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Application of the AHP methodology in making a proposal for a public work contract

M. Bertolini [a,*], M. Braglia [b], G. Carmignani [b]

[a] Università degli Studi di Parma, Dipartimento di Ingegneria Industriale, Viale delle Scienze, 181/A, 43100 Parma, Italy
[b] Università degli Studi di Pisa, Dipartimento di Ingegneria Meccanica, Nucleare e della Produzione, Via Bonanno Pisano, 25/B, 56126 Pisa, Italy

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Abstract

In this paper the Analytic Hierarchy Process (AHP) approach is proposed as a tool to select the best discount in defining a proposal for a public work contract. In the tender for public work contracts the quality characteristics of the work and time schedule are strictly defined. Consequently, the only important parameter in order to win the contract is the discount offered compared to the price of the tender. However, the definition of 'suitable' discount is a critical process involving the evaluation of many variables and aspects. For this reason, a Decision Support System (DSS) tool is desirable for the proposal management. A hierarchical structure comprising 31 criteria is reported here to illustrate the performance and characteristics of the technique proposed. This structure concerns an analysis of the proposal management process in a company which decorates public garden and park structures.

Keywords: Analytic Hierarchy Process (AHP); Public work contract; Tender; Discount; Proposal management

1. Introduction

In many cases the proposal management is an elaborate, critical process for a generic make-to-order company which designs and develops complex products and services. Unsuitable management of the proposal phase can lead to miscommunication, misallocation of resources, and in many cases missed contract opportunities. This fact is mainly due to the characteristics of the proposal process:

- it is often based on the forecast for the utilization of material and immaterial resources;
- it is based on quantitative and qualitative variables which are in many cases discordant;
- the proposal must consider:
  - the product on sale,
  - the correlated services,
  - design and accomplishment timing,
  - policies involving and subcontracting suppliers and
  - places where the intervention must be made (i.e. plant installation), availability of logistic services and infrastructures.
- it is often impossible to know or estimate the proposals of the competitors;
- a preventive negotiation is often not applicable (i.e. public tender for contract);
- the proposal cannot be modified after knockdown and is binding for the next phases;
- money penalties may be present in the contract;
- each case-job is different.

By integrating the process of prioritizing, estimating, and engaging services, it is possible to obtain the information needed for the proposal management, prioritize opportunities, and estimate costs and scope of the project [1]. Therefore, it is important to utilize appropriate techniques and decision-making criteria to support the drafting of the best possible proposal to win the order.

The literature offers several techniques to support the evaluation of different proposals. Sirajuddin and

* Tel.: +39 521 905861; fax: +39 521 905705.
E-mail address: massimo.bertolini@unipr.it (M. Bertolini).

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Al-Bulaihed [2] proposed an evaluation procedure of maintenance tenders based on two main features: (i) tender technical score, which takes into consideration four aspects (compliance with tender submission requirements; support and maintenance plan; experience and financial status of tenderer; project staffing), and (ii) tender price score, which rates the ratio of the lowest tendered price against the tendered price being evaluated.

Through a fuzzy approach for tackling problems related to qualitative multi-criteria analysis, Deng [3] proposed an effective selection of the appropriate project delivery. This is mainly based on an adequate modelling of uncertainty and imprecision in human behaviour. The fuzzy logic and multi-criteria analysis approach was also utilized by Ting-Ya Hsieh et al. [4] to select planning and design alternatives in public office buildings.

For general application, specific software is also available to determine and classify the proposals obtained. No particular techniques, instead, can be found to support the proposal making process, as this activity is (i) a very critical decisional problem for many companies, and (ii) characterized by aspects which are peculiar to each work.

In order to fill this gap, a Decision Support System (DSS) tool based on the Analytic Hierarchy Process (AHP) approach is presented in this paper. The methodology proposed permits to evaluate alternatives through a set of weighted criteria defined by the company through a simple structured process. In particular, the method is able to:

- define a structured systematic technique to carry out the proposal-making process;
- define the set of variables which must be selected and evaluated in order to determine the best proposal;
- share the know-how about proposal-making within the company (i.e. building technical memory).

The two main objectives of the methodology proposed are:

(i) use a method to support the drafting of the proposal and establish decisional criteria and their priorities;
(ii) implement a simple technique to guide subjective judgments in a correct, systematic approach. In fact, it is impractical (and also undesirable and pointless) to use a completely automated tool to determine the proposals for different works, opportunities or tenders for contract. It is useful, instead, that the decision-making process is based on experience judgments guided by a structured and systematic approach supported by decision-making tools.

Finally, the method proposed also permits to (i) use a structured systematic process to define the proposal, (ii) obtain a transparent list of decision criteria, and (iii) share know-how within the company.

The remainder of the paper is organized as follows. A rapid description of the AHP methods is reported in the following section. Section 3 deals with the hierarchical structure and criteria and, finally, the results are reported and discussed in Sections 4 and 5.

2. The AHP method

The Analytic Hierarchy Process (AHP) is a method developed by Saaty [5] to support multi-criteria decisions, where:

- *Analytic* indicates that the problem is broken down into its constitutive elements.
- *Hierarchy* indicates that a hierarchy of the constitutive elements is listed in relation to the main goal.
- *Process* indicates that data and judgments are processed to reach the final result.

The AHP methodology has been widely utilized in various fields: software selection problems [6], economic and management problem solving [7], plant location selection [8], supplier selection [9], evaluation of project termination or continuation, based on the benchmarking method [10], selection of the best alternative between different outsourcing contracts in terms of maintenance services [11], and so on.

The AHP is constituted by two phases:

(i) the hierarchy tree definition;
(ii) the numerical evaluation of the tree.

The hierarchy tree definition starts from the determination of the proposed goal, then criteria and sub-criteria are defined using the experience of the experts; finally, the alternatives known *a priori* represent the leaves of the tree.

The evaluation phase is based on pair-wise comparison. The criteria on the same level of the hierarchy are compared to establish relative importance compared to the criterion of the *father-level*. This process permits to (i) obtain values that weigh criteria, and (ii) define a ranking of the alternatives. The evaluation is bottom-up: the decision-making process starts by comparing the alternatives with the criteria of the last level; the evaluation continues up to the criteria of the first level, which are then compared to the goal.

The scheme proposed by Saaty, reported in Table 1, can be used to translate linguistic judgments into numbers.

The AHP methodology combines those data to obtain a ranking of the alternatives (usually a normalized vector). Finally, it is possible to perform a sensitivity analysis to investigate the consequences of the variation of the weight of a criterion. With the sensitivity analysis it is possible to (i) measure the robustness of the solution and (ii) determine the criteria that have more relevance on the final result.

The main advantages of using the AHP methodology are: