KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

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CEM 610

THESIS PROPOSAL:

EFFICACY OF CONTRACTOR PREQUALIFICATION MODELS

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1.0 INTRODUCTION

The construction industry is not only unique in many ways but also has enormous scope with several varied fields of interest. These areas are also highly specialized. In spite of these diversities and variations present in the construction industry, the overall objectives of the project unite a varied collection of project participants. The constantly evolving nature of the construction industry with increasing sizes and complexities of construction projects, rapid changes in building systems and technologies, political and legal regulations, their non-repetitive nature and the high financial outlay requirements all add up to demand that the project participants think about the entire construction process with great attention.

Every prospective building owner aspires to attain a completed facility of the best possible quality within the specified time while keeping the final cost within the initial budget estimate. Unfortunately, this aspiration is not always achieved sometimes because of the procedures involved in executing the construction contracts. These procedures begin with the choice of a contractor to be entrusted with the construction work, with the capability to meet the specific requirements of the owner under the contract. As mostly is the case, the project participants are ignorant of each other's style of work because of having never worked together before. This unfamiliarity with each other can cause conflicting interests with regard to their project objective.

Most of the owners recognize the role of the contractor in the overall success and final cost of the project. So construction owners as such, be they public or private, have developed many different ways of selecting contractors who will be responsible for the execution of the project. These different ways of selecting contractors have been based on several factors ranging from the circumstances of the prospective owners to the extent of advice or guidance supplied by the project consultants. The public owners for instance award contracts to the lowest responsible bidder in order to fulfill the requirements of the law that protect public interest and funds, prevent fraud, collusion, and favoritism, and obtain quality construction at reasonable and fair prices. Determination of the lowest bidder is easy and direct, while on the other hand the matter of contractor responsibility is not so simple. If the bidding contractors have

been prequalified the issue of responsibility has already been dealt with. As a result of this selection based on the lowest price, the question of contractor's ability to meet the owner's requirements in terms of capability, skill, reliability, and integrity, has more often than not been pushed out of the limelight. This contractor ability in many cases has been interpreted by the public sector to mean the bidder offering the lowest price and that can obtain the necessary bid bond. Aitah (1988) conducted a performance survey to show that the lowest price bidder in public projects in Saudi Arabia generally had low performance which consequently increased the maintenance cost. Poor quality of workmanship, delayed completion and sometimes suspension or abandonment of the projects, which amount to huge economic losses or inconveniences are among the other problems faced by relying on the lowest responsible bidder principle. Al-Ghafly (1995) has reported that about 60% of public projects are being delayed by about 110% of the original duration. Thus demonstrating, the price that is being paid for meeting the legal requirements imposed on public agencies in the bidding process.

Bearing in mind the deficiencies of public bidding procedures highlighted above, the private sector with its higher demand for the value of invested money requires better methods of ensuring that the maximum benefits available for any investment are achieved. Thus the private sector has a wider range of decision-making options because of the absence of any legal restriction with regards to the method used in selecting contractors. Actually, private bidding procedures are based on the discretion of the owner, with the advice and assistance of his design consultants and hence can be modified, altered, or waived as when it suits the owner (Clough and Sears, 1994).

Project-level constructor failure occurs when a constructor is unable to perform his or her contractual duties, and may require the project owner to invoke the contract's nonperformance clause (Russell, 1996). In order to avoid this project failure and to improve the probability of project success, there is a need to have a turnaround in the procedures used for evaluating contracts. The technical, managerial, supervisory, physical and financial capabilities of the contractors have to be thoroughly evaluated. For an unbiased and objective outcome, it is essential that the criteria should have different weight values depending on their impact on the project, or the importance placed on them by the decision maker.

Several Multi-Criteria Decision Making (MCDM) methods for contractor prequalification have been developed by various researchers (Russell, 1988; Russell and Skibniwski, 1988; Al-Alawi, 1991; Al-Gobali, 1994; Assaf and Jannadi, 1994; Munaif, 1995 etc.) to assist both public and private owners in selecting a qualified contractor.

2.0 LITERATURE REVIEW

2.1 CONTRACTOR PREQUALIFICATION

Contractor prequalification involves the screening of prospective contractors by the owner of a project or his representatives in accordance with some predetermined set of criteria found to be the necessary ingredients for ensuring quality performance, in order to determine their capabilities to perform the required work, if awarded the construction contract. The purpose served is to eliminate the incompetent, overextended, under-financed and inexperienced contractors from consideration (Clough and Sears 1994).

