CONTINGENCY MANAGEMENT IN CONSTRUCTION PROJECTS: A SURVEY OF SPANISH CONTRACTORS

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ABSTRACT

The delivery of any construction project faces risk and uncertainty. Contingencies cover residual risks and absorb both variability and uncertainty. The management of contingencies plays a key role in improving risk management and project performance. Background literature reports that construction companies usually set time and cost contingencies with the goal of protecting project objectives. It also states that construction companies identify and manage opportunities in order to enhance project performance. Likewise, despite the fact some companies maintain formal procedures to manage risk, contingencies are often defined in a subjective and non-systematic manner. Background literature presents several methods to improve the management of contingencies; however, it seems that many practitioners either do not know them or do not use them. Therefore, a sound characterization of how construction companies currently manage contingencies is required. The major goal of this research is to explore how construction companies currently manage contingencies. In order to do that, types of contingencies, major success factors, drivers, benefits and barriers faced by construction companies managing contingencies on construction projects are characterized. A survey (questionnaire) developed in two Spanish construction companies is described and its results are analyzed. This research aims to shape contingencies as a driver of process improvement in construction. Conclusions will help practitioners to deal with risk and uncertainty in construction projects.

KEYWORDS

Construction, contingency, risk, uncertainty, decision-making.

INTRODUCTION

Risk and uncertainty are present in any economic sector; nevertheless, construction industry presents comparatively higher levels (Ballard and Howell 1995, Andi 2004, Fisher 2004, Seung and Hyung 2004, Ballard 2005, Russell et al 2012).The materialization of risks may jeopardize the achievement of the project objectives (markup, project completion period and fulfillment of the scope and quality specifications); thus, risk management is of particular importance for contractors. Yet,

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certain risks have always to be accepted: those risks that have not been identified (unknowns-unknowns) and the residual risks remaining after partially accept, transfer, mitigate or avoid the ones that had been identified (known-unknowns).

Construction companies establish contingencies (money, time, resources such as raw materials, man-hours, machine-hours, space, and scope and quality specifications) in order to hedge or absorb risks whose materialization might jeopardize the achievement of project´s objectives. Thus, contingencies are an essential factor of both risk management and project success (Ford 2002, Howell 2012). Contingencies also play a role in continuous improvement strategies of construction companies (Russell et al 2012). Indeed, contingencies can become drivers of continuous improvement, sources of challenge and learning, target conditions whose achievement would necessarily imply process improvement. The operational advantages of contingencies (buffers) are understood if they are too big, improvement may appear to be unnecessary (Rother 2010, Howell and Ballard 1996).

To optimize contingencies management is, then, a major goal. "*Without empirical work explaining what actually happens in practice, which would guide or justify the development of a new approach, the vicious circle seems inevitable. Our ability to prescribe improvements (e.g., analytical models) is dependent on our ability to precisely describe reality"* (Laryea and Hughes 2011). However, it is worth highlighting that the bulk of studies into contingencies that have been analyzed depict formal or analytically derived models, without taking into account empirical information regarding how construction companies really manage contingencies.

Thus, the major goal of this research is to explore how construction companies currently manage contingencies, particularly during the construction phase of a project. For this purpose, a review of the literature on the characteristic attributes of contingencies and on the different management models proposed by several authors was conducted. This review identifies variables in order to build a questionnaire survey that will be address key aspects and attributes, challenging related ideas provided by literature.

LITERATURE REVIEW

Construction literature includes references to and definition of contingencies; most refer to the nature of the resource that provides the contingency (time, money, capacity, or inventories) and to its instrumental aims (to absorb uncertainty and variation, to hedge risks) or to its finalist objective (to protect certain project objectives) (Querns 1989, Günhan and Arditi 2007, Barraza 2011).

