them and their project managers. Also note that only eight relationships are considered here. They are shown in the diagram above by eight arrows. Self interest is also not considered here. The relationships which are not considered are to be left blank in the boxes of the table below.

Please use the scale from 1 to 9 (where 9 is "most important") to rate the importance of each relationship between project parties in terms of communication risk involved:

From (row) → To (column)	Project owner	Project owner's project manager	Contractor's project manager	Contractor
Project owner	Leave blank		Leave blank	
Project owner's project manager		Leave blank		Leave blank
Contractor's project manager	Leave blank		Leave blank	
Contractor		Leave blank		Leave blank

APPENDIX B: THIRD DELPHI ROUND

SURVEY QUESTIONNAIRE

COMMUNICATION RISKS IN CONSTRUCTION PROJECTS — INTRODUCTION

The aim of this survey is to reach a consensus between project-management experts on the most important relationships between the key project parties in terms of risk minimization in the construction phase of the project, *after* the contract is signed.

The results of the previous survey round are shown in the table below. This is the state of consensus at present stage. Both means or averages and standard deviations are shown, where standard deviations show mean or average deviations from means. The smaller they are, the greater the agreement.

From (row) → To (column)		Project Owner	Project owner's project manager	Contractor's project manager	Contractor
Project owner	Mean		7.07		6.57
	St. Deviation		1.14		2.21
Project owner's project manager	Mean	6.61		8.00	
	St. Deviation	1.30		1.96	
Contractor's project manager	Mean		8.39		6.39
	St. Deviation		0.74		1.27
Contractor	Mean	6.61		6.43	
	St. Deviation	2.08		1.22	

SURVEY QUESTIONS

A. General information

Note that personal information will remain private.

Name:

B. Risk minimization – Relative importance of relationships between project parties

Having seen the results of the previous round, or the consensus between experts at present stage, you may wish to reconsider your previous responses. But this is by no means required. However, if you do wish to modify your previous responses, use the table below.

Please use the scale from 1 to 9 (where 9 is "most important") to rate the importance of each relationship between project parties in terms of communication risk involved:

From (row) → To (column)	Project owner	Project owner's project manager	Contractor's project manager	Contractor
Project owner	Leave blank		Leave blank	
Project owner's project manager		Leave blank		Leave blank
Contractor's project manager	Leave blank		Leave blank	
Contractor		Leave blank		Leave blank

C. Communication risk minimization

Please list specific communication risks between the project parties that you consider most important for project success *after* the contract is signed. If possible, also list most appropriate risk-minimization approaches in each case.

Project owner → Contractor:
Contractor → Project owner:

Project owner → Project owner's project manager:
Project owner's project manager → Project owner:

Contractor → Contractor's project manager:
Contractor's project manager → Contractor

Project owner's project manager → Contractor's project manager:
Contractor's project manager → Project owner's project manager:

A previous version of this paper was presented at the International Building Council's (CIB) Conference at Montreal, Canada, June 26-29, 2012 (Proceedings)

THE PRINCIPAL-AGENT THEORY AND THE ROLE OF PROJECT MANAGERS IN CONSTRUCTION: GUIDELINES FOR FUTURE RESEARCH

Prof. Anita Ceric, Ph.D.
Department of Construction Management and Economics
Faculty of Civil Engineering
University of Zagreb

ABSTRACT

The principal-agent theory has been successfully applied to the research of management of construction projects. It has focused on the relationship between the project owner as principal and the contractor as agent. Also, the relationship between the contractor as principal and sub-contractors as agents has been explored. After introducing the literature in this field, this paper will present recent research into the relationship between the project owner's and contractor's project managers along the lines of the principal-agent theory. An exploratory survey was used at the first stage of research. After the exploratory survey, the Delphi method was employed for further exploration of the issues involved. It has been shown that the two managers play key roles in the construction phase even though they are both agents not related by contracts. Having summarized this research, the paper addresses the opportunities for further research in this area, which offers a challenge to the principal-agent theory in the field of construction. Guidelines for future research take the central part of the paper. They focus on communication risks caused by asymmetric information, which are of central importance to the principal-agent theory.

KEYWORDS: principal-agent theory, communication risk, asymmetric information, project management

INTRODUCTION

Good communication between key participants is most important for the success of every construction project. Communication involves sharing relevant information between project participants. Poor communication has been shown to be one of the most common project risks (Ceric, 2003). It is usually assumed that all participants cooperate and exchange information in order to achieve project's goals. Actually, there is a potential conflict of interests between project participants because they all have their own interests, as well.

The situation in which one of the two parties is better informed than the other is recognized in economics as the *principal-agent problem* (*e.g.*, Jäger, 2008). In construction projects, the project owner and contractor as principal and agent form the key relationship (Turner and Müller, 2004). Delegation of tasks establishes a principal-agent relationship between the project owner and manager, where the principal (project owner) depends on the agent (contractor or project manager) to undertake a task on the principal's behalf (Müller and Turner, 2005). It can be assumed that an agent will try to maximize his or her own benefit even when that may involve a higher damage to the client (Schieg, 2008). According to the principal-agent theory, this problem is characterized by three issues concerning the relationship between the principal and the agent: adverse selection, moral hazard, and hold-up. These three issues will be discussed in the following section.

The literature review shows that the application of the principal-agent theory in construction is extensive. It covers all three issues of risk concerning the relationship between the principal and agent: adverse selection, moral hazard, and hold-up. Analyzing papers that have been published so far, it can be concluded that most authors have researched moral hazard dealing with supply chain management, procurement systems, make-or-buy decisions, and outsourcing (Rosenfeld and Geltner, 1991; Tedelis, 2002; Yiu *et al*., 2002; Ive and Chang, 2007). Several authors have discussed the adverse selection problem and its impact on building performance and building quality (Holt *et al*., 1995; Corvellec and Macheridis, 2010). It should be noted that the hold-up problem dealing with sub-contracting and procurement systems has attracted least attention so far (Chang and Ive, 2007; Unsal and Taylor, 2010). A more detailed analysis of the key construction literature covering all three issues can be found in Ceric (2010). However, the literature does not cover the relationship between project managers in construction projects, which is central to the research outlined in this paper.

In the pages that follow, the principal-agent theory in construction is introduced first. A short summary of previous research conducted by the author is presented next (Ceric 2010; 2011). The paper closes with guidelines for future research regarding the application of the principal-agent theory to construction projects.

PRINCIPAL-AGENT THEORY AND INFORMATION ASYMMETRIES IN CONSTRUCTION PROJECTS

The owner of a project is the person or group that provides the financial resources for its delivery, accepts the project milestones, and project completion (Project Management Institute, 2000). In a standard situation, the project owner hires a contractor to perform all the activities required to complete the project. According to the principal-agent theory, the

relationship between the two parties also involves self interest of each party, which is also shown in Figure 1.

