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Framework for management of risks caused by information asymmetry in construction projects

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Subject review

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The occurrence of information asymmetry between clients and contractors is often a source of risk in construction projects. In order to develop a framework for managing these risks, a comprehensive study described in this paper was conducted. The methods employed included content analysis of existing literature and interviews among professionals with significant experience in the execution phase of construction projects. The research identified 20 key risks that arise before and after the signing of a contract between the client and the contractor. It also identified the key consequences of these risks and 15 key strategies for mitigating the risks in question. Based on the obtained results, a framework for managing these risks was developed, linking the identified risks, their consequences, and corresponding mitigation measures. This framework enables a structured approach to risk management across different phases of construction projects.

Key words:

principal-agent theory, information asymmetry, risk identification, risk mitigation measures

Pregledni rad

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Okvir za upravljanje rizicima prouzročenima informacijskom asimetrijom u građevinskim projektima

Pojava informacijske asimetrije između investitora i izvođača često je uzrok rizika u građevinskim projektima. Kako bi se razvio okvir za upravljanje tim rizicima, napravljeno je sveobuhvatno istraživanje opisano u ovome radu. Primijenjene metode uključivale su analizu sadržaja postojeće literature i intervjue sa stručnjacima sa značajnim radnim iskustvom u fazi izvođenja građevinskih projekata. Istraživanjem je identificirano 20 ključnih rizika koji se pojavljuju prije i nakon potpisa ugovora između investitora i izvođača. Također, identificirane su ključne posljedice tih rizika i 15 ključnih strategija za ublažavanje predmetnih rizika. Na temelju dobivenih rezultata razvijen je okvir za upravljanje tim rizicima koji povezuje identificirane rizike, njihove posljedice i mjere za njihovo ublažavanje. Takav okvir omogućuje strukturiran pristup upravljanju rizicima u različitim fazama građevinskih projekata.

Ključne riječi:

agencijska teorija, informacijska asimetrija, identifikacija rizika, mjere za ublažavanje rizika

1. Introduction

Risks in construction projects can be classified into various categories depending on their causes and nature. For example, Thakur et al. [1] highlight technical, logistical, environmental, financial, socio-political, and other types of risk. Among these, communication risks represent one of the most serious challenges, as they account for as much as 56% of the total risk costs in projects [2]. These risks may arise at any stage of a project [3] and not only contribute to increased costs, but may also jeopardise key project objectives [4, 5]. Moreover, communication risks often trigger chain reactions leading to other types of risk [6].

This paper focuses on the management of risks related to information asymmetry among participants in construction projects. Previous studies have identified these risks as a significant issue that has still not been adequately addressed [7, 8]. Information asymmetry refers to a situation in which project participants do not possess the same amount of primary information or fail to share such information with one another, thereby hindering the achievement of project objectives [9]. This concept is based on principal-agent theory, which describes a relationship in which one party (the principal) engages another party (the agent) to perform a specific task on its behalf [10]. In the context of construction projects, the client assumes the role of the principal, while the contractor acts as the agent. Such relationships are characterized by information asymmetry, differing levels of risk aversion, and the tendency of each participant to maximize their own benefit, which may lead to opportunistic behaviour [11].

Risk assessment and management are major elements of project management. Flanagan and Norman [12] describe it as a systematic approach to identifying and quantifying risks to enable informed decision-making regarding their management. According to International Organization for Standardization [13], risk assessment includes three main steps: risk identification, risk analysis, and risk evaluation.

Risk identification involves recognizing and providing a detailed description of all potential risks that may positively or negatively affect the achievement of project objectives. Thorough and precise identification represents one of the critical phases of the overall risk management process. After risks have been identified, experts assess the likelihood of their occurrence and their potential impact, i.e., the consequences for the project. The combination of these two elements determines the overall level or severity of risk, expressed as: Risk = probability × impact. Upon completion of risk analysis, relevant data are available for risk evaluation and for making decisions on how to address the identified risks. Risk evaluation is a phase of the risk management process in which it is determined which risks require mitigation measures and which do not require any further action. This step is essential for the effective allocation of resources and achieving optimal risk management.

Principal-agent theory and the problem of information asymmetry have become increasingly prominent in recent research within the construction industry [7, 14, 15]. A systematic literature review [16] indicates a lack of research related to the identification and analysis of risks caused by information asymmetry, whereas

studies focusing on mitigation measures are more common. This research gap highlights the need for a more detailed examination of these risks to improve the understanding and management of risks in construction projects. One of the reasons for the insufficient attention given to these risks lies in their complexity and multidisciplinary nature, encompassing psychological, sociological, and economic aspects [17].

Information asymmetry represents an inherent characteristic of the relationship between clients and contractors in construction projects. Project participants possess different objectives, levels of knowledge, interests, and access to information, resulting in a persistent imbalance in the distribution of information. Therefore, the objective of managing these risks is not their complete elimination, but rather their identification, limitation, and effective management.

The aim of this paper is to present a framework for managing risks caused by information asymmetry. The framework identifies key risks arising from information asymmetry between clients and contractors in construction projects, classifies them according to theoretical categories of information asymmetry, and determines their main consequences as well as corresponding mitigation measures. The second chapter of this paper provides an overview of the existing literature on information asymmetry in construction projects. In addition, the three theoretical groups of information asymmetry risks are described. The third chapter describes the research methodology through which the relevant risks, consequences, and measures were identified and classified. The fourth chapter presents the research results in the form of lists of key risks, their consequences, and measures for their mitigation. The fifth chapter proposes a framework for managing the relevant risks for clients and contractors. The framework connects the identified risks, their consequences, and mitigation measures, thereby facilitating the management of these risks in construction projects. The paper concludes with findings regarding the scientific and practical contribution of this research.

2. Information asymmetry in construction projects

The theoretical foundation of the problem of information imbalance in construction projects is associated with principal-agent theory and the concept of information asymmetry. Principal-agent theory originates from the field of economics and analyses relationships between two parties: the principal and the agent [18]. The problem between these two parties arises due to information asymmetry. Information asymmetry is a situation in which one party possesses more information regarding its characteristics, activities, or intentions, but does not share it with the other party, often for its own benefit [9]. Such a situation gives rise to agency costs, which include monitoring, contracting, and other costs associated with managing this relationship [19]. The primary objective of principal-agent theory is to develop strategies for reducing these costs and ensuring that agents act in accordance with the interests of the principal, for example through contractual mechanisms and systems of incentives and supervision [20].

In construction projects, principal-agent theory identifies the relationships between project participants as agency relationships involving information asymmetry, conflicts of interest, and agency costs [11]. The client is the primary principal, while its agents include designers, contractors, supervising engineers, project managers, and other participants. Furthermore, the contractor may act as a principal in relation to its subcontractors. Given the number and diversity of participants, as well as the complexity of construction projects, there exists a large number of principal-agent relationships, resulting in numerous problems arising from such relationships when one party does not possess complete information about the other. In this way, the information asymmetry present in these relationships may cause difficulties in project planning, execution, and management. This paper focuses on the relationship between the client and the contractor in a construction project, where the client is the principal and the contractor is the agent responsible for constructing the facility on its behalf (Figure 1).

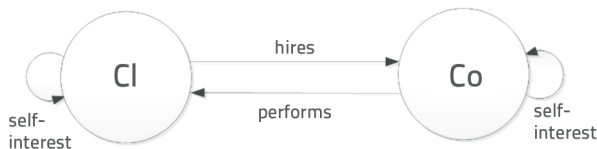


Figure 1. Basic principal-agent model of participants in construction projects (Cl – Client; Co – Contractor) [21]

In addition to the client and the contractor, other project participants also play an important role in managing information asymmetry, including the designer, supervising engineer, project manager, and, in the case of the application of FIDIC contract models, the engineer. The designer is responsible for the quality and completeness of the design documentation, thereby directly influencing the level of information asymmetry during the tendering and construction phases. The project manager is responsible for the planning, organisation, coordination, and control of all project activities, including the management of scope, time, costs, quality, risks, and communication among all participants. The supervising engineer and the FIDIC engineer play a primary role in the interpretation of contractual provisions, verification of completed works, and decision-making processes that may reduce or increase asymmetry between the parties. These participants act as intermediaries in the transfer of information and may significantly contribute to the transparency and balance of contractual relationships.

Principal-agent theory recognises several types of problems, which manifest through hidden characteristics, hidden activities and information, and hidden intentions [22]. Such problems arise from the asymmetric distribution of information among project participants, which may lead to various risks. If these risks are not recognised and managed effectively, they may significantly jeopardise the achievement of project objectives [23].

The problem of hidden characteristics arises even before **signing a contract** between the principal and the agent, that is, *ex ante*. It stems from the fact that the principal is unaware of certain characteristics of the agent, such as its performance capability

or available resources [24]. Such a situation leads to **adverse selection (AS)** [20, 24].

On the other hand, problems related to hidden activities and information arise after the contract has been signed. They refer to a reduction in the agent's level of effort during task execution [22]. These information asymmetries arise because the principal cannot fully monitor the agent's activities (hidden activities), nor accurately assess its performance (hidden information) during task implementation [25]. Although the principal can observe the outcome, it cannot know with certainty whether the agent has exerted maximum effort. In such cases, this is referred to as **moral hazard (MH)**.

The third type of problem relates to hidden intentions, which become apparent only after the signing of the contract [22]. In such situations, one party becomes aware that the other is acting opportunistically but remains in a weaker bargaining position because it has already committed certain resources to the cooperation. This represents a situation in which a partner remains in an unfavourable relationship due to obligations already undertaken, commonly referred to as **hold-up (HU)** [25].