Different authors categorize contingencies according to various other criteria. In terms of the nature of the resource that conforms it, there are time contingencies (buffers) that project schedules often include to prevent project completion delays (Leach 2003, Barraza 2011), material stockpile buffers and work in process buffers are set to protect projects from the negative impact of variability (González et al. 2011, Espino et al. 2012), capacity buffers –manpower, tools, equipment–(Alves and Tommelein 2004, González, Alarcón and Molenaar 2009) and plan buffers (inventories of workable assignments) (Ballard and Howell 1995). There are also scope and quality contingencies, described by Godfrey (2004) as "tolerance in the specification".

The term contingency, used in this document in a generic manner, is mainly employed by a number of authors to describe the amounts of money that budgets often include in order to prevent cost overruns related to unforeseen, unexpected or underestimated events (Querns 1989, Smith and Bohn 1999, Baccarini 2004, Günhan and Arditi 2007).

In the light of project phases, contractors both set contingencies during bidding processes (Smith and Bohn 1999, Laryea and Hughes 2011) and set and/or manage them during the construction phase. Even so there are few studies focused on contingency management during construction. Most of these studies are related to inventories buffers, time buffers, or capacity buffers. However, certain authors focus on the importance of a dynamic management system of contingencies throughout the work, including time and cost contingencies that have been set at early stages (Xie, Abourizk and Zou 2012).

The concept of risk is usually approached in literature with a negative tone, as a synonym for a threat. However, Cabano (2004) points out that the term risk may also imply opportunities. The definition of risk included in PMBOK (PMI, 2013) expresses both aspects too. Rooke, Seymour and Fellows (2004) state that construction companies usually plan their claims during the bidding process when they identify opportunities as lower bids: these price reductions could be seen as contingencies, whose aim is to seize opportunities. That is why these kinds of contingencies would be negative. They lead to a decrease in prices in the short term and plan on later gains.

Contingencies are a tool to manage project objectives in an uncertain environment. If those risks were realized, they could jeopardize project objectives (Godfrey 2004). Furthermore, Russell et al. (2012) state that to identify root causes of contingencies might contribute to process improvement; this strengthens the role of contingencies within the implementation of continuous improvement systems, particularly Lean Construction.

The literature also provides many references on contingencies applied in estimating project costs and duration. However, references on methodologies for managing inventories and capacity buffers are limited. References on methodologies for managing scope and quality contingencies were not found by the authors. Most of the contingencies management methods are focusing on the initial estimation of time and cost contingencies. Moselhi (1997) describes two main groups of methods: deterministic and probabilistic. The most basic deterministic method consists on estimating a general percentage to include in the budget or the schedule (Baccarini 2004, Barraza 2011); along this line, additional methods are based on identifying risks and allocating them in a itemized way of time and money to cover them (Anderson, Mukherjee and Onder 2010). Baccarini (2004) highlights that, in both methods, contingencies are calculated in a subjective way, typically derived from intuition, past experience and historical data; he also considers that this approach is arbitrary and unscientific, and a reason why so many projects are over budget. It is on this premise that a number of non-deterministic but probabilistic, formal, analytically derived methods arise in order to overcome the constraints of deterministic methods (Moselhi 1997).

Nonetheless, certain authors highlight that construction companies seldom use those formal methods: they do not even know them. Smith and Bohn (1999) describe

the main formal methods existing at that time and criticize how complex is to apply them. Barraza (2011) considers that complexity is the major reason why companies hardly use formal methods. González, Alarcón and Molenaar (2009) and González et al. (2011) reckon that empirical evidences of the actual practice of construction companies are limited; jointly with Ford (2002) and Laryea and Hughes (2011), they also consider that formal methods are overly theoretical and hard to be applied. Ford (2002) shows that empirical studies about construction phase are even more limited; this is one of the major gaps of the current knowledge on how construction companies manage contingencies. Along this line, Ford (2002) and Laryea and Hughes (2011) state that construction companies do not use analytically derived methods because they have not been developed taking into account the actual practices of these firms.

Ford (2002) and Laryea and Hughes (2011) conducted two of the rare studies focused on how construction companies actually manage contingencies. The major findings of Ford (2002) are: decision-makers do not use formal models to manage contingencies; clearly defined contingency management procedures are not found; project management tools are not used to manage contingencies; practice of contingencies management are not documented or shared; decision-makers usually hide contingencies to avoid them to be used by others; contingency management is mainly performed in the mind of managers, who make decisions based on experience, judgment and "gut feel"; and informants indicated that they intentionally keep contingency management hidden to retain control of contingency funds.

Smith and Bohn (1999) say that construction companies are reluctant to account for the cost of risk in their bidding price (i.e. they are reluctant to include cost contingencies) to remain competitive. Laryea and Hughes (2011) analyzed two entire tender processes of two different companies. They also state that bids often do not price risks (i.e. bids do not include cost contingencies). However, one of the major findings of their study was that both companies estimate three different tiers of risk apportionment in bids (i.e. three different tiers of cost contingencies). Tier 1 describes the intuitive risk allowances allocated by estimators in the tender program and price to compensate for inaccuracies and errors in the estimates. Tier 2 is related to the risk allowance included by bid teams in bids for the identified risk of a project. Finally, tier 3 consists of a residual risk allowance that firm´s management includes in the bid.

Regarding the role of contingencies in process improvement, Ballard (2005) states that buffers allow learning and enable experimentation without the risk of commercial failure. Yet, Howell (2012) sounds a note of caution. In his view, reducing contingency may be an easy path to improvement but only for a while. Competition will soon squeeze contingency and then improvement will require more innovative or radical innovations. And further, reducing contingency makes organizations less resilient.

This literature reviews the basis for determining research variables. According to this review, few studies have addressed, from an integral and dynamic viewpoint, the management of contingencies. The vast majority of contingencies management methods that have been proposed in recent years are analytically derived and not on a sound and empirical basis. There are few studies tackling current practices of contractors during the construction phase, none of them is based on the Spanish scenario. These current models are seldom used because of their theoretical nature and complexity. Therefore, the aim of this research is to help explain the process of

management of contingencies on construction companies, specifically on the construction phase of a project. Hopefully, conclusions of such research would foster more handy approaches.

RESEARCH METHOD

This research is developed in two phases. The first phase, described in this paper, can be deemed as exploratory: it does not aim to generalize but to move towards a phenomenon. It consists on a sound and extensive literature review and a survey (questionnaire) of two Spanish construction firms. Several types of questions were employed in the questionnaire; they required the use of different levels of measurement according to the type of variable: categorical or interval. For all of them relative frequency was computed. The questionnaire is shown in the Appendix of this paper. The survey addresses key aspects and attributes, challenging related ideas provided by literature. The target of the first phase is to determine the protocol of the second phase. The second phase aims to obtain more extensive and in-depth qualitative data from site managers and business managers.

Ford (2002) highlights that decision-making processes on contingencies are developed individually, not working in a team. The decision-maker often is the site manager; that is why our survey is devised to collect information about site manager´s practices on different aspect of project management (i.e. context) and on the main attributes of the concept of contingency. Nevertheless, for the purpose of contrasting information, two different questionnaires are developed: one for site managers, and another one for other technical staff members. Basically questions of the two questionnaires are alike; the difference is that site managers are asked to state what they do, while the other respondents are asked to state what they believe site managers do. In order to ensure that survey questions are intelligible, easy to respond, and lacking ambiguity, a pilot study is conducted on the initial version of questionnaires (Fellows and Liu 2008). This pilot study counts on the collaboration of an additional Spanish construction company, different from the two that are surveyed.

Once the pilot study is concluded, the survey starts. The first five questions of the questionnaire are closed-questions, asking for demographic data: experience within the sector, academic background, time of service in both the company and the current job and current position (foreman, supervisor, site manager, project manager, program manager, estimator, procurement department staff member, commercial manager or senior management). Depending on the response to the last question, the on-line system directs the respondent to one of the two questionnaires, consisting of 10 additional questions. The questions (variables) analyzed in the second part of the questionnaire are:

- Do firms have clear and explicit procedures to manage risk and uncertainty? (Godfrey 2004, PMI 2013).
- Are budgets and schedules usual tools for project management? (Ford 2002, Leach 2003, Laryea and Hughes 2011).
- Do budgets and schedules set cost and time buffers to absorb project uncertainty? (Leach 2003, Alves and Tommelein 2004, Barraza 2011, Querns 1989, Smith and Bohn 1999, Baccarini 2004, Günhan and Arditi 2007).