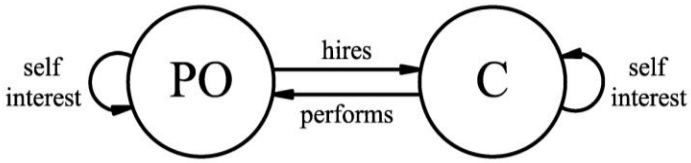


Figure 1: Project Owner - Contractor relationship (PO: Project Owner C: Contractor)

Also, the project owner and the contractor delegate their tasks to their project managers. Therefore, there are four different parties involved in the project even before its execution starts. It should be noted that the contractor's project manager is understood here as the person who is in overall charge of a particular project on contractor's behalf irrespective of the title. Namely, in some business environments this role is played by consultants. It is commonly assumed that all participants in the project will work together in order to achieve the same goal. However, there is a potential conflict of interests between the participants because they all have their self interests, too. Extending Figure 1, the relationships between all the above-mentioned participants taken together are shown in Figure 2. These are the key parties to any construction project.

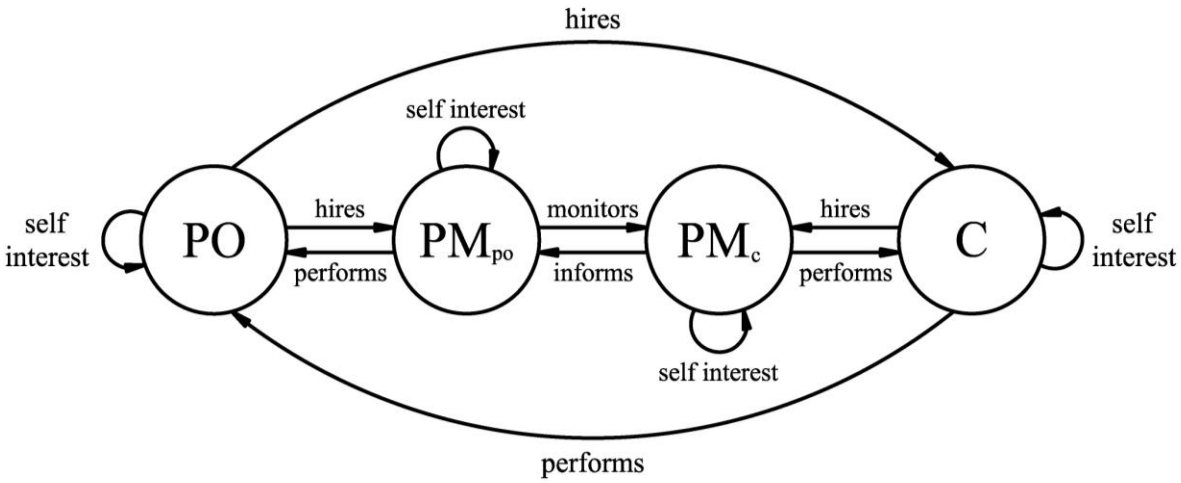


Figure 2: Principal-agent theory framework for construction projects (PO: Project owner, C: Contractor, PM_{po}: Project owner's project manager, PM_c: Contractor's project manager)

As it is shown in Figure 2, the project owner acts as the principal in relation to both the project owner's project manager and contractor as agents, and the contractor acts as the principal in relation to the contractor's project manager. Therefore, there are two principals and three agents involved, where the contractor is both a principal and agent in a project.

The situation in which one of the two cooperation partners is better informed than the other is characterized by *asymmetric information* (Schieg, 2008). After Akerlof (1970), much has been written on this subject. In 2001, George Akerlof, Michael Spence, and Joseph Stiglitz

shared a Nobel prize in economics for this important work. Information asymmetries apply whenever the principal and the agent are not in possession of the same information at the same time. In construction projects, we have four key parties that work together, and it is assumed that they will share important information in order to meet main project's targets: time, cost, and quality. However, because of self interest, they will not be willing to share all the information all of the time. Therefore, the following types of information asymmetries apply for acting parties: *hidden characteristics*, *hidden information*, and *hidden intention.* Respectively, these three types of information asymmetries generate following risks: *adverse selection*, *moral hazard*, and *hold-up*.

Based on the principal-agent theory, relationships between the project owner and contractor, as well as the two project managers employed by them, are systemized according to related asymmetric information and corresponding types of risk. Hidden characteristics are associated with adverse selection; hidden action and/or hidden information are associated with moral hazard; and hidden intentions are associated with hold-up (*e.g*., Jäger, 2008). Hidden characteristics cause the adverse selection problem *before* the contract is signed between the parties involved. It means that the project owner does not have all the information about the contractor before the contractor is hired. Similarly, the project owner does not have all the information about the project manager before hiring. The same holds for the contractor and the project manager working on the contractor's behalf. Therefore, in the case of adverse selection we have three different parties involved and three information asymmetries. The adverse selection problem occurs in the early phases of the project

Hidden information or hidden action causes the moral hazard risk. This occurs *after* the contract is signed between involved parties. For instance, the client cannot be sure that firms, once hired, will fully mobilize their capabilities on the client's behalf or on behalf of other clients of theirs (Winch, 2010). In our case, four parties are potentially involved in the moral hazard problem. After the relevant contracts are signed and the project owner has hired the contractor and the project manager, and after the contractor has hired the project manager, they cannot be sure that all information will be shared in an appropriate way because of the self interest of all the parties involved. The moral hazard problem also occurs between two project managers because they have their self interest, as well.

Hidden intentions can cause hold-up problems. The project owner can invest some money at any stage of the project and trust that the contractor will cooperate, but it can happen that the contractor will actually behave opportunistically. After the project owner realizes that the contractor is acting opportunistically, it can be too late for the project owner to withdraw investment. The same holds in the opposite direction. The contractor can also invest some money at any stage of the project and trust that the project owner will cooperate, but it can happen that the project owner will act opportunistically.

There are several ways to minimize risks that arise from adverse selection, moral hazard, and hold-up problems. These are known as *screening* and *monitoring* (Jäger, 2008; Schieg, 2008). As both screening and monitoring represent costs, they are known in the literature as "agency costs." The purpose of screening is to gather information of use to the principal in an effort to learn more about the agent's qualifications—for example, references, certificates, work probes, and credit worthiness. Similarly, the purpose of monitoring the agents is to ascertain that they are behaving in accordance with the contract. In other words, it helps reduce moral hazard and hold-up risks.

EXPLORATORY SURVEY AND THE DELPHI METHOD

This section provides a short summary of previous research conducted by the author concerning the principal-agent problem (Ceric, 2010; 2011). The research process consisted of two phases. First, the exploratory survey was conducted. The respondents were project managers with an appreciable experience in the filed. The average value of the largest project they managed was US$1 billion and they had fifteen years of experience on the average, working in a wide range of countries around the globe. Among more than thirty countries, they worked in Egypt, Hong Kong, India, Iraq, Italy, Pakistan, Poland, Russia, Saudi Arabia, Spain, Switzerland, Turkey, the United Kingdom, and the United States. A total of 27 project managers participated in the survey. Following the principal-agent theory, there were five questions. The first three concerned three issues of information asymmetry (adverse selection, moral hazard, and hold-up), which correspond to their three sources (hidden characteristics, hidden information, and hidden intentions), while the last two concerned two types of communication risk minimization (screening and monitoring). The respondents were asked to rate the importance of each issue addressed in five questions in terms of the four relationships between the key project parties, as shown in Figure 2.

