

Uncertainties in subcontractor procurement: the case of scaffolding

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Abstract

The construction industry continuously deals with unique circumstances. Projects are carried through by temporary organisations, consisting of both internal staff and external staff, such as subcontractors. The purpose of this paper is to identify and provide an understanding of how uncertainty affects the process of procuring subcontractors in the construction industry. In order to do this, a literature study describing uncertainty, what types of uncertainty exist in construction projects and how these could be managed, is composed. Furthermore, a case study involving a construction contractor in Sweden is used as a way of investigating how uncertainty affects construction processes. The paper identifies eight key types of uncertainty that affect the process of subcontractor procurement. The findings also confirm that uncertainty does play an important role in projects, manifesting in e.g. cost deviations and time delays. Finally, the paper presents a quantification of uncertainty types dependent on subcontractor procurement processes as a way of managing uncertainty, along with other recommendations.

Keywords

Construction industry, managing uncertainty, project organisation, Sweden, tendering.

1. Introduction

This paper concerns uncertainties in subcontractor procurement. It's based on the fact that suppliers often perform the majority of the work on construction sites (e.g. Frödell, 2011), that contractor-supplier relations has got less attention in research literature than contractor-client relations (Frödell and Josephson, 2012; Arditi and Chotibhongs, 2005) and that uncertainty commonly is accepted as inherent in construction activities (e.g. Johnson *et al.*, 2011; Maylor, 2010). The main purpose of this paper is twofold; firstly, to identify the uncertainties affecting the process of procuring subcontractors in construction projects and secondly, to investigate uncertainties in procuring scaffolding subcontractors for specific projects. The study is limited to a regional contractor, which has expanded rapidly since it was established ten years ago and now has a turnover of €100 million. Their main clients are municipalities, municipal organisations, industrial and commercial companies, and real estate companies. Their vision is to develop into one of the leading construction companies on the Swedish market.

2. Uncertainties in construction

The literature on uncertainties in construction projects considers the products as unique, at least with unique components and solutions, the organisations as temporary and changing during the projects various phases, and processes that need flexibility built in. Uncertainty is often viewed as a cause for problems in projects, but is also accepted as inherent (Johnson *et al.*, 2011). Clegg *et al.*, (2010) define uncertainty in general terms as “the inability to know how to continue some action, a lack of a rule or decidability about which rule to apply”. Winch (2010) explains that there are two general types of uncertainty; one related to the complexity in construction projects, for example managing and coordinating a large amount of information, activities and sub-groups, the other related to difficulties in predicting the future, for example in planning construction processes. To which extent uncertainty is found problematic and stressful is, however, dependent on several things. The case studied in this paper is from Sweden, for example, in which the culture is described as one of high acceptance of uncertainty (Hofstede, 1983; Bröchner *et al.*, 2002). For the purpose of this paper, uncertainty is defined as a situation where an entity is faced with an inability to predict the future or the consequences of a certain decision or event based on quantifiable information.

With contractors' procurement of subcontractors in mind, a literature review was performed with the purpose of identifying types of uncertainty. In total were 22 types of uncertainty identified, out of which eight were considered relevant for the case of subcontractor procurement. *Process uncertainty*. Projects are commonly carried out by several cooperating organisations. As each project is unique, and so also the temporary project organisation, there is always an amount of uncertainty regarding the process in the specific project but also regarding the temporary organisation. Maylor (2010) mentions the possibility of finding out that different teams or individuals do not function well together. *Time uncertainty*. Construction projects are commonly characterised as having a high complexity, with several factors determining this feature. A large number of activities generally have to be performed in the correct order if project completion is to be achieved successfully. As such, time is of the essence and an efficient scheduling phase is crucial in order to ensure that the project follows the estimated time (Bruni *et al.*, 2011; Yeo and Ning, 2004). Milliken (1987) describes *effect uncertainty* as the relation between cause and effect, which is unknown. A certain event may be likely to occur, but the effect on the organisation is uncertain due to a lack of knowledge of the cause and effect relationship for this event. Hence, uncertainty also exists in the predicament of how to respond to it. *Option uncertainty*. Options available at the point of decision might be too limited due to a lack of imagination from the persons who compiled the set of alternatives. Due to this, there may exist a number of unknown options that might be superior to the selected one. The sample of options in a decision situation might also contain options that are not feasible in practice (Lovell, 1995). Thus there exists a degree of uncertainty in decision-making processes. If there is a lack of proper information to base the decision on, *informational uncertainty* exists (Mann, 2011). It can be described simply by decisions made at a point when there was not enough information available to really support the decision. Tendering is a process that tends to have problems with informational uncertainty. Studies have shown that the quality of tender documents is a major problem (Laryea, 2010). *Bidding uncertainty*. A contractor's project life cycle begins with a need for work and an invitation to bid on the project by a client, followed by an assessment of the bidding opportunity and a decision whether to submit a bid or not (Naert and Weverbergh, 1978). It's common that the contractor submitting the lowest bid receives the contract (Hartmann and Caerteling, 2010). *Contractual uncertainty* may exist when it is not clearly regulated in the contract who will bear the consequences when an unforeseeable event occurs (Lonsdale, 2005). This might be problematic if the power distribution is in favour of either party. This occurs when there is a need to interpret a clause in the contract. *Cost uncertainty*. Cost estimation is a fundamental task in construction projects (Ökmen and Öztas, 2010). However, as many risk factors affect the construction process, these estimations tend to deviate from the actual costs in a favourable direction (Ökmen and Öztas, 2010). Thus, analyses of the uncertainty affecting the estimation of costs are required.

3. Method

With the purpose of studying to which extent uncertainty exists and affects the processes of tendering and procurement and the possible consequences from this uncertainty, a case study involving a large Swedish construction company was undertaken. For the first sub-study, identifying uncertainties in procuring subcontractors, interviews were held with three site managers, a project manager, the head of the calculation office, the head of the procurement office, and a head of construction. The interviews were semi-structured in order to get a broader perspective on the respondents' opinions. The interviews, which took place at either the company's main office or at site offices, lasted for approximately one and a half hours each, and were focused on the interviewees' opinion on uncertainty in tendering and production. For the second sub-study, investigating procurement of scaffolding contractors, tendering and procurement documents regarding the scaffolding work in four recently finished construction projects were examined in order to investigate uncertainty between the tendering documents, procurement documents, and the actual costs. Further, interviews were held with the four site managers for the projects. Focus was on explanations for the results, and clarification of the circumstantial factors affecting each project.

4. Uncertainties in procurement of subcontractors

In the cases of contractors winning a contract, subcontractors generally deliver quotes twice in the process. Firstly, when the contractor competes for the contract and needs prices from potential suppliers for specific tasks and, secondly, when the contractor has been awarded the contract and needs to procure suppliers. The contractor's budget in the second step is lower than the tender almost every time, as it is extremely more detailed, thus making the different accounts more easily quantifiable and decreasing the amount of risk factors to consider. The head of the calculation office and one of the site managers explained the problem of there being parts of a construction project where the estimated costs in the initial stage often differ significantly from the actual outcome. While, in most cases, this is a problem that can be managed in the end, it does involve an amount of risk where the contractor may experience less control of the budget, especially if there are several areas influenced by this uncertainty. Two site managers believed that part of the problem with uncertainty in the tendering and procurement processes lay in a lack of production experience at the calculation office. If the site managers would participate in the early processes, they might contribute by their experience. However, they feel like there simply is not enough time to actually do this. The head of the calculation office explained that the main problem was "how to spend the limited time and resources available during the tendering of a project." The most common uncertainty areas mentioned in the interviews were: additional metalwork, work related to establishment of the construction site, fire sealing, logistics and scaffolding.

4.1 Quantifying uncertainties

In order to better understand uncertainty in procurement processes, the first two authors quantified the uncertainty areas affecting the processes between and including inquiries sent to the subcontractors and the actual building process. The quantification is based on how they perceived the interviewees' opinions on the probability of each uncertainty affecting the process and also on the consequences if the uncertainties happened to affect the processes (see Table 1). While this information is highly contextual and only shows the perceived uncertainty, it still provides an understanding of how it exists in construction. Furthermore, the possible impact of each uncertainty type in each process is demonstrated, e.g. the impact of informational uncertainty in the inquiry process on this particular process. As such, the informational uncertainty in the inquiry process will only have an impact on the inquiry decisions and not in decisions made in other processes and so forth.

Table 1: Uncertainty*Impact for eight types of uncertainty (0=low level, 3=high level)

Procurement phase	Bidding	Time	Effect	Information	Process	Contractual	Cost	Option	Sum
Inquiry 1	3*3	3*2	3*1	3*2	2*1	0*0	3*1	3*3	38
Tenders 1	2*3	3*2	3*1	2*2	2*2	1*0	2*2	2*1	29
Budget	2*3	2*3	3*2	2*3	2*2	1*1	2*3	2*3	47

Inquiry 2	2*2	1*3	2*2	2*3	1*2	1*1	2*2	2*2	28
Tenders 2	1*2	1*3	2*2	2*3	1*2	1*1	2*2	1*2	24
Contract	1*2	1*3	1*3	1*3	2*2	2*3	2*3	1*3	30
Construction	0*0	1*3	1*3	1*3	1*3	2*3	1*2	1*2	22
Total	29	30	26	34	21	15	29	28	

The sum of uncertainty multiplied by the impact for each process and uncertainty type is also demonstrated as a way of quantifying uncertainty as risk. While it is clear that the level of uncertainty in general tends to decrease as the project progresses, the impact tends to deviate more. As Table 1 demonstrates, the sum of uncertainty multiplied by impact (i.e. risk) is highest in the processes of inquiry 1, budget and contract. The high risk in inquiry 1 can be explained by the high amount of uncertainty that exists in the early processes, as the amount of specifications and information is still relatively low. The budget and contract phase, however, show both high uncertainty and impact, since they are the processes where the most decisions are to be made. This is further indicated by the fact that the option uncertainty and impact are highest in the inquiry phases, the budget phase, and the contract phase, whereas they are relatively low in the tender phases. This is due to the fact that option uncertainty exists in decision-making processes, and where different options with unknown consequences exist.

As illustrated, the risk for each respective uncertainty type for the whole process is quite similar, with the exception of informational and contractual uncertainty. The low level of risk for the contractual uncertainty may be explained by the fact that no major uncertainty exists until the actual signing of the contract, where the contractor is bound in to the chosen option to some extent and if something goes wrong, it might have major consequences. The high level of risk for the informational uncertainty can be explained by the reasoning that a lack of proper information will obviously have a major impact on the project. As this is known to some extent, it will also add to the sum of informational uncertainty that exists due to the relatively low amount of specifications and information in the early processes of a project. Hence, uncertainty and impact are interrelated; if an individual knows that the wrong information will cause major problems in the project, the perceived uncertainty regarding the information will increase. Bidding uncertainty and time uncertainty is high in the early processes and significantly lower in the later. That bidding uncertainty is relatively high in these processes is due to the fact that the contractor has begun looking for the best subcontractor, but still only gets quite a low amount of information from the actors. However, they still need to figure out which subcontractor is the best for this particular project, and what terms such as cost or trust should be considered.

4.2 Scaffolding

The interviewees especially mentioned scaffolding being problematic and uncertain. In most projects, scaffolding cost overruns were experienced, which had a quite large impact on the project. While the assembly, transport and disassembly of scaffolding are included in the tendering documents, there is still a lack of prediction of how the scaffolding is actually going to be used or changed during the project. Due to this, the scaffolding account often experience a major cost increase for changes made during the rental time of scaffolding, as well as for extended rental time. The usual approach when procuring a scaffolding contractor at the case company is to begin by sending out tender documents containing specifications on what should be priced. Necessary information such as façade drawings must be attached to this document. These are sent to a number of companies that have declared their interest in the project. From this information, each scaffolding contractor puts together a tender, specifying the cost for delivery, assembly and disassembly work, as well as the rental cost. Usually a list of extra options is included in the price as well as a price list of selectable options. The tenders are weighted against each other and chosen based on different criteria such as price, trustworthiness and earlier experience of the company. A negotiation over the final terms follows before the contract is signed. Since the rent time is uncertain and dependent on external factors, it is most often priced as an on-going cost. As scaffolding was explained to be an account with large cost deviations, which were hard to predict and thus influenced with uncertainty, four recent projects were studied. In Table 2, the estimated cost made by the calculation office in the tendering phase, the procurement cost and the actual outcome of the accounts of scaffolding are presented. The actual cost for the projects was between 35 and 85% higher than the estimated cost in the budget. While cost increases certainly could be hypothesised prior

to the case study, such high increases were surprising. Interviews with the site managers indicated that it is often easy to explain these increases post-project, but more difficult to predict them pre-project.

The site manager for *project 1* gave four reasons for the increased scaffolding costs. First, there was a lot of additional scaffolding ordered during the project, and changes made to the scaffolding due to demands from the different professions working on the scaffolding such as painters, carpenters and metal workers. Second, the total rental time for the scaffolding was increased due to a delay in the project because of difficult ground conditions. Third, scaffolding inside the house needed to be built. Fourth, weather protections for the scaffolding were needed, as well as temperature protection due to the delay of the project, which pushed the façade work into the winter season. The site manager for *project 2* experienced several problems. More scaffolding was necessary compared to that which was calculated as they needed to build around balconies, which had not been predicted in the budget phase. This also led to an increase in loading towers. Weather protection for the scaffolding also needed to be added. Furthermore, there was a major time issue due to several reasons. The construction order was changed, which led to scaffolding being necessary from a much earlier stage than was calculated. Also, the façade works were delayed for a number of months due to the mason not working according to schedule. *Project 3* was explained to have four causes for increased costs. Additional scaffolding was procured compared to the estimated amount, which increased both the contract sum and the rental cost. In addition, the total rental time was increased by almost 50%. Several changes to the scaffolding were also made, as well as additional orders for scaffolding inside the house. In *project 4*, the causes for the increase were slightly different from the other projects. Here, the main cause for the increase was that the company did not really understand what type of scaffolding that was procured. While they thought they had procured an ordinary and adjustable type of scaffolding, the subcontractor delivered a type that was extremely difficult to change and adjust due to the needs of different professions, which led to a large increase in cost for the adjustments. Like the other projects, scaffolding inside the house was also needed to a larger degree.

Table 2: Estimated Cost, Procurement Cost, and Outcome for Four Construction Projects.

Project	Type of project	Estimated cost (kSEK)	Contract price (kSEK)	Contract price / Est. cost (%)	Actual cost (kSEK)	Actual cost / Est. cost (%)	Actual cost / Contract price (%)
1	Retirement homes	1,125	721	-36	1,845	64	156
2	Housing	1,284	1,204	-6	2,250	75	87
3	School	207	207	0	383	85	85
4	Pre-School	273	117	-57	370	35	217

According to the site managers, additional scaffolding, either due to a larger order from the beginning or through changes during the construction phase, is a major reason for increased costs. Another large area of increasing costs according to the site managers is increased rent time, for example, due to a delay in the project or through a delay caused by other subcontractors. The last area explained by the site managers that experiences cost increases in many projects was weather protection. While this is budgeted for in a separate account, it is important to consider the risk of project delays leading to other types of weather protection if scaffolding is still used close to the winter season. However, the site managers agree that this should be included in the tender from the subcontractors, as they are ultimately the ones who are scaffolding professionals and possess the knowledge and experience related to this. However, the tenders tend to vary a lot, both in price but also in specifications and options. One example that showed significant variation between different tenders was “free rental time”, where some tenders had no free rent included, while others had up to eight weeks. The site managers were also in agreement when explaining that contracts and inquiries are often too vague, and occasionally refer to oral agreements, which might lead to contractual disputes. One site manager mentioned that it is in general very hard to follow up and evaluate the scaffolding account, as the invoices sent by the subcontractors often do not contain enough information to trace the costs and compile them accordingly.

5. Concluding remarks

The purpose of this paper was to study uncertainties in the process of subcontractor procurement in construction projects. Based on a case study, it was confirmed that uncertainties have a major effect on this process. These uncertainties were structured into eight types of uncertainties derived from the literature. Based on interviews with managers in a large construction company, it was found that most types of uncertainties were significant. It was further confirmed that the uncertainties were high in the initial phases and then reduced in the following phases. It was also found that the largest uncertainties were related to the initial budget on which the tender was based, followed by the inquiry in the first tender round. The paper also presents a quantification of uncertainty types in each subcontractor procurement process where the amount of uncertainty and its possible impact on the project is specified. Furthermore, several uncertainty-reducing activities, supported by literature, which could be possible ways of addressing the problem, are presented. Studying uncertainties in the procurement of subcontractors is, however, complicated. One reason is that the uncertainties are closely related to each other. Another reason is that the perceived uncertainties are related to known unknown information, i.e. there is probably not known unknown information that influences the future process. The practitioners, however, raised a number of questions during the study. This shows an interest among practitioners in discussing uncertainties they face during projects and also that it stimulates practitioners to reflect on existing uncertainties and how they can handle these.

6. References

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