

Management of OSH across supply chain in construction industry

Karin Reinhold

Department of Business Administration, Tallinn University of Technology, Estonia. E-mail: Karin.Reinhold@taltech.ee

Marina Järvis

Department of Business Administration, Tallinn University of Technology, Entrepreneurship University of Applied Sciences, Estonia. E-mail: Marina.Jarvis@taltech.ee

The construction industry is a high-risk working environment due to the temporary nature of work sites and the numerous hazards involved. Occupational health and safety (OSH) management is complex due to the involvement of multiple stakeholders, particularly subcontractors who may not be clear about their roles and responsibilities. According to the literature, three approaches to address OSH in construction supply chains are mainly used: procurement strategies, industry-level certification schemes, and product-related initiatives. The aim of study was to identify supply chain instruments that are used in a contractor-subcontractor relationship for OSH management in Estonian construction sites. The study collected evidence through document analysis, on-site visits, and semi-structured interviews with key informants of the main contractor, sub-contractors, and stakeholders. The study explores two forms of practices, contractual governance and relational governance, employed by main contractors to improve OSH in Estonian construction sites. Future recommendations for improving OSH in the Estonian construction supply chain include implementing a Code of Conduct, having clear procurement criteria for OSH, and using visualized training methods with artificial intelligence (AI) management elements.

Keywords: construction safety, contractual governance, relational governance, supply chain.

1. Introduction

The construction industry is widely recognized as one of the most hazardous sectors because of the temporary nature of the work sites and the variety of dangers and risks involved (Majumder, 2022). These hazards include working on unstable surfaces that may result in slips, trips, and falls, as well as working at heights, being exposed to noise, vibration, dust, and hazardous substances, and coping with challenging weather conditions and awkward positions during work procedures (Phinias, 2023).

In the construction industry, the business framework encompasses a multitude of stakeholders, including the client, main contractor, subcontractors, labour agencies, engineering consultants, architectural firms, etc. This relationship can also be viewed as is a network of stakeholders organised around a main or general contractor (Rompoti et al., 2020). One

of the defining features of this sector is that the main actors in the supply chain are working concurrently on the same construction site, leading to complexity regarding occupational safety and health (OSH) management in supply chain.

The presence of extended supply chains that traverse multiple regulatory and institutional frameworks can impede the effectiveness of traditional national OSH regulations (Amengual and Kuruvilla, 2020; Walters and James, 2011). Companies are subject to influences from upstream suppliers and downstream customers, making it challenging to exercise full control over OSH requirements at their subsidiaries and suppliers. As a result, there may be consequences from smaller incidents to large accidents (e.g. The Deepwater Horizon explosion, Rana Plaza Fire). Therefore, there is a need for stronger control of OSH throughout the entire supply chain.

The aim of study is to identify supply chain instruments that can be used in a contractor-subcontractor relationship to improve OSH in construction sites.

2. Literature review

Supply chains in the construction sector are rather atypical and different from other industrialized supply chains, because of its temporary nature (Rompoti et al., 2020). They are characterized by companies at different levels of the supply chain who do simultaneous work in the same geographical location. Typically, larger companies serve as the main or general contractors in the construction industry, overseeing extended networks of subcontractors, where the work is performed by smaller firms and independent workers. However, these subcontracting practices can result in difficulties with OSH management, particularly as intense competition for building contracts can result in reduced attention to OSH. It is known that the construction industry is sensitive to all kind of risks, as far as time, quality and costs are concerned. According to Choe et al. (2020), subcontractors may be unclear about their roles and responsibilities in OSH management and miss important information regarding OSH policies and procedures. Additionally, James et al. (2015) have proven that subcontractors are at greater risk due to factors such as longer working hours, financial stress, high work intensity, and concentration in high-risk segments of the supply chain.

In construction supply chains, power imbalances can be significant, with main contractors exerting significant influence over the subcontractors who perform much of the actual work (James et al., 2015a; Donato et al., 2015). Temporary employment arrangements are prevalent upstream in the supply chain, and unionisation vary considerably across EU Member States, being one of the lowest in Estonia. Less than 10% of workers are members of trade unions. Union density decreased rapidly in the 1990s, and has continued to decline since then. According to Choe et al. (2020), the distribution of responsibilities regarding OSH management can be unclear, and workers employed through subcontractors may have limited knowledge of critical OSH policies and procedures. Additionally, the physical distance between construction sites and the back-offices of contractors and subcontractors may create a knowledge gap in

OSH management (James et al., 2015a). Despite these concerns, research on OSH within integrated systems that include subcontractors in the construction sector is limited (Johansson et al., 2019).