The key finding from this exploratory survey was that, *after* the contract is signed between the project owner and contractor, the most important relationship in risk minimization is that between the project owner's and contractor's project managers. They are both agents and there is no contract between them, which is an interesting challenge for the principal-agent theory. Interestingly, a number of project managers suggested that communication protocols should be part of project administration so as to ensure better communication between all the participants.

Following the exploratory survey, there were two additional Delphi rounds. The results of the exploratory survey itself were considered as the first round. The Delphi method was chosen as an appropriate tool because the project managers are geographically spread apart. Also, they were not available for consultation over lengthy periods of time. All of the project managers that were selected from the exploratory survey for the next two Delphi rounds were practitioners with considerable expertise in the project management field, as witnessed by their thirteen years of experience on the average, and the average of the largest project they managed assessed at $1.4 billion. For the second Delphi round 20 of the 27 respondents were selected. In the final Delphi round, 11 out of 15 respondents took part. The focus was on risk minimization in the construction phase.

The key finding from the Delphi method confirmed and strengthened the main finding from the previous exploratory research. The central relationship in construction projects *after* the contract is signed is that between the project managers. Therefore, they play the most important role in the risk minimization process in the construction phase of a project.

GUIDELINES FOR FUTURE RESEARCH

Taking into consideration the findings from the previous section, there are three directions for future research proposed here. First, strategies of communication risk minimization could be explored in further detail. Second, future research could look into more complex relationships between project participants. Third, the communication process between

project participants could be investigated in much greater detail, so as to arrive at viable communication protocols. These possibilities will be briefly discussed below.

Selection of strategies for minimizing communication risk caused by information asymmetries

As argued in the previous section, the project mangers play the most important role in risk minimization in the construction phase *after* the contract between the project owner and contractor is signed. One of the possibilities for future research is focusing on the construction phase and selection of the appropriate strategies for minimizing communication risk between project participants caused by information asymmetries.

According to Schieg (2008), there are six strategies for minimizing information asymmetries between project participants:

1. bureaucratic control (contracts),
2. information systems,
3. incentives (bonuses),
4. corporate culture,
5. reputation, and
6. trust.

A survey could be used to establish the rank list of the six strategies mentioned above for risk minimization. Once again, the respondents would be project managers with considerable experience and expertise in the field. They would be asked to rate the importance of each strategy for minimizing information asymmetries mentioned above in terms of the four relationships between the key project parties: project owner-contractor; project owner's project manager-project owner; contractor- contractor's project manager; and contractor's project manager-project owner's project manager. After this step, the multi-attribute utility theory can be used for compiling a rank list of the strategies for risk minimization, calculating the overall utility function for each alternative.

Exploring more complex relationships between project participants

Future research should also consider more complex relationships between construction project participants, and especially the agents. In particular, this would involve consultants, such as designers—either engineers or architects. The relationships shown in Figure 2 could be widened by adding the designer to better understand the complexities of the construction process beyond the four key participants investigated heretofore (Figure 3).

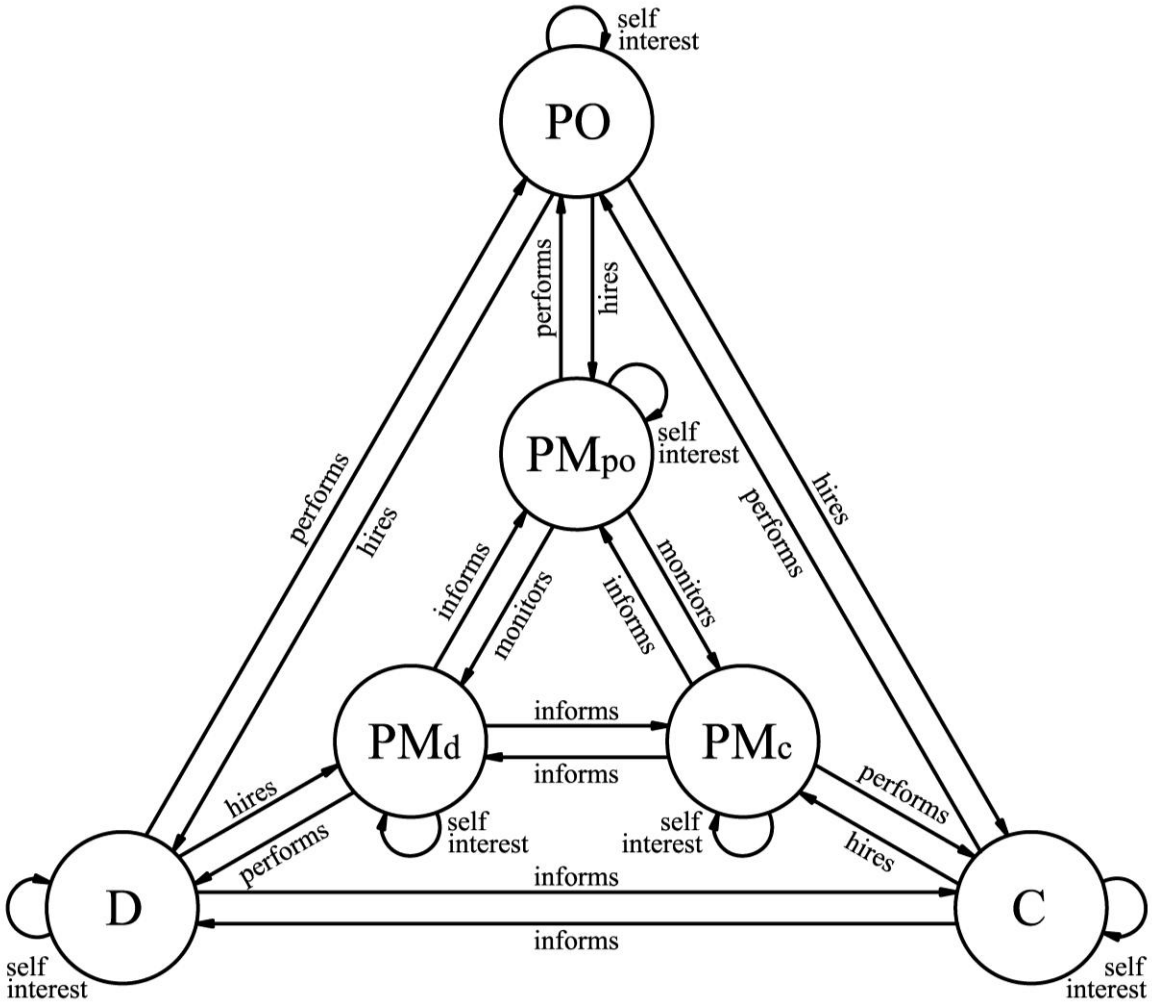


Figure 3: Principal-agent theory framework for construction projects (PO: Project owner, C: Contractor, D: Designer, PM_{po}: Project owner's project manager, PM_d: Designer's project manager, PM_c: Contractor's project manager)

As can be seen by comparing Figures 2 and 3, the number of relationships between the key project participants rapidly increases. When there are only the project owner and contractor, as well as their project managers, there are twelve relationships between them altogether, two of which are between project managers, who are not related by contracts. By comparison, there are twenty-four relationships when the designer and the designer's project manager are added. In addition, eight of these relationships do not involve contracts, which is a full third of all the relationships involved. Adding more project participants, such as sub-contractors, would furthermore complicate the picture quite rapidly.