The issue of information asymmetry in the contractual relationship between the client and the contractor does not represent solely a technical or organisational challenge, but also a legal issue. The contractual relationship between the client and the contractor in the Republic of Croatia is primarily regulated by the Obligations Act (Official Gazette Nos. 35/05, 41/08, 125/11, 78/15, 29/18, 126/21, 114/22, 156/22, 145/23, 155/23), which defines the fundamental elements of construction contracts, including the rights and obligations of the contracting parties, responsibility for the **construction phase**, and protection mechanisms in cases of non-performance of contractual obligations. In the case of public investments, the additional regulatory framework is provided by the Public Procurement Act (Official Gazette Nos. 120/16, 114/22), which regulates contractor selection procedures, as well as the principles of transparency, equal treatment, and market competition. This regulatory framework is important because information asymmetry arises within formally defined contractual relationships. It also determines the boundaries within which information asymmetry may be considered lawful, for example when it arises from natural differences in expertise, experience, and access to information among project participants. The client may possess a better understanding of the financial aspects of the project, including the budget, deadlines, and expectations towards the contractor. This may result in situations in which the contractor is not fully aware of the client's financial constraints or objectives, which may affect project planning and execution. On the other hand, the contractor possesses more detailed information regarding its work, project progress, and construction quality, which may be difficult for the client to monitor fully, as every form of control entails additional costs. Such information asymmetry is unavoidable in complex projects. In contrast, situations may also arise in which one party deliberately withholds or distorts key information to gain an unfair advantage, thereby violating the principles of good faith and fair dealing, as well as the balance of contractual relationships. In this paper, the identified risks may be interpreted through this distinction, whereby

certain forms of information asymmetry exceed the boundaries of lawful conduct and enter the domain of legally disputable practices. The difference between public and private investments significantly affects the dynamics of information asymmetry. In public projects, the regulatory framework provides formal mechanisms for reducing asymmetry, including transparent procedures, the possibility of submitting questions, and appeal mechanisms. In private projects, such formal mechanisms are often not standardised, which may increase flexibility, but also the risk of unbalanced relationships.

For example, in the context of public procurement, the issue of contractor responsibility may arise when a contractor accepts the tender conditions without submitting additional questions or using legal remedies such as appeals. In such cases, it may be considered that the contractor has assumed a certain level of risk associated with information asymmetry. However, this does not exclude the client's responsibility for the clarity and completeness of the documentation, particularly in situations where a lack of information may lead to significant deviations during project implementation. Therefore, the problem of information asymmetry in public procurement cannot be attributed unilaterally to one party, but must instead be viewed as the result of an interaction between the regulatory framework, the quality of documentation, and the behaviour of the participants.

In practice, various mechanisms are available for mitigating and resolving the consequences of asymmetry, including contractual provisions (e.g. clauses relating to variations, risk allocation), procedures for clarification and amendment of documentation, appeal procedures in public procurement, as well as judicial protection in cases involving breaches of contractual obligations. Although these mechanisms cannot eliminate asymmetry entirely, they enable its legal addressing and the reduction of its negative consequences.

Despite the existence of formal mechanisms in public procurement, certain forms of information asymmetry remain present. This particularly relates to implicit information concerning the project, future changes, the organisational capacities of the contracting authority, or actual expectations during project execution, which cannot be fully formalised through tender documentation. The following section of this paper describes the methodology used to identify risks caused by information asymmetry in construction projects and presents a framework for their management.

3. Research methodology

The previous chapter defined the concepts of information asymmetry and highlighted how information asymmetry among participants in construction projects may generate various project risks. Given the limited application of practical methods for managing these risks, as well as the lack of extensive scientific literature addressing them, it was necessary to undertake the first step towards effective management by developing a framework for managing the relevant risks through the identification and classification of risks, their consequences, and mitigation measures. For this purpose, a systematic review of the relevant scientific literature was conducted with the aim of identifying and categorising

risks associated with information asymmetry among participants in construction projects. In addition, their consequences in construction projects, as well as measures for their mitigation, were identified. Defining consequences and mitigation measures is necessary for carrying out subsequent stages of risk management, namely risk analysis and risk mitigation. Furthermore, semi-structured interviews were conducted to gain insight into the views of industry experts regarding the identified risks, consequences, and mitigation measures, as well as to supplement the preliminary lists with additional items where appropriate. Based on the collected data, final lists of key risks, consequences, and mitigation measures were established.

3.1. Systematic literature review

The systematic literature review was conducted with the aim of analysing previous scientific research addressing the phenomenon of information asymmetry in the context of construction projects. Part of the results of this analysis was previously published in paper [16], whereas this article presents the results relating to the identification of key risks caused by information asymmetry, their consequences, and mitigation measures.

The analysed literature was retrieved from two renowned scientific databases – Web of Science Core Collection and Scopus – which enabled a comprehensive insight into the issue and the risks caused by information asymmetry in the construction sector. The following keywords were used in the search process: "*asymmetric information*", "*information asymmetry*", "*adverse selection*", "*moral hazard*", "*hold-up*", and "*construction*". These terms were searched in combination within the titles, abstracts, and keywords of scientific papers. Following the search of the two electronic databases, all retrieved records were imported into the Mendeley software. All subsequent stages of the literature review were conducted within this software, thereby ensuring objective analysis and precise management of the collected sources [26].

The collected publications were processed in accordance with the guidelines of the PRISMA methodology [27], whereby a total of 94 scientific articles met the inclusion criteria because they contained one or more examples of risks associated with information asymmetry, their consequences, or mitigation measures. Through content analysis of the collected scientific papers, categorised lists of risks were developed for the three categories of information asymmetry: adverse selection, moral hazard, and hold-up. In addition, lists of consequences and mitigation measures were also established. For additional evaluation of the data obtained from the literature, semi-structured interviews were conducted.

3.2. Interviews

To assess the practical relevance of the data obtained from the scientific literature, interviews were conducted with experts possessing extensive experience in the field of construction projects. The key advantage of this method lies in its ability to collect detailed and content-rich information [28].