There are a few private owners who often choose to negotiate the construction contract with a reputable contractor basing their decision on either their previous experience with the contractor, instinct, political and social influences or on the advice of their consultants and on the other hand there is a vast majority of construction contracts that are procured using the low-bid system where price is the sole basis for determining a successful bidder (Russell and Skibniwski, 1988). It has also been proposed that time can be used as an additional criteria to evaluate bids of highway construction contracts (Ellis and Herbsman, 1991). A further proposal was also observed that took the past performance of contractors as a means of assessing likely quality to be achieved, past accident records as a means of assessing safety performance levels, and then converted these criteria into cost terms to enable a comparison of the bidders (Ellis and Herbsman, 1991).

All of these approaches have serious setbacks because of lack of objectivity and because they do not take into account the procedure for selecting the most suitable contractors that possess the minimum capacity of undertaking any project, to participate in the bidding process. Therefore it is essential to ensure that the

qualification of the contractors is based on such factors as experience, competence, and financial ability before they are issued bidding documents or invited to submit proposals.

Russell et al (1990) stated that contractor prequalification decision-making involves a wide range of criteria that often consists of both qualitative and subjective information. The process remains largely an art where subjective judgment, based on the individual's experience, becomes an essential part of the process. They highlighted these parameters to include reputation, past performance, financial stability, references, experience record, firm capacity, current workload, and technical expertise. Wideman (1999) defined prequalification as an assessment of contractor's capabilities, current capacity, etc., as an initial part of the selection process. This he said will narrow down the number of bidders to be invited for tendering and also the amount of work and hence cost for both the bidders that are unlikely to be successful on these grounds as well as the reviewers of the submissions, in order to make final selection for award.

Russell and Skibniewski (1988) identified a generic logic in the prequalification decision making process. Three distinctive parts of the process are:

- the characteristics of the contractor;
- the characteristics of the owner
- the resulting decision

The evaluation method developed by Russell and Skibniewski (1988) provides a mechanism for dividing the prequalification problem into related parts and formalizing the means by which prospective contractors are evaluated.

Sources of data for evaluating candidate contractors can be obtained from information supplied by contractors in prequalification questionnaires, company brochures, financial statements, previous sureties and insurers, etc.

2.2 PREQUALIFICATION DECISION CRITERIA

Decision criteria set used in the screening process to select a suitable contractor for a given project empowers the owner or his representative to determine

whether the contractor is capable or competent enough to perform the work within budget, on schedule and at the required safety and quality standards. Selecting the proper decision criteria is essential especially to a private owner whose objectives almost always comprise of maximizing profit, market share, goodwill and future growth. Birrell (1978 and 1985) studied the factors and criteria, which top quality subcontractors' use in evaluating the managerial performance of general contractors. These criteria can be seen as the intrinsic managerial cost and time-sensitive factors by which general contractors, or any manager of construction, could improve performance, competitiveness and profitability. The criteria found in the literature (Al-Alawi 1991, Munaif 1995, Al-Gobali 1994, Birrell 1985, Russell 1990, Russell and Skibniewski 1990, Clough and Sears 1994 etc.) include the following:

1. Financial Stability

Financial stability is a factor that makes its appearance in almost every prequalifying team's list. Basically this criterion involves evaluating the financial condition of each candidate contractor. This indicates the capacity of the candidate contractor to fully meet financial commitments. Russell (1990) indicated the importance of contractor's credit rating, banking arrangements and financial statement to measure the solvency (or liquidity), efficiency and profitability of a contractor, in assessing his financial capability.

2. Experience

This criteria has been used in regular use for prequalification but has been called by different names like past project performed, past performance, experience etc. This involves evaluating the candidate contractor's project records to determine whether or not he has handled jobs of similar scope and complexity in the past or currently. Birrell (1985) indicated that possessing experience in projects similar to the proposed in terms of type, size and complexity should be an important evaluation criterion. This can be determined from satisfaction expressed by past clients/customers. This can also include investigating the performance history of the contractor in terms of completion on schedule and within budget, effectiveness of quality and cost control, and the quality of finished products.

3. Current Work Load (Capacity)

This criterion also sometimes called as current projects on hand involves the evaluation of the candidate contractor's manpower, equipment and financial resources vis-à-vis his ongoing work projects to determine if his current commitment can impact his performance on the project for which he is being currently prequalified.

4. Management and Manpower Qualification

Also known as experience of key personnel, it is concerned with the qualification and skill of the management (administrative staff and engineering professionals) and labor crew (craftsmen and trades). This is important as Clough and Sears (1994) remarked that the financial success of a construction enterprise depends almost entirely on the quality of its management. Russell (1991) contended that 8 out of 14 projects studied failed because of lack experience of the management and technical staff.

5. Contractor Organization

This seeks to evaluate the effectiveness of flow of information and decision making process among the different levels of the company. The importance of company organization was stressed by Birrell (1985) and Al-Gobali (1994).

6. Location of Head Office

This is concerned with the geographical location of the contractor's head office, the idea being that closer the office is to the proposed building site the better would be the backup support provided by the office. This is important because of the numerous support services rendered to the site personnel by the head office and the need for prompt feedback. These services include project financing, recruitment, staffing, ticketing, passports, visas, housing, catering, material procurement, expediting of materials, renting or leasing equipment,

evaluation of design changes and contract modification, negotiations and approval of change orders and resolution of technical disputes. This calls for the availability of transportation and communication facilities to facilitate the decision-making requirements.

7. Knowledge of Geographic Location of Project

The lack of knowledge about the geographic location, environment and local conditions of a project can be a reason for contractor's failure (Russell 1991) and project delay (Hazmi 1987). Lack of knowledge about the location increases the contractor's risk exposure and the probability of disputes arising.

8. Equipment Resources

Availability of equipment and their maintenance program are major factors affecting contractor performance. In this criterion the available resources in terms of personnel, plant and equipment are evaluated (Al-Gobali 1994). Equipment shortage and low productivity may cause project delay (Hazmi 1987) and equipment cost control (maintenance, repair and replacement) is an important element of contractor's failure (Russell 1990b).

9. Procurement and Material Management

With material cost ranging between 30 to 60% of total building project cost, procurement and material management are evidently essential to project success. Ubaid (1991) found that material delay is a major cause of project delay. Contractor's Procurement expertise and material management skills will result in on-time delivery avoiding delay as well as the additional cost for storage and double handling of early material delivery. Al-Gobali (1994) also lists procurement as one of the organizational factors that make or break the chances of the success of the project.

10. Safety Record

Accidents at construction sites may not only result in a loss of life but also result in increased insurance premium rates on the subsequent projects by the same contractor. It also results in a loss of goodwill. The selection of a contractor with a good safety record can minimize construction accidents and thereby save construction costs (Al-Gobali 1994). Ubaid (1991) ranked this criterion as number 8 out of 14 factors affecting project performance.

11. Claim Attitudes

This is a measure of trust and cordiality in the relationship between the owner and contractor. Cooperation and coordination between the parties will lead to reduced interface problems, delays and consequently cost. Past experience of contractors can indicate their tendency towards litigation. Owners should avoid contractor's who are inclined to litigation as a way of making profit. Consequently past record of claims and disputes are asked for. (Al-Gobali 1994).

12. Quality Program

A quality program in place always increases the chances of a better finished project. Hence Russell and Skibniewski (1988) have included the existence of a quality program as a criterion in the prequalification process.

13. Past Owner Contractor Experience

Earlier interaction between the owner and the contractor plays a vital role in selecting a contractor as the owner prefers to work again with a contractor that has produced the earlier project at the required cost, time and quality benchmarks.

14. Other Criteria

Other criteria that have taken into consideration for the prequalification process include scheduling (Al-Gobali 1994), staff available, substance abuse policy (Russell et al. 1990) and company reputation (Jennings et al. 1998).

2.3 MULTI-CRITERIA DECISION MAKING (MCDM)

MCDM approach is a methodology that makes the decision making process easier in cases where several diverse points of view have to be taken into consideration by optimizing the multiple attributes, objectives and goals. Zeleny (1982) defined criteria as all those attributes, objectives, or goals, which have been judged relevant in a given situation by a particular decision maker. The history of MCDM started with the work of Pareto in 1896 where the problem of the aggregation of criteria into a single criterion was examined.

Mathematically, a multicriteria decision problem can be defined as a situation in which after defining a set *A* of actions and a consistent family *F* of criteria on *A*, one wishes

1. to determine a subset of actions considered to be the best with respect to *F* (choice problem),
2. to divide *A* into subsets according to some norms (sorting problem), or
3. to rank the actions of *A* from best to worst (ranking problem) (Vincke, 1992).

However it should also be realized that a multicriteria problem is usually an ill-defined mathematical problem because it has no objective solution that can be universally accepted at all possible circumstances. There is generally no action that is better than all the others for all the criteria considered simultaneously. Therefore, the solution of a multicriteria decision problem is not like arriving at some hidden facts after much contemplation but on the on the other hand it only helps the decision maker to understand the often complex data involved in the concerned problem and arrive at a solution. This solution will be of the 'compromise action' type and will depend strongly on the decision maker's personality, on the circumstances in which the decision aiding process take place, on the way in which the problem is presented and on the method used.

2.4 MULTI-CRITERIA DECISION MAKING METHODS FOR CONTRACTOR PREQUALIFICATION

The different MCDM methods for contractor prequalification to be considered under this study are discussed below.

1. Weighted Evaluation method

This technique was originated by Lawrence Miles in1972, which he called Function Rating and explained in Parker (1985). It is a formally organized process for selecting optimum solutions in circumstances involving several criteria. In evaluating alternatives, these criteria are assigned different weight values depending on their potential impact on the project under consideration, or the importance placed upon them by the decision maker. The system is divided into two processes; criteria weighting process (paired comparison) and matrix analysis.

The system used in determining the weights of importance to be assigned each criterion is called "paired comparison" (Parker, 1985). This is based on making a simple decision involving a choice between two things, like "yes-no" or "either-or" answer.

Al-Alawi (1994) and Assaf and Jannadi (1994) applied the weighted evaluation to contractor prequalification in Bahrain and Saudi Arabia respectively. Other application includes Russell and Skibniewski (1988).

2. Dimensional weighting method

Under this method, each criterion or decision parameter and its weight of importance are determined based on the Owner/Consultant's (decision maker's) requirements. The contractors are rated on a scale of 1-10 (1 – "Unsatisfactory", 10 – Excellent"), subjectively, with respect to these criteria based on the total score, which is calculated as a weighted sum of ratings over all the criteria using the percentages given in Table 1. All the aggregate scores are then ranked. This selection process is compensatory

since a high score in one dimension can compensate a low score in another dimension.

Table 1: Results of Dimensional weighting strategy for Contractor prequalification (Russell and Skibniewski 1988).

CONTRACTOR SELECTION CRITERIA	WEIGHT (%)
Experience over last five years in construction of similar projects	15
Experience in completion of project on schedule	12
Present workload & capability to support project	16
Experience and capability of contractor key site management personnel from similar projects	16
Availability of first line supervisors	12
Quality control program and quality of work on past projects	8
Owner/Contractor past relationship	14
Past and Present experience on legal suits and claims attitude	7
TOTAL SCORE	**100**

In order to make a decision, this strategy utilizes a decision rule such as: if the candidate contractor's aggregate score is less than or equal to a certain minimum score, then the prequalification decision is "no" and hence the contractor is rejected. Only the qualified contractors will be permitted to submit their proposals. Alternatively, a subjective judgment may be used such as: select the three highest scores to participate in the bidding process (Russell and Skibniewski 1988).

3. Two-step prequalification method

The first step under this method entails the employment of a dimension-ordering strategy. In other words, contractors are either qualified for the second part or disqualified from further participation depending upon how well they satisfy a number of preliminary screening dimensions such as whether or not the contractor has:

- Performed work of similar size and type.
- strong financial stability
- work load of similar project type.

The second step utilizes the dimensional weighting strategy using more specific criteria to determine the competitiveness of any contractor as a bidder as previously described (Russell and Skibniewski 1988). Appropriate criteria for the second step are shown in Table 2.

This method allows rapid elimination of unwanted contractors such that the owner can focus his attention on the remaining contractors. However, this method may eliminate some contractors possessing excellent characteristics in areas not considered in the evaluation (Al-Alawi 1991).

4. The prequalification formula method

There are formulae used in the prequalification selection of contractors by some public owners, especially in the United States. The formulae are used to calculate the maximum capabilities of contractors. The purpose of the formulae is to provide some objectivity in the decision-making by the owner, by reducing his over-dependence on subjective judgment. Maximum capacity refers to the maximum amount of uncompleted work in progress, which the contractor can have at any one time. However, if the project cost exceeds the difference between any contractor's maximum capacity and the amount of current uncompleted work, such a contractor will not be allowed to bid while using the formula method (Russell and Skibniewski 1988).

Table 2: Contractor Selection Criteria (Russell and Skibniewski 1988).

WEIGHT (%)	BIDDER SELECTION CRITERIA
8	Past experience on owner's major projects
8	Experience in the last ten years in construction of similar project
8	Experience capability of contractor's key site management personnel on similar projects
8	Past owner/contractor relationship
6	Experience in completion of projects on schedule
6	Present workload and capability to financially support project under consideration
6	Availability of first-level supervisors and number presently employed
5	Scheduling and cost control system and method of utilization
5	Home-office corporate support of project including engineering and procurement
5	Experience and capability of contractor's technical field personnel
4	Past and present experience regarding law suits or claims
4	Availability of skilled crafts
4	Capability to manage subcontractors and planned subcontracts
4	Quality-control program and quality of work on past projects
4	Availability of owned construction equipment
3	Contractors methodology to construction of projects
2	Capability to perform field purchasing and material control
2	Use of construction procedures, rigging, welding control, etc.
2	Drawing control procedure
	Proximity of contractor's home office to project
100	

The formula is based on the information given in the contractor's balance sheets and income statements. For example, the Ohio State Department of Transportation employs the contractor's net current asset (obtained from the most current financial statement) multiplied by 10 in order to determine the maximum allowable work volume for a given contractor. Then the final ratings are determined by modification of the net current asset by using the following factors: for organization and key personnel 20%; for planning and equipment 20%; for construction experience 20%; for credit 15%; and for past performance 25%.

Similarly, the Iowa State Department of Transportation determines the financial capacity of a candidate contractor by obtaining the difference between total net current asset and total net current liabilities and adding to one-half of the difference between non-current assets and non-current liabilities. The formula is represented mathematically as;

Financial capacity = (Net current assets – Net current liabilities) + ½ (Non-current assets – Non-current liabilities).

This rating is then multiplied by an "ability factor" to determine the final ratings using the following factors: for attitude and cooperation 10%; for equipment 20%; for organization 20%; and for work performance 50%.

Much of the financial analysis is based on examination of ratios between figures on the balance sheets and on the income statements. The ratio also can be compared with those of similar firms and with industry average at a given time to evaluate the relative performance of the company.

5. DIMENSIONWIDE STRATEGY

A dimensionwide strategy has been used by owners in which the most prominent dimension is selected and all contractors are evaluated with respect to it. Then the contractors are moved on for evaluation to the next most prominent dimension. At each evaluation step, the contractor is judged for that dimension only. If the contractor fails at any particular evaluation step then he is discarded from the contractor list and not considered for subsequent evaluation steps. This process of elimination is carried on till all the evaluation steps are exhausted and a qualified contractor list is arrived at. Evidence of this approach has been observed by Russell and Skibniewski (1988).

6. SUBJECTIVE JUDGMENT

Russell and Skibniewski (1988) have expostulated that in some instances, individuals perform prequalification based on their subjective judgment and not on a structured approach. This judgment is influenced by many factors with previous experience of the decision maker with the contractor being one of them. This approach can lead to incorrect decisions because it lacks a rational approach.

7. THE ANALYTIC HIERARCHY PROCESS

The Analytic Hierarchy Process (AHP), introduced in the early 1970s by Thomas L. Saaty is used for dealing with complex technological, economic and socio-political problems. This is done by simplifying and expediting the natural decision making process (Saaty, 1980). The method utilizes pair wise comparison by breaking a complex unstructured situation into its component parts, arranges those parts into a hierarchy, assign numerical values to subjective judgments regarding relative importance (or preference), and synthesize those values to determine which variable has the highest priority and should be acted upon to influence the outcome of the situation.

The distinguishing feature of AHP technique from the other MCDM techniques is that it does not necessarily require a tangible numerical scale of ratio and can thus be applied to the measurement of intangible criteria. The fundamental synthesis technique is additive. It also has a consistency check for encouraging enforcement of judgment transitivity. The analytic hierarchy process has been well researched and has been applied in hundreds of areas. The process has been implemented in the commercial software HIPRE, Criterion, and Expert Choice.

An application of AHP to contractor prequalification was carried out by Munaif (1995) and Fong et. Al (2000).

6. POINT ALLOCATION METHOD

Point Allocation (PA) method is a simple and commonly used in multi-criteria decision making process. But its basis isn't well thought out or explained. This method consists of assigning a hypothetical number of points, e.g. 3, 5 or 10 to decision criteria and/or alternatives. This allocation is strictly at the discretion of the decision maker. The redeeming feature of PA is its simplicity. PA is ignored by researchers because of its lack of theoretical foundation. It is more likely to be seen in "popular" literature or in basic management texts as an example of a simple method for decision aiding (Zeleny 1982). This process has been implemented in the commercial available software GroupSystems V and VisionQuest.

It is reported that the United States Army Corps of Engineers uses a variant of this technique under the name 'merit point system' (MPS) in determining qualified bidders. MPS is based on weighted criteria such as experience on similar projects, equipment and manpower availability, time and quality dimensions, but the method further establishes a relationship between the total score of the criteria and the bid price. The contract is awarded to the bid that receives the lowest price per merit point. But this method is more relevant in the evaluation of bids than prequalification.

2.4 THE BESPOKE APPROACHES (BA)

BA tends to incorporate several decisional techniques simultaneously and exhibit a lot of deviation from each other. The initial stage of BA usually deals with judgment either by the decision maker. This judgment is carried out based on some cut off criteria. A binary decision (Yes/No) follows with tenders receiving a No answer being eliminated instantly from the evaluation process. It is a logical and effective process of reducing a large set of contractors with ease. But the risk is ever present that a good contractor may be wrongly eliminated in the initial proceedings. (Holt, 1998).

3.0 THESIS OBJECTIVES

The objectives of this thesis are:

1. To survey the different methods of contractors' prequalification in order to identify the different variables used in these methods and their application mechanisms.
2. The primary objective of the research is to run a comparison analysis of the different methods.
3. To assess the different methods of contractors' prequalification by comparing data input requirements to the quality of the prequalification outcome.
4. To assess the sensitivity of the prequalification outcome of each method to the variation in the input variables.
5. Based on the above, make conclusions and recommendations on the method(s) most suited for pre-qualifying contractors in the Kingdom.

4.0 RESEARCH METHODOLOGY:

The first objective will be achieved through an extensive review of literature. The remaining objectives will be achieved by simulation using hypothetical data. The choice of use of hypothetical data will be explained at the end of this section. The

mathematical manipulation/processing will be done using software suitable for the particular prequalification method, when available

Figure 1 shows the simulation process. Initially the criteria for prequalification are identified. Contractors have varying profiles of prequalification data. A contractor is assigned a score value on each of the prequalification criteria. In order to compare the prequalification methods every possible combination of scores on prequalification criteria that can form a contractor profile need to be considered. The comparison process must be exhaustive, meaning that no possible contractor profile is left unconsidered. The number of combinations of contractor profiles that can be determined mathematically depends on the number of criteria used and the number of possible values for the scores. As an example, consider the situation where only three criteria are used for prequalification with three possible score values for each: high, medium, and low. This situation will generate twenty seven possible contractor profiles, (high-high-high, high-high-medium, high-high-low, and so on.) In general,

Possible contractor profiles = m^k, where:

k = Number of criteria.

m = Number of possible score values.

Once all possible contractor profiles have been determined the simulation process is performed. In Figure 1 a contractor profile is referred to simply as a contractor. The process of simulation starts by selecting a method of prequalification, applying the method on a contractor, and obtaining the results. Another contractor is then selected and evaluated by the same method, and so on until all the contractors have been evaluated by the method. Thus the results of evaluation of each contractor by the selected method are obtained. The same process is then repeated by selecting another method and applying it to each contractor. When the simulation process is completed comprehensive results of the evaluation of all contractors by all the methods are available for analysis.

The data to be used for this research is hypothetical data. There are two reasons for this choice.

1. The number of possible contractor profiles to be used to compare the methods can become quite large and practically impossible to obtain empirically.
2. To achieve the main objectives of this research (the comparisons of the methods) would require the use of all possible contractor profiles. This best achieved through hypothetical construction. Real data will fall short of mapping all possible contractor profiles.