Establishing communication protocols in contracts

Many of the communication problems occur in the construction phase, when conflict can become dysfunctional and disruptive (Emmitt and Gorse, 2007). Such conflict is detrimental to both the project owner and contractor as the principal and agent. Exploring the intricacies

of the monitoring process would require much more detailed investigation of project managers and their interaction to arrive at the most promising interplay between formal and informal communication during construction. As shown by the exploratory survey presented in the previous section, communication protocols defined in contracts may help improve the monitoring process (Ceric, 2010). In particular, this is what a large number of respondents suggested in their comments to the survey. Such an investigation could be best achieved by means of interviews and/or focus groups.

CONCLUSIONS

As outlined in the Introduction, the principal-agent theory in construction was first introduced in this paper. A short summary of previous research conducted by the author was presented next. Guidelines for future research regarding the application of the principal-agent theory to construction projects complete the paper.

As has been argued in the previous section, there are three directions for future research worth considering at this stage. First, strategies of communication risk minimization could be explored. Second, future research could look into more complex relationships between project participants, including the designer. Third, the communication process between project participants could be investigated in greater detail, so as to explore viable communication protocols between the key project participants.

On the basis of research into the relationship between the project owner's and contractor's project managers conducted to date, it deserves greater emphasis in further research. Especially in the construction phase, this relationship is crucial for the understanding of project management as a field. The three directions outlined in the previous section offer great promise. Only by understanding better the relationships not regulated by contracts can we expect significant advance of the field.

ACKNOWLEDGMENTS

I would like to thank two anonymous referees for the CIB International Building Council Conference 2012.

REFERENCES

Akerlof, G. (1970), The Market for Lemons: Quality, Uncertainty, and the Market Mechanism, *Quarterly Journal of Economics*, Vol. 84, No. 3, pp. 488-500.

Ceric, A. (2003), *A Framework for Process-Driven Risk Management in Construction Projects*, PhD Thesis, Research Institute for the Built & Human Environment, School of Construction and Property Management, University of Salford, Salford.

Ceric, A. (2010), The Impact of Asymmetric Information on Communication in Construction Projects, Working Paper Proceedings, Engineering Projects Organizations Conference, South Lake Tahoe, California, November 4-7.

Ceric, A. (2011), Minimizing Communication Risk in Construction Projects: A Delphi Study of the Key Role of Projects Managers, Working Paper Proceedings, Engineering Projects Organizations Conference, Estes Park, Colorado, August 9-11.

Chang, C.Y. and Ive, G. (2007), The Hold-Up Problem in the Management of Construction Projects: A Case Study of the Channel Tunnel, *International Journal of Project Management*, Vol. 25, No. 4, pp. 394-404.

Corvellec, H. and Macheridis, N. (2010), The Moral Responsibilities of Project Selectors, *International Journal of Project Management*, Vol. 28, No. 3, pp. 212-219.

Emmitt, S. and Gorse, C. (2007), *Communication in Construction Teams*, Abingdon, Oxon, Taylor & Francis.

Holt, G. D., Olomolaiye, P.O. and Harris, F. C. (1995), A Review of Contractor Selection Practice in the U.K. Construction Industry, *Building and Environment*, Vol. 30, No. 4, pp. 553-561.

Ive, G. and Chang, C.Y. (2007), The Principle of Inconsistent Trinity in the Selection of Procurement Systems, *Construction Management and Economics*, Vol. 25, No. 7, pp. 677-690.

Jäger, C. (2008), *The Principal-Agent—Theory within the Context of Economic Sciences*, Norderstadt, Herstellung und Verlag, Books on Demand GmbH.

Müller, R. and Turner, J.R. (2005), The Impact of Principal-Agent Relationship and Contract Type on Communication between Project Owner and Manager, *International Journal of Project Management*, Vol. 23, No.5, pp. 398-403.

Project Management Institute (2000), *A Guide to the Project Management Body of Knowledge*, Newton Square, Pennsylvania.

Rosenfeld, Y. and Geltner, D. (1991), Cost-Plus and Incentive Contracting: Some False Benefits and Inherent Drawbacks, *Construction Management and Economics*, Vol. 9, No. 5, pp. 481-490.

Schieg, M. (2008), Strategies for Avoiding Asymmetric Information in Construction Project Management, *Journal of Business Economics and Management*, Vol. 9, No. 1, pp. 47-51.

Tadelis, S. (2002), Complexity, Flexibility, and the Make-or-Buy Decision, *American Economic Review*; Vol. 92, No. 2, pp. 433-437.

Turner, R. and Müller, R. (2004), Communication and Cooperation on Projects between the Project Owner as Principal and the Project Manager as Agent, *European Management Journal*, Vol. 22, No. 3, pp. 327-336.

Unsal, H.I. and Taylor, J.E. (2010), Modelling Inter-Firm Dependency: A Game-Theoretic Simulation to Examine the Hold-Up Problem in Project Networks, *Journal of Construction Engineering and Management*, in press.

Winch, G. (2010), *Managing Construction Projects*, Oxford, Blackwell Science.

Yiu, C.Y., Lo, S.M., Ng, S.T. and Ng, M.M.F. (2002), Contractor Selection for Small Building Works in Hong Kong, *Structural Survey*, Vol. 20, No. 4, pp. 129-135.

A previous version of this paper was presented at the Engineering Project Organizations Conference at Rheden, The Netherlands, July 10-12, 2012 (Working Papers Proceedings)

STRATEGIES FOR MINIMIZING INFORMATION ASYMMETRIES IN CONSTRUCTION PROJECTS: PROJECT MANAGERS' PERCEPTIONS

Prof. Anita Ceric, Ph.D.
Department of Construction Management and Economics
Faculty of Civil Engineering
University of Zagreb
anita@grad.hr

ABSTRACT

Communication risk is of crucial importance in construction projects. The situation in which one of the project parties is better informed than another is known as information asymmetry. This problem is addressed by the principal-agent theory. According to this theory, information asymmetries cause three problems: adverse selection, moral hazard, and hold up. The focus here is on strategies for minimizing information asymmetries in the construction phase. A survey of project managers was conducted to establish an understanding of the relative importance of risk-minimization strategies established in the literature: bureaucratic control (contracts), information systems, incentives (bonuses), corporate culture, reputation, and trust. The multi-attribute utility theory was used to analyze the responses. According to the project managers who participated in the survey, trust is the most important strategy in the construction phase, followed by bureaucratic control (contracts) and information systems.

KEYWORDS: principal-agent theory, information asymmetries, risk-minimization strategies, project managers, multi-attribute utility theory

INTRODUCTION

The research presented here has evolved in three stages, of which the last one is presented in this paper. The results of previous stages were presented elsewhere (Ceric, 2010, 2011). Throughout, the principal-agent theory has formed the foundation of the research project. The relationship between the project owner and contractor was extended to include their respective project managers. The project owner is the overall principal, and all the others are agents. However, the contractor is the principal with respect to the contractor's project manager. These four participants are crucial in every construction project.

The first stage of the research involved an exploratory survey of project managers with substantial experience in the field. The research considered all project phases, both before and after the contract is signed between the key project parties. It was established that the relationship between the two project managers is central to the construction phase itself, which is characterized by risk minimization. During this phase, the project owner and contractor play subsidiary roles, which offers an interesting challenge to the principal-agent theory because both project managers are agents, and there is no contract between them.