Table 1. Codes used in the qualitative content analysis of interview transcripts (adapted from [21])

	Code	Description
Predefined codes	+	Agreement with the item (risk, consequence, or mitigation measure)
	-	Disagreement with the Item
	+/-	Partial agreement with the item
	Reason	Reason for agreement, disagreement, or partial agreement with the item
	Addition	New item added by the respondent
	Example of a risk	Practical example in which a risk caused by information asymmetry was identified
	Example of a consequence	Practical example in which a risk consequence was identified
Codes identified during the analysis	Example of a mitigation measure	Practical example in which a risk mitigation measure was identified
	Market context	Explanation of differences in the occurrence of risks caused by information asymmetry depending on the market in which the company operates
	Participant context	Explanation of the context of risk occurrence due to common behavioural patterns, capabilities, or inabilities of project participants
	Project type context	Explanation of differences in the occurrence of risks caused by information asymmetry depending on the type of project (public / private)
	Modification	Modification or supplementation of the item

The interviews were conducted with nine experts with at least 17 years of experience in construction projects, all of whom currently hold managerial positions. The sample was selected purposively, with the aim of obtaining in-depth and high-quality data from experts who had participated in large and complex projects. Such a small, homogeneous sample is characteristic of qualitative research focused on specific topics [28]. After nine interviews, data saturation was observed, marking the end of further data collection. Three respondents came from organisations operating as public clients, two were from private construction contracting companies, while the remaining respondents came from private companies specialising in consultancy services, supervision, design, and project management. All respondents included in the study, although some did not formally belong to contracting organisations, possessed significant practical experience in the execution of construction projects. Through their professional roles, they were directly involved in project preparation and implementation processes, which included detailed knowledge of the roles of contractors and clients, both in the pre-contract phase (e.g. analysis of tender documentation, risk assessment, and decision-making regarding participation) and in the post-contract phase (management of execution, coordination of participants, and resolution of contractual issues). Therefore, their responses reflected both the contractor’s and the client’s perspectives, despite their formal organisational affiliation. All respondents had worked on projects in Croatia, while four of them also possessed international experience in various countries. Their expertise predominantly related to public projects, whereas private investments were represented to a lesser extent, which is consistent with the focus on large and complex projects, predominantly associated with public investments in Croatia.

The questions used in the semi-structured interviews were mostly predefined to ensure a more objective analysis; however, respondents were given the opportunity to provide open-ended answers. The interviews focused on the evaluation of the lists of risks, consequences, and mitigation measures collected from the

literature, whereby the experts provided comments, expressed agreement or disagreement, and shared examples from their own experience, together with suggestions for improving formulations to enhance clarity. Each respondent participated in one interview, the duration of which ranged from 52 minutes to two hours. The interviews were conducted at company premises, at the Faculty of Civil Engineering, University of Zagreb, or via online platforms, with particular attention devoted to creating a confidential atmosphere that encouraged openness. All interviews were recorded and transcribed, thereby ensuring a rich database for further analysis. The interview transcripts were analysed using qualitative content analysis in Microsoft Word. At this stage, specialised software tools may be used; however, such tools cannot independently identify codes, but may only partially accelerate text analysis [29, 30]. Therefore, it was decided that specialised text-coding software would not be used in this research. Some of the codes were defined prior to the analysis, whereas others were determined during the analysis itself. Specifically, it was established that the significance of particular risks, as well as the applicability of mitigation measures, varies depending on the type of project (public or private). It was also observed that the approach to risk management differs depending on the role of the participant (whether implemented by the client or the contractor) and the market in which the company operates. Consequently, it was important to use additional codes to record the experts’ specific comments regarding the contexts in which they were speaking. The final list of codes is presented in Table 1.

4. Results and description of the main elements of the framework

The following section presents the results of this research, namely the identified elements of the framework proposed for managing risks caused by information asymmetry. The main elements of the framework consist of the identified risks, their consequences, and mitigation measures. First, the risks

identified through the literature analysis and interviews with experts are presented. These risks were classified according to the types of information asymmetry, with the aim of determining the phase of the construction project in which they may occur and enabling further research within the defined categories. Subsequently, the identified consequences and corresponding mitigation measures are presented.

4.1. Key risks caused by information asymmetry

Before signing a contract between the client (principal) and the contractor (agent) in construction projects, circumstances often arise in which one party does not possess complete insight into the capabilities of the other. In such situations, adverse selection (AS) risks occur. Table 2 presents eight risks arising from hidden characteristics, associated with the initial phase of contractors competing for the award of a contract – the first point of contact between the agent and the principal. The usual contractor selection model is based on the tenders. Owing to strong competition, contractors frequently offer prices below market levels to secure a contract [15, 31], which may result in inaccurate estimates, whether due to intention, inexperience, or lack of expertise [15]. In addition, contractors often do not possess complete information regarding the project, its scope, or quantities of work [23, 32–36], particularly when the project has not been finalised, when the client changes requirements, or when the project involves new technologies [37]. Under such circumstances, contractors who are incapable of delivering the project may submit bids, while the client may incorrectly assess their capabilities.

Due to the complexity of construction projects, clients are often unable to define all requirements precisely and therefore rely on contractors to provide accurate information, thereby creating potential information imbalance [38]. In such situations, demonstrating the contractor's capability is essential, for example through certificates, warranties, and bank guarantees. However, the reliability of such evidence may be questionable owing to the reduced signalling value of certificates [37, 39], lack of information regarding the contractor's reputation, or misrepresentation [23, 35, 36]. During the tendering process, other risks may also arise, such as collusion between the client and the contractor, among contractors themselves, or between contractors and subcontractors, which negatively affects project costs and implementation [35, 36]. Subcontracting represents a particular challenge because the client often does not possess complete information regarding subcontractors, their capabilities, or intentions [35, 40], while arrangements between contractors and subcontractors, together with inadequate disclosure of subcontractors, further increase the risk. In addition to the risks identified through the literature review, the experts interviewed emphasised that the financial instability of either the contractor or the client represents a significant hidden risk prior to contract signing, which may cause serious negative consequences during project execution as well as after project completion.

After the contract is signed, during the construction phase of a project, situations frequently arise in which the activities or

information of one party are partially or completely concealed from the other party. Risks associated with such information asymmetry are identified in the literature as moral hazard (MH), and six key risks have been identified (see Table 2). The most common examples of hidden activities include the use of lower-quality materials, reduced quantities of executed works, concealment of errors, and, in general, a lower level of effort by the contractor in fulfilling contractual obligations [35, 36]. This occurs due to the client's limited ability to control, whether because of a lack of expertise or financial resources [38], whereby the contractor may assume greater risks in the expectation that sanctions will not follow. Contractor behaviour is also influenced by unforeseen conditions, such as adverse weather conditions [41], and sometimes by the deliberate concealment of information or refusal to fulfil obligations [42]. High-quality information exchange within the project team can reduce the number of errors [43]; however, in the absence of clearly defined communication rules and a collaborative environment, information is often delayed. Collaboration may be improved through workshops [44], partnering relationships [45], digital tools such as building information modelling (BIM) and blockchain [9, 45], as well as the early involvement of all stakeholders [46]. Differences between planned and executed quantities of work are common [47], and their causes may include poor planning [32–34], unforeseen events, or changes introduced by the client [23, 35, 36]. Difficulties in controlling quantities arise from inadequate or untimely supervision. An additional risk stems from deteriorated relationships among participants, particularly where trust and willingness to cooperate are lacking [43, 48]. Poor collaboration, unevenly distributed risks and responsibilities [49], and the absence of expectations regarding future cooperation may encourage opportunistic behaviour by the contractor [46, 50]. Subcontracting represents a particular challenge, as the contractor must transfer the system of control and incentives to subcontractors [51]. The final highlighted risk relates to the low visibility of certain construction works, which complicates the subsequent verification of quality and quantities. In such cases, where the legislative framework is weak, abuses and manipulations in dispute resolution may occur [51, 52]. Within the category of moral hazard risks, no additional items were proposed by the experts during the interviews. All risks identified in the literature were verified through the interviews, and their nature was further clarified through practical examples shared by the respondents.

The final category of information asymmetry relates to the hidden intentions of one party to place the other party in an unfavourable position by revealing key information only once the project has already significantly progressed. If the other party is unable to comply with the new requirements, suspension of works or financing may occur. This situation is known as hold-up (HU) risk, and this research identified six key risks of this type (see Table 2). It most commonly manifests itself during subsequent negotiations, for example when the client requests additional or modified works after the signing of the contract, while the contractor exploits its bargaining advantage to charge higher prices for such works [53, 54]. Due to limited alternatives, the client often accepts such conditions to avoid project interruption. Owing to its superior knowledge of

Table 2. Risks identified through the literature review and interviews with experts; AS – adverse selection risks, MH – moral hazard risks, HU – hold-up risks

ID	Risk	Source	Interviews
AS1	Poor / deficient tender documentation	[23, 32–37, 58]	verified
AS2	Contractor qualifications are unknown / unverifiable	[23, 35, 37–39, 45, 59]	verified
AS3	Inability to identify and exclude a manipulative low bid	[15, 31, 43, 60, 61]	verified
AS4	Collusion between participants before or during the tendering process	[35, 36]	verified
AS5	Misrepresentation or concealment of subcontractors	[35, 40]	verified
AS6	Prevented / hindered selection of a trustworthy business partner	[46]	verified
AS7	(Hidden) unstable financial condition of the contractor	interviews	added
AS8	(Hidden) unstable financial condition of the client	interviews	added
MH1	Concealment of information regarding the actual quality of construction	[11, 32–36, 38, 40–42, 45, 50, 60, 62–70]	verified
MH2	Restricted information exchange between the client and the contractor	[23, 35, 36, 40, 43–46, 52, 59, 63, 64, 71–73]	verified
MH3	Subsequent project modifications	[23, 32–36, 47, 58]	verified
MH4	Lack of mutual trust and understanding	[43, 46, 48–50, 74]	verified
MH5	Inadequate documentation of site events on the construction site	[51, 52, 64, 70, 75]	verified
MH6	Opportunistic behaviour due to one-off cooperation	[46, 50]	verified
HU1	Suspension of work by the contractor	[38, 50, 53, 54, 70, 76–78]	verified
HU2	Restricted negotiation due to political or public influence	[44, 51, 54, 55, 70, 77–79]	verified
HU3	Suspension of information due to distrust	[50]	verified
HU4	Lack of knowledge regarding the contractor’s actual costs	[57]	verified
HU5	Withholding of payments by the client	interviews	added
HU6	Delays in client decision-making	interviews	added

the construction process, the contractor may intentionally fail to report deficiencies in the design documentation to exploit them at a later stage [38]. In large infrastructure projects with a high degree of asset specificity, the client is placed in an unfavourable position because the resources already invested cannot easily be reallocated, while the contractor uses its advantage to impose additional demands [50, 55, 56]. This increases transaction costs through prolonged negotiations and potential disputes [54]. An additional problem arises in the absence of long-term cooperation and trust, as both parties refrain from genuine collaboration to avoid weakening their own bargaining positions [50]. Finally, the absence of cost-control mechanisms enables the contractor to withhold information for the purpose of achieving financial gain at the client’s expense [57]. Within this group of risks, the interview respondents emphasised the importance of defining more precisely the actors responsible for causing hold-up situations. The literature demonstrates a tendency to view the client as the party predominantly exposed to hold-up risks; however, the analysis of practical examples indicates that such a relationship is not unambiguous. Based on comments related to the description of risk HU1, three separate categories of risks were identified that more accurately reflect real situations in construction projects: suspension of work by the contractor, withholding of payments by the client, and delays in client decision-making.

4.2. Key consequences

Risks arising from information asymmetry may negatively affect the achievement of project objectives. In addition to jeopardising the project itself, these risks have broader consequences, such as deteriorating relationships among stakeholders, which often leads to conflicts and disputes. In the long term, information asymmetry in construction projects also contributes to a reduction in the overall productivity of the sector. Adverse effects on project objectives include increased costs [43, 47], project delays [53], reduced quality of executed works [80], and difficulties in the implementation of new technologies and innovations [11]. In addition, these risks negatively affect future cooperation among partners [81], give rise to legal disputes [55], and undermine trust and open communication [42, 82]. In the longer term, the consequences of information imbalance are reflected in reduced efficiency across the entire industry [58]. Qualified contractors earn lower profits [31] or withdraw from competitive tendering procedures [32–34], while clients lose interest in financing projects [37]. Ultimately, companies participating in such projects bear higher transaction costs [55]. During the interviews, respondents highlighted two additional important consequences through real examples of risks

Table 3. Consequences of risks identified through the literature review and interviews with experts

ID	Consequence	Source	Interviews
P1	Increased costs	[15, 31–34, 36, 38, 43, 47, 51, 53–55, 67, 76–78, 83, 84]	verified
P2	Deterioration of relationships among project participants / disputes	[32–34, 40, 42, 53–55, 81, 82]	verified
P3	Reduced quality	[36, 40, 52, 59–62, 74, 80, 81]	verified
P4	Failure to achieve the benefits of new technologies and innovations	[11, 37, 39, 45, 52, 66, 72, 73, 85]	verified
P5	Project delays	[41, 43, 53]	verified
P6	Contract termination	interviews	added
P7	Damage to organisational reputation	interviews	added

associated with information asymmetry: contract termination and damage to the reputation of companies involved in the project. The final list of key consequences of risks caused by information asymmetry is presented in Table 3.

4.3. Key mitigation measures

The mitigation measures most frequently mentioned in the relevant literature relate to the so-called optimal contracts and their control during project implementation [82]. Within these, the design of incentive mechanisms for contractors plays a particularly important role. Contracts, for example, contain clauses intended to encourage contractors to provide clients with accurate information regarding costs [86, 87], execute works in accordance with the planned schedule [71, 83], respond to unforeseen circumstances [41], and adapt to project changes [57, 88, 89]. Additionally, contracts should include a balanced allocation of risks [67], clearly defined performance criteria for contract implementation [53, 54], clearly expressed intentions of the contracting parties [11], mechanisms for price adjustments in accordance with market changes [61], precisely defined performance requirements, technical specifications and quality standards [58], as well as protective instruments such as guarantees [70].

Contractual provisions should also provide rewards for contractors in cases where works are completed ahead of schedule while satisfying quality requirements [53], as well as where cost savings are achieved [48, 85]. At the same time, contractors should bear sanctions if the project is not completed within the agreed budget and timeframe [52, 85]. Moreover, the project should have a developed system for reporting and monitoring contract implementation [14, 38], as well as a mechanism for evaluating contractor performance [65].

Prior to contract signing, the client should apply various methods to assess the characteristics of agents, contractors who compete in tenders (screening). This may be carried out in three ways. The first involves investigating the background, reputation, and previous projects of companies participating in the tender procedure [84]. The second relates to the detailed analysis of submitted tenders [83], including comparison of offered prices with market prices to assess their justification and competitiveness. The third option is to require financial guarantees from tenderers, such as advance payment guarantees or bank guarantees [50], thereby confirming

their seriousness and financial capability to fulfil contractual obligations.

On the other hand, contractors may themselves signal their quality and reliability to clients, for example through the presentation of certificates [37] or through marketing activities [36, 37]. One significant risk is price dumping, which is why knowledge of methods for calculating the optimal tender price may help to avoid it [31].

A significant proportion of risks arising from information asymmetry may already be limited during the contractor selection phase. This particularly applies to situations in which the client has the possibility of selecting a contractor with a verified reputation [80], aligned organisational values and business culture [44, 90], or one with whom there is already previous experience of cooperation and an established partnering relationship [81].

Effective quality control plays a key role in reducing risks associated with information asymmetry during the execution phase [75]. In addition to supervision itself, the cooperation of participants and the open sharing of information and benefits from the very beginning of the project are also important [45]. Communication among stakeholders should be transparent, accountable [14, 70], credible [70], honest [23], and more informal in nature [38]. Trust between participants should be established and maintained throughout the entire duration of the project [8].

The client should also provide contractors with non-financial (intrinsic) forms of reward, such as enhancement of reputation, a greater degree of autonomy and responsibility, job satisfaction, stability, and alignment of objectives [62]. Finally, transparency in information management may be achieved using various information systems [39], including BIM [91, 92], blockchain [91], software platforms for project management [46], and the application of open-book accounting principles [47, 81]. This reduces the scope for information manipulation and improves coordination and decision-making.

During the interviews, respondents recognised three additional mitigation measures for risks caused by information asymmetry: replacement of company representatives, mediation between participants through a third party, and the establishment of communication protocols. Replacement of representatives was recognised as effective in cases of personal conflicts, disagreements, or impaired trust among project participants. The possibility of mediation through a neutral third party was also

Table 4. Mitigation measures determined through the literature review and interviews with experts, adapted from [93]

ID	Mitigation measure	Source	Interviews
M1	Financial incentives for the contractor (bonuses)	[8, 11, 14, 23, 38, 40, 41, 44, 46–48, 53, 57, 61, 62, 65, 66, 71–73, 75, 80, 82, 83, 86, 88, 89, 94–101]	verified
M2	The tenderer signals its characteristics to the client (advertising, reputation)	[8, 36, 37, 44, 50, 53, 55, 58, 59, 65, 66, 70, 80, 84]	verified
M3	Cooperation and trust-building	[8, 14, 23, 37, 38, 44, 45, 48, 70, 74, 77, 81, 87]	verified
M4	Information systems	[8, 9, 36–40, 43–48, 81, 91, 92]	verified
M5	Regular and thorough quality control	[11, 40, 42, 60, 66, 72, 73, 75, 80, 102]	verified
M6	Contractually defined criteria for monitoring contractor performance	[14, 23, 38, 48, 51, 53, 54, 58, 61, 65]	verified
M7	Fair distribution of risks between the client and the contractor	[15, 43, 48, 61, 67, 81, 85, 98, 99]	verified
M8	Contractual penalties	[23, 46, 48, 52, 53, 75, 101]	verified
M9	The client reviews submitted tenders	[14, 31, 36, 72, 73, 78, 83]	verified
M10	The client verifies tenderers (certificates, guarantees, financial stability)	[14, 36, 61, 70, 84]	verified
M11	Non-financial rewards for the contractor (enhancement of reputation, job satisfaction, autonomy)	[40, 48, 52, 62]	verified
M12	Selection of a tenderer with a similar organisational culture (values, objectives)	[8, 44, 90]	verified
M13	Replacement of company representatives	interviews	added
M14	Mediation between participants through a third party	interviews	added
M15	Communication protocols	interviews	added

emphasised. The largest number of respondents additionally highlighted the importance of clearly defined communication protocols. Although these were initially included within measure M4 – Information systems, it was decided to present them separately because the respondents emphasised their key role in risk prevention, regardless of the use of information systems. The final list of key mitigation measures for risks caused by information asymmetry is presented in Table 4.

In the context of risk management, it is important to emphasise that the proposed measures do not operate solely to mitigate the consequences of realised risks, but also to reduce their probability of occurrence. For example, tenderer verification procedures, high-quality preparation of project documentation, clearly defined contractual conditions, and the establishment of supervision systems represent preventive mechanisms that may significantly reduce the likelihood of risks caused by information asymmetry arising. However, due to the inherent nature of such risks, their complete elimination is generally not possible; rather, the objective of management is to achieve an optimal balance between prevention and consequence mitigation.

5. Framework for managing risks caused by information asymmetry

Based on the literature analysis and interviews with experienced construction project experts, key risks

associated with information asymmetry were identified, together with their consequences and possible mitigation measures. Figure 2 illustrates a framework for managing these risks, the structure of which was developed according to the highlighted risks, their consequences, and the corresponding measures necessary for effective management in construction practice.

Risks associated with hidden characteristics (adverse selection) arise prior to contract signing, during the tendering phase. On the other hand, risks arising from hidden information and activities (moral hazard) and hidden intentions (hold-up) occur after contract signing, during the construction phase, and may persist throughout project delivery.

These types of risks most commonly affect project objectives, both during construction and after its completion. Effective risk management requires their timely identification, particularly during the tendering phase, as well as their continuous monitoring and the application of mitigation measures to reduce their frequency or negative impact.

The proposed framework illustrates the logical relationship between risks, their consequences, and mitigation measures throughout different project phases. Its application in practice involves the identification of relevant risks in a specific project phase, assessment of their potential impact, and selection of appropriate measures for their management.

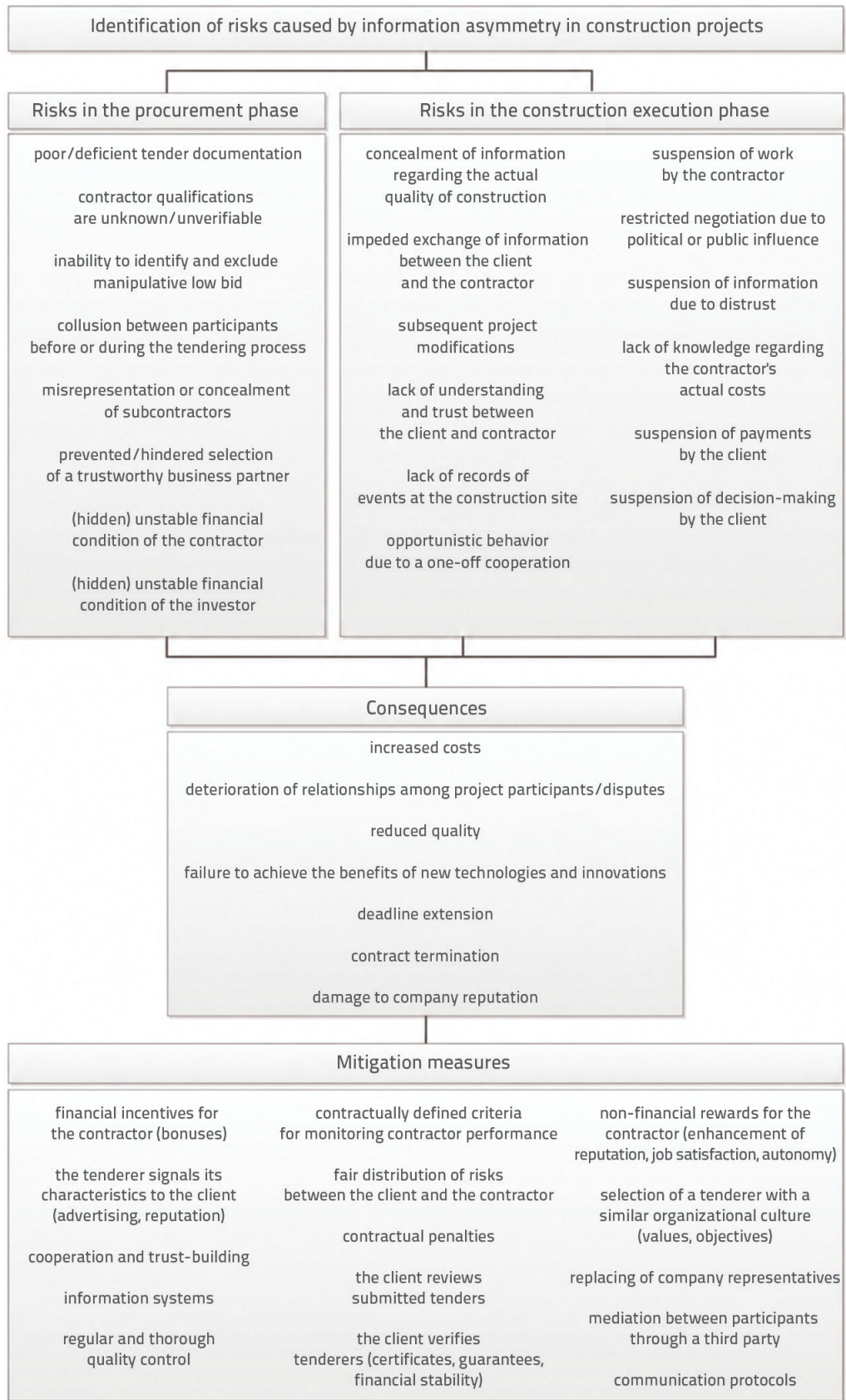


Figure 2. Framework for managing risks caused by information asymmetry

6. Conclusion

This paper presents a framework for managing risks arising from information asymmetry in construction projects. The study identified and classified the key risks associated with information asymmetry between clients and contractors according to the theoretical categories of principal-agent theory. It further identified their principal consequences and corresponding mitigation measures, thereby providing a structured basis for systematic risk management throughout the project life cycle.

Due to the diversity of construction projects, the framework developed in this research has certain limitations regarding its generalisation. The interview-based research established that the significance of risks, as well as the applicability of mitigation measures, varies depending on the type of project (public or private). It was also observed that the approach to risk management differs depending on the role of the participant – whether it is implemented by the client or the contractor. Therefore, it is important to apply the framework in a manner adapted to different project types and participant perspectives to effectively connect risks, their consequences, and the corresponding mitigation measures.

The primary contribution of this research is the establishment of a foundation for the identification of risks arising from information asymmetry in future construction projects. The

established consequences indicate the project objectives that may be affected, emphasising the importance of their timely recognition during the early stages of the risk management process. In addition, the prioritised mitigation measures identified in this study may serve as a basis for the development of appropriate risk response strategies. Future research should validate the proposed framework using empirical evidence obtained from completed construction projects and evaluate its applicability across different procurement systems, contractual arrangements, and national construction markets

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