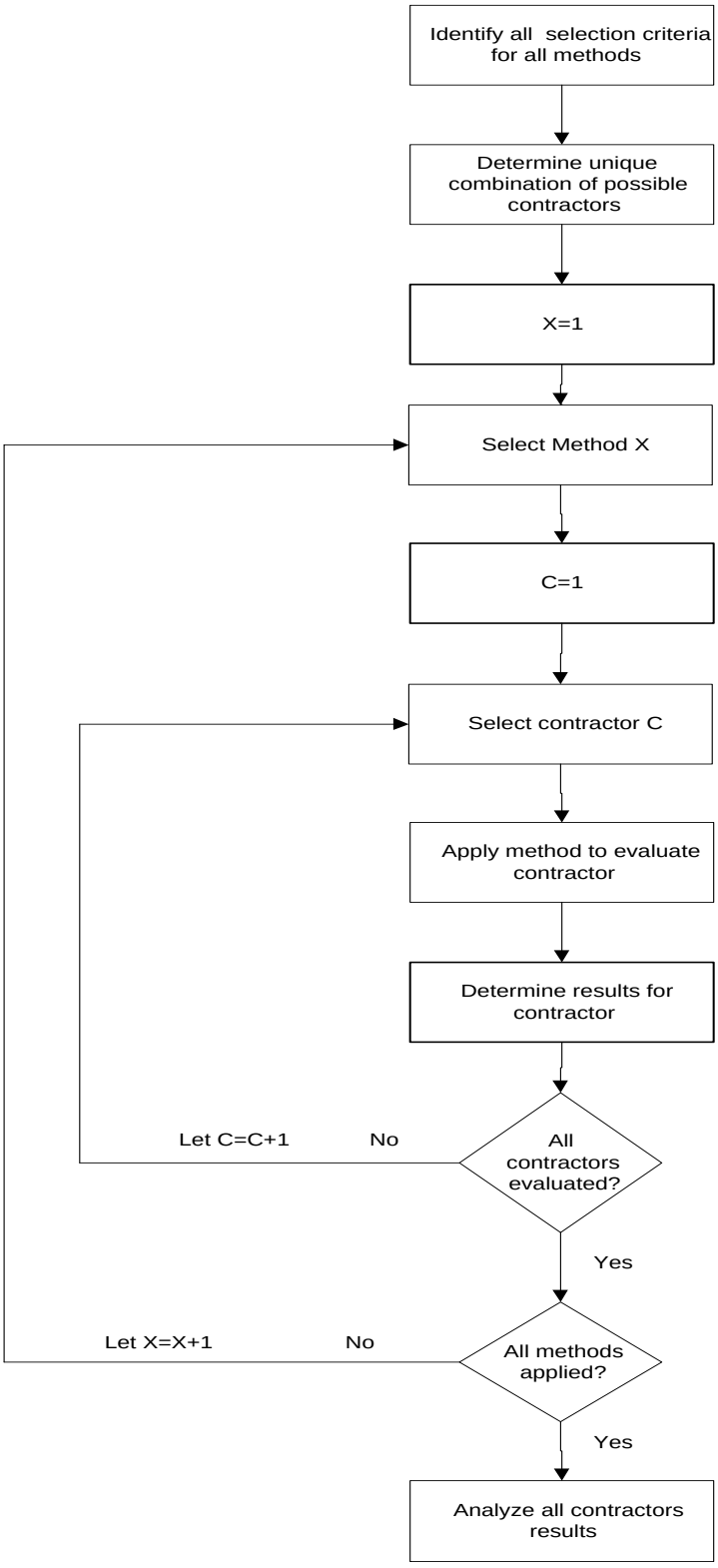

Figure 1: Research Methodology Flow Chart

5.0 BENEFITS AND UTILIZATION OF EXPECTED RESULTS

A comparative analysis of the prequalification methods, which is a main objective of this research, has not been done previously, as far as the investigators know. Such analysis will provide conclusions and recommendations useful to the construction industry and to the improvement of contractor prequalification systems. The study will also investigate situations where a simple and less costly system of prequalification may be just as efficient as a complex and costly system in the selection of qualified contractors. Additionally the study will provide a comprehensive source of prequalification criteria relevant to the local environment.

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