The second stage probed this finding by using the Delphi method. Again, a panel of highly-experienced project managers working for both project owners and contractors were asked several rounds of questions in an attempt to arrive to a consensus concerning the most important relationships between project parties in terms of risk minimization in the construction phase. The results obtained by the Delphi method confirmed the findings of the exploratory survey.

The third and final stage of the project involved another exploratory survey to establish the relative importance of different risk-minimization strategies in the construction phase. Project managers who participated in previous research stages were approached once again. Following the principal-agent theory, Schieg (2008) offered the following risk-minimization strategies in construction projects: bureaucratic control (contracts), information systems, incentives (bonuses), corporate culture, reputation, and trust. It is hoped that the results presented below will be of help in guiding future research in this field.

This paper is presented in eight sections. First, the principal-agent theory as applied to construction is presented. Second, strategies for minimizing information asymmetries in construction projects are discussed. Third, the research methodology is presented. Fourth, the results from the survey questionnaire are examined. Fifth, comments by respondents are presented. Sixth, these results are combined with results of the previous research to arrive at the final ranking of risk-minimization strategies using multi-attribute utility theory. Seventh, the limitations of the study are discussed. Finally, conclusions and suggestions for further research are presented.

THE PRINCIPAL-AGENT THEORY APPLIED TO CONSTRUCTION PROJECTS

Communication and exchange of information are of vital importance in all construction projects. According to Turner and Müller (2004), the key relationship is between the project owner as the principal and the contractor as an agent. As Ceric (2010) argues, the project owner's and contractor's project managers also play important roles in construction projects

as agents. Here, the contractor acts as the principal in relation to the contractor's project manager. According to the principal-agent theory, information asymmetries apply whenever the principal and the agent are not in possession of the same information at the same time. There are several types of information asymmetries: *hidden characteristics*, *hidden information*, and *hidden intention*. These three types of information asymmetries generate the following types of risk: *adverse selection*, *moral hazard*, and *hold-up* (Jäger, 2008).

Adverse selection describes information asymmetries when the principal does not have the exact qualifications of the agent. It occurs *before* the contract between them is signed. The result can be the wrong choice of the contractual partner. In the case of the moral hazard there are information asymmetries *after* the contract is signed. The principal cannot control all the agent's activities and an information imbalance in favour of the agent can occur. If the agent uses this situation opportunistically, then this type of asymmetric information is called moral hazard. If the principal makes large investments in money or other resources because of the trusty relationship with the agent, and if these investments get lost in the case that the agent acts uncooperatively, these result with the problem called hold-up. The principal has already made an irreversible investment and this enables the agent to confront the principal with excessive demands, for instance.

The owner of a project is the person or group that provides the financial resources for its delivery, accepts the project milestones, and project completion (Project Management Institute, 2000). In construction projects, the project owner hires a contractor to perform all the activities required to complete the project. Also, the project owner and the contractor delegate their tasks to their project managers. Therefore, there are four different parties involved in the project even before its execution starts. It should be noted that the contractor's project manager is understood here as the person who is in overall charge of a particular project on contractor's behalf irrespective of the title. In some business environments this role is played by consultants. However, it is important to note that project owner's and contractor's project managers play important roles in any construction project even though they are not in a contractual relationship with each other.

COMMUNICATION RISK-MINIMINIZATION STRATEGIES

The previous research has shown that project managers play the most important role in risk minimization in the construction phase, after the contract between the project owner and contractor is signed (Ceric, 2010, 2011). Therefore, the research presented here is focused on the construction phase and communication risk minimization in this phase. According to Schieg (2008), there are six strategies for minimizing information asymmetries between project participants: bureaucratic control (contracts), information systems, incentives (bonuses), corporate culture, reputation and trust.

The above strategies find considerable albeit fragmentary support in the literature. They will be considered in turn. The relationship between project participants is generally controlled by means of *contract* (Bower and Skountzos, 2003). The contract sets out the intentions of the two parties, and so the roles and responsibilities of both sides are clear in the case any dispute arises (Simester and Turner, 2003).

As Schieg (2008) points out, *information systems* promote transparency, directness, and timeliness of communication, as well as permanence of the information available. Current emphasis is firmly on digital information and improved communication through web technologies that provide tools for better exchange of information between project participants (Emmitt and Gorse, 2007).

The use of *incentives* involves payment of a bonus or incentive to a contract party for performing its work (Bower and Skountzos, 2003). In partnering, incentives are an important way of reinforcing collaboration in the short term and helping to build trust between project participants (Bresnen and Marshall, 2000).

According to Schieg (2008), *corporate culture* plays a special role in construction. Shared values, targets, and competences minimize coordination costs. Also, it gives identity to an organization (Cheung *et al*., 2011).

Reputation is a key component of strategic competitive advantage (Jäger, 2008). As such, it is capable of effectively countering harmful opportunistic behavior. However, it should be noted that reputation has relevance only with respect to past action (Wilson, 1985).

According to Zaghloul and Hartman (2003), the success of any construction project is questinable without *trust* even when powerful control systems, including contractual documents, are available. As Kadefors (2004) argues, if trust is present, people can spontaneously engage in constructive interaction without pondering what hidden objectives motivate their partners.

Grounded in large part in the principal-agent theory, the above strategies offer a coherent framework for further investigation. It is hoped that the results of the research presented here will be of value in further inquiry. However, risk-minimization strategies certainly need greater emphasis in future research.

RESEARCH METHODOLOGY

As stated in the Introduction, the research presented here is the third and final stage of an investigation into project managers' perceptions concerning communication risk due to asymmetric information in construction projects. Throughout, the principal-agent theory has provided the foundation for the investigation.

The same twenty respondents who participated in the previous stages of this research were selected for the present stage. The previous stage employed the Delphi method. The respondents are practitioners with considerable expertise in the field as witnessed by their thirteen years of experience on the average and the average value of the largest project they have managed assessed at $1.4 billion. They have worked both for project owners and contractors in more than thirty countries, including Egypt, Hong Kong, India, Iraq, Italy, Pakistan, Poland, Russia, Saudi Arabia, Spain, Switzerland, Turkey, the United Kingdom, and the United States. Many of the largest projects have been in infrastructure, but many other types of projects were involved. However, the respondents cannot be said to be representative of all project managers, the population of which is beyond the scope of the present study.

At this stage of the research project, the respondents were asked to rank the risk-minimization strategies presented above in terms of their importance in reducing information asymmetry (Appendix). The scale used was from 1 to 9, where 9 is "most important." This scale is ostensibly ordinal, but it can be meaningfully interpreted as the interval scale, as it involves only levels of importance, from least to most important. Each level of importance can be understood as the same as any other, and the scale can thus be interpreted as linear.

As will be shown below, the means and standard deviations of the answers are presented first. Then the utility functions are calculated using the multi-attribute utility theory. These functions are calculated by combining the relative importance of strategies in the focus at this stage of the research, and the relative importance of different relationships between project parties, which were obtained in the Third Delphi Round at the previous stage of the research (Ceric, 2011). The overall utility function that ranks all the strategies was thereby obtained.

