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Introduction

The construction industry is a strategic sector in the country's economic development due to the capacity of providing the infrastructure necessary, also impacting different sectors of the economy to grow. This phenomenon is only possible due to the multiplying factor this sector has over both supply chain and labor absorption. However, the sector faces issues to achieve good productivity due to its multifaceted, dynamic and fragmented nature between different stakeholders and sub-processes, in which the subcontracting process is widely practiced.

The subcontracting system is generally described as the contractual process in which a main contractor subcontracts parts of the work to another contractor. The performance of subcontractors, or rather the non-performance, affects the performance of the industry as a whole, triggering persistent problems of quality, productivity, non-payment and security [1]. Thus, the selection of the right subcontractor, for the right work is essential to the success of the project.

In the literature, subcontractor selection models are often proposed where different approaches are used, such as multi-criteria decision, genetic algorithms, linear programming, Fuzzy set theory, and others. In this paper, the focus is a multi-criteria selection model where the tradeoff process requires less cognitive effort and less information from the decision maker. That is different from the standard compensation procedure that requires great cognitive effort from the decision maker. Therefore, the present research proposes to develop a process for selecting subcontractors in civil construction using the FITradeoff method.

FITradeoff method application

The subcontractors' selection in projects consists of the selection of the "optimal subcontracted" to execute certain work package, according to the performance of the subcontractor at the beginning of the set of criteria that reflect the required capacity. In this sense, the criteria cost, duration, quality, know-how, and cooperation were chosen from the literature review and later validated by the decision-maker.

A project was chosen for the problem selection. The project network consists of 32 activities and has a variety of 13 activities, in other words, some activities are repeated on the floors, e.g. concreting of the structure. Therefore, the subcontractor selected to perform a certain activity on the floors should be strictly the same. For each activity, there is a set of subcontractors with performances in the abovementioned criteria. The goal is to get a set of “most appropriate subcontracted ” that represents the decision-maker’s preferences.

The rationality of compensation refers to the existence of tradeoffs. For [2], the cognitive effort associated with the questions made to the decision-maker should be reduced. In this sense, we opted for the use of the FITradeoff Method proposed by [3] because of its flexible characteristic. Second [3], FITradeoff is an elicitation procedure that requires partial information by the decision-maker and preserves the axiomatic structure of the tradeoff but requires a lower cognitive effort, which leads, consequently, a lower rate of inconsistencies.

The application of the FITradeoff method consists of three phases. The first one is the modeling of the preferences characterized by the interaction of the decision-maker – software, where they occur: Step 1 – ranking of the criteria's scale constants, in this application the decision-maker ordered the criteria as it follows: cost > duration > quality > cooperation > know-how; Step 2 – flexible elicitation, where questions are made about the decision maker’s preference between Consequence A or Consequence B (tradeoffs). The consequences have different performances for two criteria. For example, Consequence A has a median performance in the duration criterion, and the worst performance in quality and Consequence B has the worst performance in duration and the best performance in quality. The decision maker’s preference for each question will result in a different rate of one criterion over the other.

The second phase of the method consists in the identification of the selected subcontractor and its scale constants. The third phase is a sensitivity analysis in which cost and duration criteria were varied by 10% more and for less in a simulation of 1000 replications to verify if there is a change in the selected subcontractor.

Conclusions and perspectives

The set of subcontractors selected presents a general performance in cost equals to 6,309,704.00 Indian Rupees (INR), a duration of 146 weeks, 80.41% in quality, 77.17% in cooperation and 82.05% in know-how.

It was observed that cost is the main criterion for the decision-maker, and the strong tradeoff relationship between cost and duration, in which the best performance in one will be at the expense of the lower performance of the other. The preference of the decision-maker that faces this type of tradeoff is determinant for the outcome of the schedule.

This paper is part of ongoing research that seeks the development of a methodology that uses multicriteria methods in conjunction with genetic algorithms. Thus, the selection process is able to evaluate subcontractors considering the subjectivity of the decision-maker, from the assumption that preferences vary according to the type of activity of the project, the various criteria and the construction schedules meeting the cost restrictions and penalty for delay.

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