- What methods do firms use to estimate those buffers? (Moselhi 1997, Smith and Bohn 1999, Baccarini 2004, Anderson, Mukherjee and Onder 2010, Barraza 2011, Xie, Abourizk and Ziu 2012).
- Is it feasible to use contingencies in order to seize opportunities and not only to face threats? (Rooke, Seymour and Fellows 2004).

The contact person of company A received an e-mail with the link to respond the survey on-line on 12 December 2013; on January 7, this contact person sent an e-mail to 53 staff members. In the case of company B, the dates are December 18, 2013, and January 9, 2014, respectively. Company B invited 203 staff members to respond the survey. In order to make the survey easier to understand and answer, a brief description of the research was included. In both cases, the survey was closed on January 26, 2014.

DEMOGRAPHY

Jointly, the two companies sent the survey to 256 people, 108 of whom were supervisors. One hundred and thirty eight valid responses were collected, one of whom corresponded to a foreman (0.72 %), 18 to supervisors (13.04 %), 41 to site managers (29.71 %), 35 to staff members of different technical departments (procurement, occupational hazard prevention, estimating, quality and R&D) (25.36 %), 20 to program managers (14.9 %), 12 to commercial managers (8.70 %) and, finally, 11 to senior management (7.97 %).

37.96 % of the surveyed site managers responded to the questionnaire, while 65.54 % of the rest of the surveyed professionals did. A clear mismatch exists that might be related to the fact that site-managers intentionally keep contingency management hidden to retain control of contingency funds (Ford 2002). In the second phase of the research this issue will be further developed.

SURVEY RESULTS AND DISCUSSION

Regarding the existence of formal procedures for project risk and uncertainty management, collected data were misleading: 53.75 % of respondents mentioned the existence of such a procedure, while 46.25 % stated that they did not know of it. This contradiction was reported to the top-management of both companies and the response was alike: neither company have such a procedure. The encountered reality, no clear risk management procedures are used by these two firms, fits the findings of Ford (2002). However, this contradiction will be researched during the second phase of the study.

The survey confirms the importance of both budgets and schedules as project management tools (Ford 2002, Leach 2003, Laryea and Hughes 2011). All the valid responses agree that site managers make “always, nearly always or very frequently” a budget and a schedule at the beginning of the construction phase of any project. But there are also many respondents (31.70 % of site managers and 71.13 % of the whole rest of respondents) who say that site managers “ever or hardly ever” take into account data from bidding process in order to make budgets and schedules. Perhaps, once again, the personal nature of project construction management might explain it.

Regarding time and cost buffers that site managers may include in the schedule and in the budget, respectively, the results of the survey show that about half of the

total respondents (site managers and the rest alike) consider that supervisors "ever or hardly ever" include such buffers. The question was posed stressing that buffers could be explicit or not. It is possible for buffers to get included in task duration and cost estimates, quantities or unit rates (Leach 2003, Laryea and Hughes 2011) and, perhaps, site managers intentionally set contingencies in a tacit way in order to retain project control (Ford 2002). It is also possible, however, that the fact that contingencies are not set at all reflects a poor and hazardous risk management policy. This may respond to a willful management-by-objectives approach, or even it could reflect the existence of opportunities that have been identified despite they have not been documented. Additional research is needed on this topic.

About the methods that site managers use to set cost and time buffers, the conclusions of the survey are:

- Site managers set contingencies subjectively. This was confirmed regarding time buffers by 80.49 % of the site managers, while the percentage reached 100 % in the case of money buffers. As for the rest of professional profiles, 62.88 % agreed that site managers set subjectively time buffers, while 77.32 % consider the same in the case for money buffers (Moselhi 1997, Baccarini 2004, Anderson, Mukherjee and Onder 2010, Barraza 2011).
- Site managers estimate both cost and time buffers individually. They do not share the decision-making with other staff members (Ford 2002).
- 19.51 % of site managers claim they use Critical Chain Project Management (CCPM) to set time buffers; 17.55 % of the other professional profiles agree.
- None of the respondents say that site managers use Monte Carlo or "other methods" to estimate time or cost buffers (Smith and Bohn 1999, Ford 2002, González, Alarcón and Molenaar 2009, Barraza 2011, González et al. 2011, Laryea and Hughes 2011).

Over 80 % of the respondents claim that the completion date set in the initial schedule could be earlier than the completion date agreed with the client, because some opportunities to speed up the job have been identified. Along this line, over 60 % of the respondents refer that in order to estimate the target profit of the work, site managers take into account two aspects: on the one hand, costs and incomes objectively measurable and, on the other hand, pricing of opportunities that have been identified to reduce costs or to increase income from the construction project. During the second phase of this project a more extensive research will be developed on this topic. However, on the basis of the facts provided above, it could be considered that construction companies use a kind of contingency that has not been clearly described in the literature: "negative" cost and time buffers used to price those opportunities that have been identified and could reduce the time and optimize the cost. This kind of "negative" contingency would be, on the other hand, the way to quantitatively reflect the claims that firms plan during tendering processes. These claims explain why construction companies can bid lower prices, even below cost-recovery levels (Rooke, Seymour and Fellows 2004).

CONCLUSIONS

Construction companies surveyed in this study do not typically use the formal and analytic methods proposed in the literature to manage contingencies. Certain authors (Ford 2002, Francis and Hester 2004, Laryea and Hughes 2011) highlight the importance of management methods founded on an empirical basis. However, only one study (Ford 2002) takes partially into account the actual contingency management practices of construction companies. This research initiative aims to overcome this gap, exploring the actual practices of construction companies during the construction phase of a project. Improving the knowledge on this topic is essential if contingency management is to drive process improvement.

The survey developed in this paper confirms, for the Spanish scenario, some ideas in the literature provides from other cultural environments. The main findings are described as follows:

- None of the two companies has clear management procedures to assess and manage project uncertainty.
- All the site managers who responded the survey made budgets and schedules, "always or nearly always", prior to begin the work.
- About half of the site managers do not typically include time and cost buffers in their budgets and schedules.
- When time and cost buffers are established, the site managers generally do it in a subjective manner.
- Site managers commonly assess opportunities that have been identified in order to reduce project completion time and/or to optimize project economic performance. The quantitative result of such assessment aims to shorten completion time and/or increase profit, which implicitly introduces a kind of contingency that has not been clearly described in the literature: a "negative" contingency. This "minus sign" contingency would fit the dual aspect of risk (threat and opportunity) that certain authors claim (Cabano 2004, PMI 2013).

Moreover, this study has also opened interesting lines of research where further analysis is needed. It is necessary to explore more extensively the above findings, mainly in the "negative" contingencies topic. And other sorts of contingencies provided in the literature but not tackled by the survey must be studied. The second phase of this research will provide an explanation for how Spanish construction companies manage risk and uncertainty during the construction project using contingencies; in order to do this, the following questions, among other, should be answered:

- Procedures of risk and uncertainty management: Why is it that contractors do not have these procedures?
- Launch of the construction project: budget and schedule. How do site managers make an initial definition of scope and quality? Do site managers tend to systematically identify and assess opportunities? Do site managers share information about such processes with their co-workers? Why don't site managers take into account tendering process information? Why do site

managers set contingencies in a subjective manner? What factors do site managers take into account in order to quantify contingencies? Why do half of the site managers not typically include contingencies in their budgets and schedules?

- Dynamic construction project management: Do site managers monitor the initial estimations of contingencies? If yes, then how do site managers reassess contingencies? Is work-in-process used as a contingency? If yes, then how is it quantified? Who is responsible for doing it? How are capacity buffers defined? Who is responsible for doing establishing and monitoring them?
- Comprehensive risk management: Are contingencies managed holistically?

ACKOWLEGMENTS

We would like to express our most sincere appreciation to the companies that collaborated in this study, particularly to the people that have dedicated a few minutes of their time to contribute with their valuable ideas.

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APPENDIX: QUESTIONNAIRE.

The first five questions of the questionnaire refer to demographic topics: construction industry experience, current company experience, educational background and current position. The respondent´s current position entails two specific questionnaires from question 6 to 15: one for site managers and another different for the whole rest of positions. But both questionnaires are very similar. Site managers have been asked to say what they believe or what they make, while the rest of positions have been asked to say what they believe site managers think about or make. Another difference between both questionnaires is that some questions of the rest of positions one include an additional choice: "I do not know". The specific questionnaire that non-site managers answered is shown below.

> 6.- Please, indicate your opinion about the corporate procedure of your company to manage uncertainty related to events or facts that could affect to construction project performance. a.- I am not aware of such procedure in my company. b.- I know the procedure but I normally I do not use because I consider it is useless. c.- I know the procedure but I normally I do not use because it is non-mandatory. d.- I know the procedure and I normally use it while it needs improvement. e.- I know the procedure, I normally use it and I consider it is good enough. f.- I know the procedure but I do not know either it is normally used nor it is good enough.
>
> 7.- Please, indicate if you believe that site managers make an initial schedule and an initial costs and incomes budget of their construction projects. a.- Always. b.- Almost always. c.- Very frequently. d.- Just sometimes. e.- Never or hardly ever. f.- I do not know.
>
> 8.- Regarding the above mentioned initial schedule and budget, please, indicate if you believe that site managers take into account those coming from bidding process. a.- Always. b.- Almost always. c.- Very frequently. d.- Just sometimes. e.- Never or hardly ever. f.- I do not know.
>
> 9.- Please, indicate if you believe that the initial schedule includes time buffers (explicit or not) to absorb uncertainty about the materialization of different events and its impact on the length of the scheduled tasks. a.- Always. b.- Almost always. c.- Very frequently. d.- Just sometimes. e.- Never or hardly ever. f.- I do not know.
>
> 10.- Please, indicate which one of the following methods is more frequently used by site managers to set up the above mentioned time buffers. a.- They subjectively estimate buffers based on different factors that could delay the

completion of the construction project. b.- They subjectively estimate buffers, but not based on any previously identified factors. c.- Critical Chain. d.- Monte Carlo. e.- Others (name). f.- I do not know.

11.- Please, indicate if you believe that the initial budget includes cost buffers (explicit or not) to absorb uncertainty about the materialization of different events and its impact on the cost of the construction project. a.- Always. b.- Almost always. c.- Very frequently. d.- Just sometimes. e.- Never or hardly ever. f.- I do not know.

12.- Please, indicate which one of the following methods is more frequently used by site managers to set up the above mentioned cost buffers. a.- They subjectively estimate buffers based on different factors that could make the construction project to overrun. b.- They subjectively estimate buffers, but not based on any previously identified factors. c.- Monte Carlo. d.- Others (name). e.- I do not know.

13.- Please, indicate how do the target completion date and the contract completion date relate. a.- They usually match. b.-Normally, target completion date is earlier than contract completion date. c.- Normally, target completion date is later than contract completion date. d.- I do not know.

14.- Whenever the target completion date is earlier than the contract completion date is due to: a.- Some opportunities have been identified to speed up the construction project. b.- It is needed to speed up the construction project despite no opportunities have been identified to do it. c.-The two are mixed together. d.- I do not know.

15.- The rationale behind the profit target of the initial budget that site managers make is based on: a.- Costs and incomes objectively measurable. b.- Pricing of opportunities that have been identified to reduce costs or to increase incomes of the construction project. c.- The two are mixed together. d.- I do not know.