The multi-attribute utility theory is a well-known decision-making technique used under conditions of both certainty and uncertainty (Luce and Raiffa, 1957; Keeney and Raiffa, 1976; Saaty, 1994; Flanagan and Norman, 1993; Ceric, 2003). It is used in cases when the best alternative solution must be chosen, i.e. for compiling a ranking list of the alternatives offered. Here, the alternatives are the risk-minimization strategies. Alternatives are weighted with respect to one or more given criteria with the purpose of calculating the overall utility function for each alternative. The value of the overall utility function is used to form the ranking list of alternatives - that is, to provide the best alternative.

Among others, Kangari and Boyer (1981), Hwang and Yoon (1981), and Ibbs and Crandall (1982) have used the multi-attribute utility theory as a technique for qualitative risk analysis. For the calculation of utility functions, mean values or other statistical parameters can be used (Moselhi and Deb, 1993). As will be shown below, mean values are used in this paper for the calculation of utility functions.

SURVEY QUESTIONNAIRE RESULTS

Out of twenty respondents who received the exploratory survey, fifteen have responded (response rate: 75 percent). Again, the respondents have participated in the previous two stages of this research project (Ceric, 2010, 2011). All the respondents are project managers with extensive international experience, who have worked for both project owners and contractors. The results of the survey concerning risk-minimization strategies in the construction phase are presented in the form of mean values and standard deviations (Table 1). These results will be further refined below using the multi-attribute utility theory, but several brief comments are in order at this stage.

As can be seen from Table 1, the most important risk-minimization strategy in the relationship between the project owner and contractor in the construction phase is bureaucratic control (contracts). In addition to the highest mean value, the standard deviation is lowest, showing agreement between respondents. This shows that the respondents are in agreement as to the importance of this strategy even in the construction phase. However, trust comes on top in terms of importance in all other relationships covered by the survey. Most important, trust is the key to the relationship between the project managers and their

employers – the project owner and contractor. This is shown not only by the highest mean values, but also by the lowest standard deviations. This is an important result of potential value for future research.

Table 1: Results of the survey questionnaire

Strategies/Relationships		Project owner - Contractor	Project owner - Project owner's project manager	Contractor - Contractor's project manager	Project owner's project manager - Contractor's project manager
Bureaucratic control (contracts)	Mean	8.40	5.93	5.47	6.73
	St. Dev.	1.12	2.34	2.03	2.49
Information systems	Mean	5.60	6.73	6.47	6.80
	St. Dev.	2.10	1.91	2.13	2.21
Incentives (bonuses)	Mean	5.40	6.00	6.00	3.60
	St. Dev.	2.50	1.96	2.17	2.38
Corporate culture	Mean	5.27	6.33	6.40	5.47
	St. Dev.	2.02	1.59	1.35	2.23
Reputation	Mean	6.80	6.40	5.87	5.80
	St. Dev.	1.66	1.40	1.88	2.31
Trust	Mean	6.20	8.40	8.27	7.47
	St. Dev.	2.18	0.83	0.96	1.77

PROJECT MANAGERS' PERCEPTIONS OF RISK-MINIMIZATION STRATEGIES

In support of the main findings, it is useful to review the respondents' comments in to the last part of the survey. In particular, the respondents were asked to comment on the strategy/relationship they considered most important. Here, only a selection of these comments will be presented.

Most important, the respondents recognize the key place of the contract in construction projects. However, they also believe that trust is crucial to the success of these projects. One respondent states as follows:

> Contract is the most important instrument that regulates the information between the project owner and contractor. Hence, a well-designed contract which describes the ways of information transfer is the most effective way to decrease the information asymmetry risk. On the other hand, regarding the parties and their project managers, trust is an important issue affecting the information transfer. A trustful relation between the project owner and the owner' project manager and the contractor and the contractor' project manager can prevent conflict of interests between the parties and it can promote the information exchange.

Another respondent argues in a similar vein:

> Bureaucratic and other pre-defined formal-control methods are the most effective means at corporate level (i.e. between the companies). However, less formal control methods come into the picture at the personal level and between the companies and their managers. In conclusion, it is always the contract between the project owner and the contractor used by all parties that is at issue when problematic conditions arise during construction. A well-defined contract is the most important mean to reduce risks to the minimum.

Yet another respondent states as follows: "Trust takes time to develop between the parties, and it is very fragile, but once developed it outshines all the other strategies in terms of project control and risk minimisation." Similarly, another respondent argues: "The most important document is the contract. But the trust between the parties is as important as the contract." With respect to the relationship between the contractor and the contractor's project manager, one respondent states as follows: "Contractor should entrust an assignment to his project manager with full trust that he can competently perform. However, the contractor's trust should be reflected in the service contract, giving the project manager a mandate sufficient for implementation of the risk-minimization policies."

One respondent comments on information systems as a strategy in the following words: "Project managers need to set up as good information systems as possible to keep all moves visible to all parties at all times. Last but not least, such visibility leads to stability and trust in the project."

Concerning reputation as a strategy, one respondent states as follows:

> Reputation is the most important strategy since a contractor with good reputation to complete the project on time and with minimum problems will definitely minimize the risk for the project owner. It is the same for the contractor. A reputable project manager will definitely be much more predictable for the employers than any other. So the risk is minimized.

One of the responses concerning incentives is as follows:

> Incentives are important for the stakeholders executing the project. One of the problems is that the incentives between the different stakeholders (basically the project owner and contractor) might not be aligned, thus leading to inefficiencies in the whole process. My guess is that the alignment of all the incentives, plus a robust performance management structure to keep track of these incentives, could improve the project performance substantially. The alternative is to control the performance and/or risk of the contractor by using bureaucratic control, which might be less constructive and might lead to operational inefficiencies.

Overall, bureaucratic control (contracts) is given an important place in most comments by respondents, but trust nonetheless surfaces as the most important risk-minimization strategy in the construction phase. This is reflected in the numerical results presented in Table 1. Information systems, reputation, and incentives are commented upon by several respondents only. Interestingly, no respondent has commented on corporate culture as a strategy.

RANKING OF RISK-MINIMIZATION STRATEGIES USING MULTI-ATTRIBUTE UTILITY THEORY

The multi-attribute utility theory was used for the calculation of the overall utility functions used to define the ranking of strategies for minimization of risks caused by information asymmetries in the construction phase offered by Schieg (2008). The overall utility function combines the ranking of relationships between project parties and the ranking of risk-minimization strategies. The calculation of the overall utility function to arrive at the final ranking proceeded in three steps.

First, the results of Delphi Round Three from Ceric (2011) were used for the determination of utility functions for each relationship between the four key participants. For the calculation, mean values of project managers' responses were used (Table 2). They range from 1 to 9 in terms of importance. In Delphi Round Three, each relationship was considered from both sides, as indicated by arrows in the table. The mean values of these are used at this stage. The results are presented in Figure 1.

Table 2: Results of Delphi Round Three (Ceric, 2011)

Rank	Relationship	Mean	St. Dev.
1	Project owner's project manager → Contractor's project manager	8.57	0.65
2	Contractor's project manager → Project owner's project manager	8.46	0.63
3	Project owner → Project owner's project manager	7.07	1.07
4	Project owner → Contractor	6.79	0.97
5	Contractor → Project owner	6.71	0.99
6	Project owner's project manager → Project owner	6.61	1.18
7	Contractor → Contractor's project manager	6.57	1.16
8	Contractor's project manager → Contractor	6.36	1.15

For the calculation of the utility function values concerning relationships between project parties for minimizing the risks caused by information asymmetries, averages of mean values of project managers' responses from both sides are used:

Project owner - Contractor: (6.79 + 6.71)/2 = 6.75
Project owner - Project owner's project manager: (7.07 + 6.61)/2 = 6.84
Contractor - Contractor's project manager: (6.57 + 6.32)/2 = 6.47
Project owner's project manager - Contractor's project manager: (8.57 + 8.46)/2 = 8.52

Subsequently, the average values are added, and the utility function values are obtained by means of normalization. For example, the utility function value for the relationship between the project owner and contractor for minimizing the risks caused by information asymmetries is calculated as follows:

U(Relationship 1) = 6.75/(6.75 + 6.84 + 6.47 + 8.52) = 0.236

The sum of all utility function values concerning relationships between project parties for minimizing the risks caused by information asymmetries equals 1 (0.236 + 0.239 + 0.226 + 0.298 = 1).

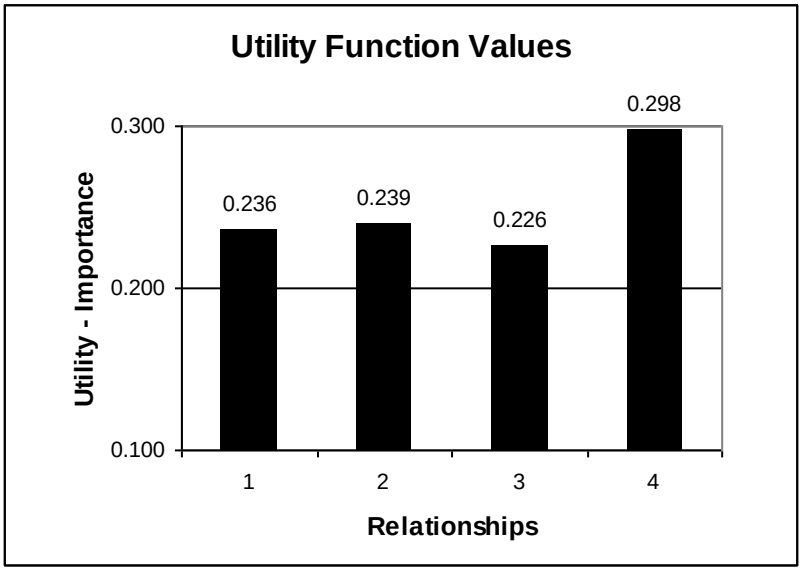


Figure 1: Utility function values for relationships between key project parties (1: Project owner - Contractor; 2: Project owner - Project owner's project manager; 3: Contractor - Contractor's project manager; and 4: Project owner's project manager - Contractor's project manager)

Second, the utility functions for all six strategies are calculated from the responses of project managers (Table 1). Again, the scale from 1 to 9 in terms of importance was used (Appendix). These are the alternatives for risk minimization in the construction phase. For the calculation of utility functions, mean values from the responses of project managers are used once again (Table 3).

For example, the utility function value for Strategy 1 (bureaucratic control including contracts) for the relationship between the project owner and contractor is calculated as follows:

U(Strategy 1) = 8.40/(8.40 + 5.60 + 5.40 + 5.27 + 6.80 + 6.20) = 0.223

The sum of all utility function values concerning strategy 1 for the relationship between the project owner and contractor equals 1 (0.236 + 0.149 + 0.142 + 0.188 = 1).

Table 3: Utility function values for risk-minimization strategies

Strategies/Relationships	Project owner – Contractor	Project owner - Project owner's project manager	Contractor - Contractor's project manager	Project owner's project manager - Contractor's project manager
Bureaucratic control (contracts)	0.223	0.149	0.142	0.188
Information systems	0.149	0.169	0.168	0.190
Incentives (bonuses)	0.143	0.151	0.156	0.100
Corporate culture	0.140	0.159	0.166	0.152
Reputation	0.181	0.161	0.153	0.162
Trust	0.165	0.211	0.215	0.208

Third, the overall utility functions are calculated by combining the utility functions for the four relationships between key parties and the six strategies (Figure 2). The overall utility function offers the ranking of risk-minimization strategies in the construction phase. For example, it is calculated for Strategy 1 as follows:

T(Strategy 1) = 0.236*0.223 + 0.239*0.149 + 0.226*0.142 + 0.298*0.188 = 0.176

The sum of all overall utility function values concerning all six strategies for minimizing the risks caused by information asymmetries equals 1 (0.176 + 0.170 + 0.135 + 0.154 + 0.164 + 0.200 = 1).

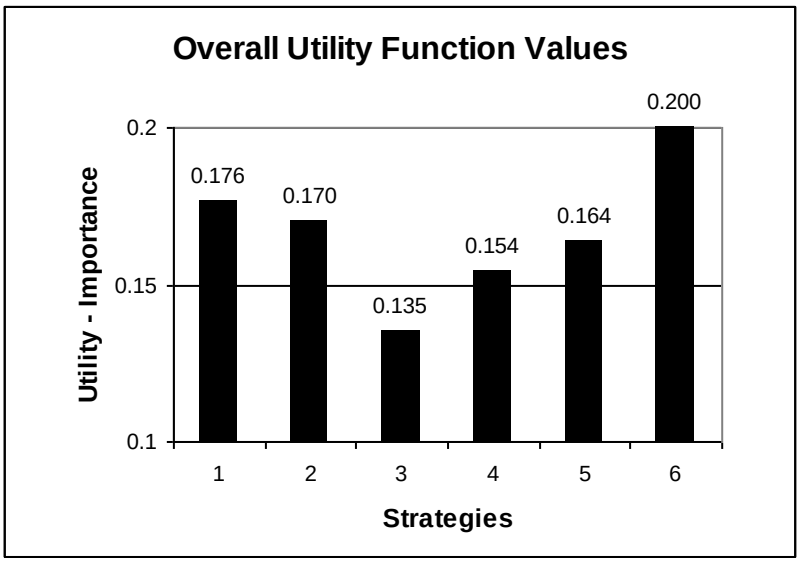


Figure 2: Overall utility function values for risk-minimization strategies (1: Bureaucratic control (contracts); 2: Information Systems; 3: Incentives (bonuses); 4: Corporate culture; 5: Reputation; and 6: Trust)

As Figure 2 shows, the multi-attribute utility theory applied in this research demonstrates that trust is the most important risk-minimization strategy in the construction phase. It is followed by bureaucratic control (contracts) and information systems. Reputation, corporate culture, and incentives (bonuses) follow, in that order. These results take into consideration both the relative importance of relationships between project parties, as presented in previous research (Ceric, 2011), and the relative importance of strategies investigated at this stage.

LIMITATIONS

The main limitation of the results presented here is in the small number of respondents. Again, fifteen out of twenty respondents actually returned their responses. However, this limitation has to do with the Delphi method used in the previous stage of this research project. There, twenty potential respondents was an adequate number. Given their

experience with the research presented here, which proceeded in three stages, it was considered worthwhile to gather their responses on risk-minimization strategies, as well.