Enforcing regulations has the most impact in the upper tiers of the supply chain, but it is challenging in the lower tiers, where OSH risks are prevalent. Additionally, inspection capabilities have been decreased and subcontracting practices have complicated inspections. As a result, governance mechanisms, initiated by clients or principal contractors, are increasingly being implemented, with a focus on high-risk subcontractors further down the chain (James et al., 2015b; Walters and James, 2011). The position of main contractors is ambivalent. While subcontracting allows them to outsource work to smaller companies and maximize their profits, it also leads to longer and more complex supply chains where OSH performance can suffer, as subcontractors face pressure to meet deadlines and budgets (James et al., 2015b; Walters and James, 2011). At the same time, main contractors are concerned about reputational damage caused by the actions of their subcontractors (James et al., 2015a; Wright, 2016).

Walters and James (2011) identified three main approaches to addressing OSH in construction supply chains: procurement strategies, industry-level certification schemes, and product-related initiatives. One way for companies to ensure compliance with OSH regulations is by using OSH standards as a primary criterion when selecting subcontractors to perform specific tasks. Salomäki et al (2022) studied occupational safety in alliances including subcontractors and see an alliancing as a relatively new procurement method in large infrastructure and other construction projects. The study showed developed mature safety culture inside the alliance project, however the need for future studies with more sophisticated OSH research approaches was emphasised by authors.

Relational mechanism play an important role in ensuring good OSH across the supply chain as well. The role of trust is considered crucial in the relationship between a client and a contractor, as highlighted in studies by Ceri et al. (2021), Manu et al. (2011) and Abas et al. (2022) To foster trust-based relationships and shared safety culture on a construction site, it is crucial to implement various

key elements which are highlighted in the studies by Shepherd et al. in 2021. These may include creating awareness programs, promoting safety culture, providing support to contractors for safety implementation, encouraging reporting of near misses, establishing an effective safety education system, and fostering an environment conducive to open communication. Alfons van Marrewijk (2015) agrees that organisational culture is a crucial factor that drives knowledge sharing in construction. However, the author emphasizes that culture is not merely a strategic plan that an organisation can create and implement in specific areas of its operations. Instead, it is the sum of interactions, symbols, and practices that shape an organisation's identity. As a result, it is not feasible to create a single, unified organisational culture in the context of large-scale construction projects that involve multiple partners and long-term timelines. Hence, it is crucial to comprehend the different subcultures that are likely to emerge during the construction process and establish effective communication strategies to integrate them.

3. Material and Methods

In our case-study, three types of evidence were collected. First, we analysed the documents such as companies' webpages, Codes of Conducts, annual reports, safety policy etc. Second, we organized on-site visits to construction sites in order to get an overview of the application of OSH practices through supply-chain. And third, we conducted ten semi-structured interviews with key informants of the main contractor as well as the four sub-contractors. We made sure that each company was represented by at least one employer representative and one workers' representative. The study focus on OSH practices and supply chain mechanisms and instruments that are applied in a contractor-subcontractor relationship to improve OSH in construction sites. The interviews were conducted in Estonian and Russian languages. Each interview lasted an average of 1.5 hours and was recorded. Additionally, we had two individual semi-structured interviews with stakeholders (Labour Inspectorate and External auditor). The field work was done during Summer and Autumn 2022. Interviews were then fully transcribed and analysed. The basic descriptive codes were formulated to sort the data into more manageable

groupings according to their content. The raw data was coded in NVivo14.

4. Results

The main contractor is a residential developer who leads housing projects from the start till the end, without doing construction work itself. The actual construction work is outsourced to subcontractors. The main contractor has a remarkable reputation and has received multiple awards. For instance, it was recognised as having the best working environment in 2017 among SMEs by the National Labour Inspectorate, and it has also been awarded the Golden Mark for Responsible Employer in 2021. The interviewed stakeholders confirmed that focal company selected for the study has outstanding safety culture and taken total responsibility over OSH and providing safety training for all workers.

The focal company has clear criteria for subcontractors, materials, and quality of provided services as well as univocal procurement practices. The procurement process takes place via an innovative software solution where an internal database has been created and the system for selecting possible subcontractors has been developed. Each procurement is being sent for possible contractors through the database. All subcontractors can participate in procurement; however, preference will be given to subcontractors with a proven track record and positive experience of working together. During the procurement, following activities and processes are being assessed:

- procurement communication practices,
- quality of construction work,
- work flow in construction site,
- communication during guarantee period,
- workplace health and safety (e.g. number of occupational accidents, monitoring of incidents).

Each monitored activity has clear criteria for assessment and the best possible company is being selected. However, the price and quality of construction work are the main criteria, followed by other criteria. During 2022-2023, the main contractor is adopting software-based procurement practices that encompass OSH and work quality. These practices cover a range of aspects, such as construction procedures, materials, provided services, work progress, meeting deadlines, pricing, and quality of communication with the primary

company at different stages of the project, including the guarantee period after the work is completed. However, the main contractor is facing a significant challenge in enhancing the assessment of subcontractors' OSH performance.

The interviewed subcontractors confirmed that they were selected through the formal procurement process established by the main contractor. One of the subcontractors stated that in his opinion, the selection process was fair, and that he received orders through an official procurement system. The subcontractor was well-informed about the selection procedures. During the interview, the subcontractor emphasized that the main contractor is keen on social sustainability, including OSH monitoring, incident reporting, safety assessments, and the subcontractor's adherence to all safety rules and requirements.

During the interviews, it was pointed out that the main contractor has assumed complete responsibility for OSH in its construction sites and has implemented several measures to ensure a strong safety culture. First, safety education is taken very seriously: OSH training (in Estonian, Russian and English) in the construction site is carried to all subcontractors' workers (when successfully completed, the worker receives access right to the site). The training covers general OSH requirements on the construction site, as well as specific procedures and actions to take during emergency situations. One of the Estonian subcontractors emphasised the importance of safety training while doing construction work: *"It is important to stay healthy and come home safe. OSH training provided by the main contractor is important for our workers, because it reminds us about safety requirements again and again."* (Subcontractor 2, Int 5).

Each worker receives a pocket-sized safety booklet with pictures and pictograms that can be carried with them every day if needed. The primary company plans to create short videos in the future to facilitate the uptake of OSH requirements during the training.

Apart from the safety training that is mandated by the legislation and provided by the main contractor, workers also receive occasional short trainings on specific topics. These trainings include preventing accidents and falls from height, providing basic first aid, and selecting, adjusting, and maintaining personal protective equipment (PPE). They are conducted during an "Awareness day" organized annually by the main contractor,

where external experts are usually invited to give presentations and conduct safety inductions for all workers. Subcontractors emphasized that after these events, workers are able to provide ideas for further safety training days and recommendations for improving the working environment.

The construction sites of the main contractor are subject to clear monitoring activities that affect the entire supply chain. Daily check-ups, conducted through construction site rounds, involve a business impact analysis (BIA audit app) to observe the work of all subcontractors present on-site. Only workers with personal badges are permitted to enter the construction site. Additionally, random checks at the gate are carried out every day to ensure safety compliance. The working environment and safety manager is available for counselling subcontractors and visits the construction site weekly. The focal company conducts OSH audits once a month, performed by an external construction OSH expert invited by the company, and documents the findings. Furthermore, a senior on-site manager who has received adequate safety training and developed relevant skills performs an OSH conformity assessment once a month. Every year, the company's top managers, who have undergone OSH training, conduct an OSH audit.

During the interviews, subcontractors acknowledged that the focal company has specific and comprehensive measures in place to enforce adherence to safety requirements and conducts daily monitoring to ensure compliance. The subcontractors are also informed about the potential penalties that may be imposed by the main contractor for any identified non-compliance. One of the subcontractors admits that he has also paid the penalties (a photo about violation and the amount of penalty has been sent to his e-mail), and these are not 'a small amount of money', mainly due to safety violations by his own subcontractors. At the same time, he understands why it is practiced by the focal company: *"Grass ignorance cannot be tolerated in constructions sites and that's what the focal company fights against. Money is the best motivator in these cases."* (Subcontractor 4, Int 9)

The interviewed subcontractor tries to be a good example himself, too, but he acknowledges that it can take time to cultivate a strong safety culture, particularly among migrant workers: *"I don't always know how are my migrant workers thinking while doing their regular routines. They*

come from Ukraine, from Tadjikistan etc – and their working culture, as well as safety culture, develops also with time.” (Subcontractor 4, Int 9)

The main contractor has a near-miss registration system that is effective and provides prompt solutions in the BIA system. Concealment of incidents is not permitted on the site, and every incident must be reported to the focal company and the BIA system. Notification of incidents is usually sent by phone or email, together with photos and explanatory notes. If a representative of the main contractor notices an incident, the subcontractor is immediately informed and included in the development of solutions with the focal company.

Subcontractors 3 and 4 believe that it is crucial for the main contractor to conduct thorough inspections of construction sites and address even minor issues promptly. According to their opinion, the main contractor pays attention to small incidents that often go unnoticed on Estonian construction sites managed by other similar contractors. These incidents are discussed with subcontractors to prevent potential accidents from occurring.

According to Subcontractor 1, maintaining effective communication and open dialogue with the focal company is essential to avoid misunderstandings and promote collaboration towards ensuring safety and building trust. Several subcontractors have established long-term relationships and have collaborated with the client for many years, resulting in a higher level of trust between them. According to Subcontractor 1, the main contractor's past experiences and long-standing positive collaboration are crucial factors in selecting them as a subcontractor again on the current construction site, which is indicative of their dependability and helps to build trust: *“I guess my workers did good work in previous site and I have earned the trust with the focal company.” (Subcontractor 1, Int 4).*

The subcontractors also emphasize that creating positive and supportive relationship the main contractor gives a good platform for co-operation in different fields, including OSH. For example, one of the subcontractors admits that he actively avoids potential conflicts to maintain a productive and harmonious working environment. According to his opinion, conflict resolution skills are crucial in the construction industry, and personalities that encourage conflicts are not suitable for the job. Moreover, he with his company shares the same view as the main contractor regarding

safety and is open to having transparent communication when necessary.

Finally, the impact of Covid-19 and the Russian-Ukrainian war was discussed and consequently, has caused supply problems for materials and products, putting high time and work organization pressure on subcontractors. Lessons from managing work during the pandemic have highlighted the need for clear requirements for all subcontractors to minimize health risks.

5. Discussion and Conclusions

This study gives new knowledge about the possibilities to improve OSH in construction sites. The study showed how the challenges ensuring OSH management in supply chain are successfully overcome. These challenges arise due to the complex subcontracting practices prevalent in the industry, where larger companies serve as main contractors and use a network of smaller subcontractors.

The main contractor in our case study is a reputable residential developer who outsources the construction work to subcontractors. The company has established clear criteria for subcontractors and has implemented an innovative software solution for procurement. The main contractor is committed to social sustainability, particularly in terms of OSH monitoring. The company takes safety education seriously, providing OSH training and occasional short trainings on specific topics to all subcontractors' workers. The construction sites are subject to clear monitoring activities and audits to ensure compliance with safety requirements. Subcontractors are informed about potential penalties for non-compliance and have acknowledged the company's specific and comprehensive measures in place to enforce adherence to safety requirements. Overall, the company's commitment to safety and sustainability have contributed to its success and positive reputation in the industry as well as development positive safety culture.

It is possible to say that there are two forms of practices employed by the main contractor: contractual governance and relational governance in order to influence OSH in the construction site. The main contractual governance practices identified in the study were sustainable tendering and purchasing practices, reserved funds for specific work environment related delays or problems, clear

agreements, specific practices, processes, or materials required or prohibited in the contract, required certifications of specific work, such as fire safety and working in heights, as well as regular monitoring and auditing.

Enforcing regulations is most effective in the upper tiers of the supply chain but is challenging in the lower tiers, where OSH risks are prevalent. Thus, governance mechanisms, initiated by the main contractors, are increasingly being implemented, with a focus on high-risk subcontractors further down the chain. This was demonstrated also by earlier studies (James et al., 2015b; Walters and James, 2011).

The main relational governance practices identified in the study were the previous experiences and positive long-term cooperation, effective communication and open dialogue, organisational culture, called 'a people-centric culture', focusing on OSH, people, job organisation and design, cooperation, learning (including OSH professionals) and safety knowledge sharing, leading/managing by good examples. The earlier studies confirmed also that relational mechanisms play an essential role in ensuring good OSH across the supply chain (Ceri et al., 2021; Manu et al., 2011; Shepherd et al., 2021; Abas et al., 2022) and long lasted relationship and effective communication allows ensure stable delivery performance and OSH. Creating awareness programs, promoting mutual understanding about safety and safety culture, providing support to contractors for safety implementation, and establishing an effective safety education system are some of the key elements required to foster trust-based relationships and a shared safety culture on a construction site. It is important to emphasize that a good organizational culture is the basis for driving knowledge sharing in construction. While a single, unified organizational culture may not be feasible in large-scale construction projects involving multiple partners and long-term timelines, effective communication strategies can integrate the different subcultures likely to emerge during the construction process.

Future recommendations for improving OSH in the Estonian construction supply chain have been identified. These recommendations include:

- Implementing a Code of Conduct that is agreed upon and signed by the main contractor and subcontractors/suppliers, and putting it into practice with relevant metrics to measure its impact on OSH.
- Having clear procurement criteria regarding OSH when selecting subcontractors/suppliers, which can proactively influence the safety performance of subcontractors working on the same construction site.
- Using more visualized training methods that can automate the interaction about safety-related issues, even with AI management elements, which can help workers remotely access real-life training material to improve their skills and knowledge quickly.

In conclusion, we can say that the construction industry's unique supply chain characteristics and subcontracting practices present significant complex challenges in ensuring OSH management. Implementing combination of governance mechanisms, using OSH standards as a primary criterion when selecting subcontractors, and fostering trust-based relationships and a shared safety culture can help mitigate these challenges.

Further research should be focus on green supply chain management in construction as well as to explore governance mechanisms that have impact of second tier suppliers and what impact (e.g. direct or indirect) they have on OSH.

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