CONCLUSIONS

The research presented in this paper shows that trust is the most important risk-minimization strategy in the construction phase. It is followed by bureaucratic control (contracts) and information systems. Reputation, corporate culture, and incentives (bonuses) follow, in that order. The importance of trust is a pointer for future research in project management. Although it is an elusive concept at first sight, practitioners in the field appreciate and understand it well.

As has been argued by Ceric (2012), there are three plausible directions for future research of risk minimization based on the principal-agent theory that are worth considering at this stage. First, strategies of communication risk minimization could be explored. The first step in this direction has been attempted in the research presented in this paper. Here, trust has emerged as the key strategy worthy of further investigation. Second, future research could look into more complex relationships between project participants, including the designer. Third, the communication process between project participants could be investigated in greater detail, so as to explore viable communication protocols between the key project participants.

ACKNOWLEDGMENTS

I would like to thank two anonymous referees for the Engineering Project Organization Conference 2012.

I very much appreciate the contribution of the respondents of the survey: Serap Ciliz, Mete Demir, Ahmet Erol, Medhat Etman, Cihat Gurel, Sinisa Matic, Ferit Oncel Mocan, Sinisa Radakovic, Wilhelm Reismann, Ophir Rozenfeld, David Owen, Aydin Sakin, Gullem Sivecas Gibert, Rifat Sonmez, and Ertugrul Unluturk. I would like to thank them all.

Last but not least, I would like to thank the Ministry of Science of the Republic of Croatia for the sponsorship of the five-year research project under my supervision entitled "Human resource management in construction projects" (Project Code Number: 082-0822156-2998).

REFERENCES

Bower, D. and Skountzos, F. (2003), Partnering, benchmarking and incentive contracts, in Turner, R. (Ed.), *Contracting for Project Management*, Hampshire, Gower Publishing Limited, pp. 81-104.

Bresnen, M. and Marshall, N. (2000), Motivation, commitment and the use of incentives in partnerships and alliances, *Construction Management and Economics*, Vol. 18, pp. 587-598.

Ceric, A. (2003), A Framework for Process-Driven Risk Management in Construction Projects, Ph.D. Thesis, University of Salford.

Ceric, A. (2010), The Impact of Asymmetric Information on Communication in Construction Projects, Working Paper Proceedings, Engineering Projects Organizations Conference, South Lake Tahoe, California, November 4-7.

Ceric, A. (2011), Minimizing Communication Risk in Construction Projects: A Delphi Study of the Key Role of Projects Managers, Working Paper Proceedings, Engineering Projects Organizations Conference, Estes Park, Colorado, August 9-11.

Ceric, A. (2012), The Principal-Agent Theory and the Role of Project Managers in Construction: Guidelines for Future Research, *CIB Proceedings, Management of Construction: Research to Practice*, Montreal, Canada, June 26-29.

Cheung, S.O., Wong, P.S.P. and Wu, A.W.Y. (2011), Towards an Organizational Culture Framework in Construction, *International Journal of Project Management*, Vol. 29, pp. 33-44.

Emmitt, S. and Gorse, C. (2007), *Communication in Construction Teams*, Oxon, Taylor and Francis.

Flanagan, R. and Norman, G. (1993), *Risk Management and Construction*, Oxford, Blackwell Science.

Hwang, C.L.G. and Yoon, K. (1981), *Multiple Attribute Decision Making: Methods and Applications*, Springer-Verlag, Berlin.

Ibbs, C.W. and Crandall, K.C. (1982), Construction risk multi-attribute approach, *Journal of the Construction Division*, ASCE, 108, No. C02, pp.187-200.

Jäger, C. (2008), *The Principal-Agent Theory within the Context of Economic Sciences*, Norderstadt, Herstellung und Verlag, Books on Demand GmbH.

Kangari, R. and Boyer, L.T. (1981), Project selection under risk, *Journal of the Construction Division*, ASCE, 107, No. CO4, pp. 597-607.

Kadefors, A. (2004), Trust in project relationship-inside the black box, *International Journal of Project Management*, Vol. 22, pp. 175-182.

Kenney, R.L. and Raiffa, H. (1976), *Decisions with Multiple Objectives: Preference and Value Trade-offs*, New York, John Willey and Sons.

Luce, R.D. and Raiffa, H. (1957) *Games and Decisions*, New York, John Willey and Sons.

Moselhi, O. and Deb, B. (1993), Project Selection Considering Risk, *Construction Management and Economics*, Vol. 11, No. 1, pp. 45-52.

Project Management Institute (2000), *A Guide to the Project Management Body of Knowledge*, Newton Square, Pennsylvania.

Saaty, T.L. (1994), *Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process*, RWS Publications, Pittsburgh, Pennsylvania, Vol. VI, AHP Series.

Turner, R. and Müller, R. (2004), Communication and Cooperation on Projects between the Project Owner as Principal and the Project Manager as Agent, *European Management Journal*, Vol. 22, No. 3, pp. 327-336.

Schieg, M. (2008), Strategies for Avoiding Asymmetric Information in Construction Project Management, *Journal of Business Economics and Management*, Vol. 9, No. 1, pp. 47-51.

Simister, S. and Turner, R. (2003), Standard form of contract, in Turner, R. (Ed.), *Contracting for Project Management*, Hampshire, Gower Publishing Limited, pp. 59-63.

Wilson, R.B. (1985), Reputation in games and markets, in Roth, A. (Ed.): *Game Theoretic Models for Bargaining with Incomplete Information*, Cambridge, Cambridge University Press, pp. 27-62.

Zaghloul, R. and Hartman, F. (2003), Construction contracts: The cost of mistrust, *International Journal of Project Management*, Vol. 21, pp. 419-424.

APPENDIX: SURVEY QUESTIONNAIRE

The aim of this survey is to rank strategies for communication-risk minimization in the construction phase after the contract is signed between the project owner and contractor. There are four key parties crucial to the success of every project, and there are some risks associated with information asymmetry between them. In addition to the project owner and contractor, their project managers play key roles, as well.

The construction literature offers the following six strategies for the minimization of risk caused by information asymmetry:

bureaucratic control (contracts),
information systems,
incentives (bonuses),
corporate culture,
reputation,
and trust.

In this survey, the task is to rank them in terms of each relationship involved. Here, we take each relationship to go both ways. The table below matches six strategies and four relationships. Each relationship should be considered in turn. For instance, start with the project owner and contractor by ranking all the strategies from 1 to 9, and then proceed to the next relationship.

SURVEY QUESTIONS

A. General information

Note that personal information will remain private.

Name:

B. Strategies for risk minimization – Relative importance of relationships between project parties

Please use the scale from 1 to 9 (where 9 is "most important") to rate the importance of each relationship between project parties in terms of strategies for risk minimization:

Strategies/Relationships	Project owner - Contractor	Project owner - Owner's project manager	Contractor - Contractor's project manager	Owner's project manager - Contractor's project manager
Bureaucratic control (contracts)				
Information systems				
Incentives (bonuses)				
Corporate culture				
Reputation				
Trust				

Please comment on the strategy/relationship in the above table that you consider most important: