NEURAL NETWORK AND REGRESSION MODELS TO DECIDE WHETHER OR NOT TO BID FOR A TENDER IN OFFSHORE PETROLEUM PLATFORM FABRICATION INDUSTRY

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ABSTRACT

NEURAL NETWORK AND REGRESSION MODELS TO DECIDE WHETHER OR NOT TO BID FOR A TENDER IN OFFSHORE PETROLEUM PLATFORM FABRICATION INDUSTRY

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In this thesis, three methods are presented to model the decision process of whether or not to bid for a tender in offshore petroleum platform fabrication. A sample data and the assessment based on this data are gathered from an offshore petroleum platform fabrication company and this information is analyzed to understand the significant parameters in the industry.

The alternative methods, “Regression Analysis”, “Neural Network Method” and “Fuzzy Neural Network Method”, are used for modeling of the bidding decision process. The regression analysis examines the data statistically where the neural network method and fuzzy neural network method are based on artificial intelligence. The models are developed using the bidding data compiled from the offshore petroleum platform fabrication projects. In order to compare the prediction performance of these methods “Cross Validation Method” is utilized.

The models developed in this study are compared with the bidding decision method used by the company. The results of the analyses show that regression analysis and neural network method manage to have a prediction performance of 80% and fuzzy neural network has a prediction performance of 77,5% whereas the method used by the company has a prediction performance of 47,5%. The results reveal that the suggested models achieve significant improvement over the existing method for making the correct bidding decision.

Keywords: Bidding, Regression Analysis, (Fuzzy) Neural Network, Modeling, Offshore Petroleum Platform Projects

ÖZ

AÇIK DENİZ PETROL PLATFORMU ÜRETİMİ ENDÜSTRİSİNDEKİ BiR İHALEYE TEKLİF VERİLİP VERİLMEMESİ KARARI İÇİN YAPAY SİNİR AĞI VE REGRASYON MODELLERİ

Sözgen, Burak
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Bu tezde açık deniz petrol platformu üretimi endüstrisindeki bir ihaleye teklif verilip verilmemesiyle alakalı karar mekanizmasının modellenmesinde kullanılabilecek üç alternatif metod sunulmuştur. Örnek veri grubu ve bu veriler üstünde açık deniz petrol platformu üreticisi bir şirket tarafından oluşturulan veriler, endüstrideki önemli parametreleri anlamak amacıyla analiz edilmiştir.

Teklif kararının modellenmesinde "Regrasyon Analizi", "Yapay Sinir Ağı" ve "Bulanık Yapay Sinir Ağı" yöntemleri kullanılmıştır. Regrasyon analizi metodu verileri istatistiksel olarak incelerken yapay sinir ağı ve bulanık yapay sinir ağı metodları yapay zeka çalışmalarına dayanmaktadır. Bu modeller açık deniz petrol platformu projelerine ait teklif verileri kullanılarak oluşturulmuştur. Bu metodların tahmin performanslarını karşılaştırabilmek için "Çapraz Geçerlilik" metodu uygulanmıştır.

Bu çalışmada geliştirilen modeller firmanın kullandığı teklif karar verme metodu ile kıyaslanmıştır. Analizlerin sonuçları regrasyon analizi ve yapay sinir ağı metodlarının %80 düzeyinde bir tahmin performansına ulaştığını ve bulanık yapay sinir ağı metodunun %77,5 düzeyinde tahmin performansına sahip olduğunu, öte yandan şirketin kullandığı metodun ise %47,5 düzeyinde bir tahmin performansına sahip olduğunu göstermektedir. Sonuçlar doğru teklif kararının alınması için önerilen modellerin mevcut yönteme göre önemli bir ilerleme sağladığını işaret etmektedir.

Anahtar Kelimeler: Teklif Verme, Regrasyon Analizi, (Bulanık) Yapay Sinir Ağları, Modelleme, Açık Deniz Petrol Platformu Projeleri

To My Beloved Family

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AFC	Approved For Construction
AHP	Analytical Hierarchy Process
ANN	Artificial Neural Network
BCR	Beyond Contractual Reward
DSS	Decision Support System
EPC	Engineering, Procurement, and Construction
EPIC	Engineering, Procurement, Installation and Commissioning
FA-GRNN	Fuzzy Adaptive Generalized Regression Neural Network
GRNN	Generalized Regression Neural Network
FNET	Fuzzy Network Scheduling
ITT	Invitation To Tender
MSE	Mean Square Error
PERT	Program Evaluation and Review Technique
PUM	Project Unit Management

RM	Regression Model
SHE	Safety, Health and Environment
QA	Quality Assurance
QC	Quality Control

CHAPTER 1

INTRODUCTION

The construction industry is composed of different sectors with various kinds of skills, resources and management experience and there is intense competition between contractors to win more projects, as Newcombe (1990) states. In addition, the effect of world globalization and technological improvements enable companies to bid for both international and domestic tenders, which can be seen as an advantage for construction companies. However this situation is frequently a disadvantage for most of the companies since the number of competitors increases for each available project. Therefore winning a tender and securing a new project will be more challenging and require detailed and complex work in the bidding stage. This will increase the cost and as a result reduce the profit, or increase the bid value of the company in order to achieve the same profit margin. In this event, a higher bid value is likely to result in a reduced chance of winning the tender.

One of the most attractive sectors in the construction industry is the offshore industry, which is rather a niche market compared to the other sectors. The offshore industry integrates the construction industry and the petroleum industry in order to create solutions for the outstanding projects which are generally offshore petroleum platforms and can be classified as international projects involving different parties from all over the world.

The petroleum industry owes its origins to the efforts of Edwin Drake from Pennsylvania, the USA, who constructed the world's first oil drilling tower in 1859 (http://en.wikipedia.org/wiki/Drake_Oil_Well, Last accessed: 17 June 2009). Since 1859, the petroleum industry has grown up rapidly and various kinds of products have been derived from pure oil and utilized in daily life. Since oil and gas are not renewable energy resources there is limited availability, thus major oil companies operating worldwide in this industry have endeavored to find new oil and gas reserves. In 1947, the first offshore well was constructed in the Gulf of Mexico and this event is accepted as the birth of the offshore industry all around the world. (http://www.ooae.org/acrobat_files/oral_history/DWA-Robinson-Oil-Industry.pdf, Last accessed: 22 June 2009)

The supply and demand for oil and gas is reflected by Longwell (2002) which shows the change from 1900's to the foreseeable future, as shown in Figure 1.

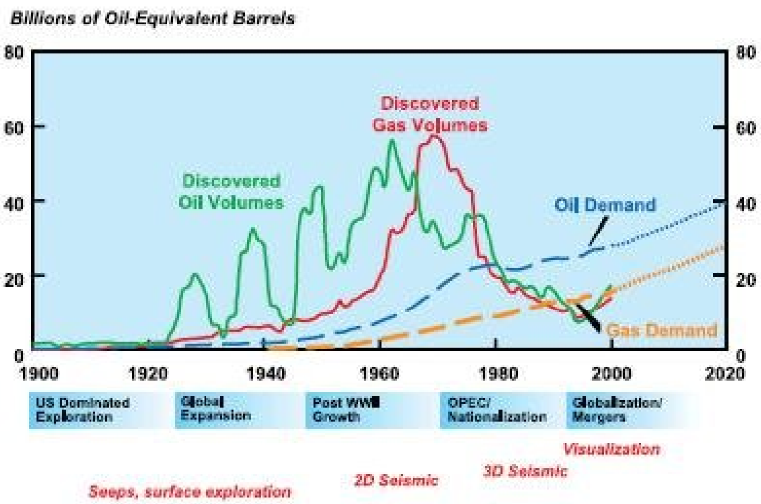

Figure 1. Change in Supply and Demand over Time by Longwell (2002)

As seen in figure 1, the demand for both gas and oil started to increase in the early 1950's and by the 1980's the capacity of the oil and gas reserves being discovered in the world started to decrease. In order to bridge the gap between growing demand and reducing supply, oil companies began to focus on finding new reserves and getting the maximum output from previously discovered reserves which are generally found offshore. As previously stated, the offshore industry is a smaller market than the construction industry in terms of the number of planned projects and delivered projects per year, which makes the market more competitive for the offshore petroleum platform fabrication companies.

In this remarkably competitive environment, the outstanding tenders are usually medium or large scale projects which require a detailed and complex evaluation-calculation period with the cooperation of different departments, e.g., electrical and instrumentation, piping and structural, at the bidding stage. This complicated preparation period inevitably involves a considerable amount of time and expense for the fabrication company.

An example of a "bidding for tender" procedure of an offshore petroleum platform fabrication company is presented in Appendix A, and also the tender organization is shown in Figure 2. In this procedure, the crucial milestones are defined as:

- Receipt of the tender by Marketing and Sales department
- Assignment of project manager and tender team after decision to tender is taken by senior management
- Preparation of the tender plan by commercial manager which shows the departments participating in the tender, the time limits and responsibilities of these departments, scope of work and financial/risk aspects
- Control and provision of the costs related to payments, currency, bank guarantees, taxation, etc
- Control and provision of the costs related to the insurance issues through the legal department

- Control of all legal implications of the tender
- Estimation of the enquiry package for all the work to be performed by the company
- Preparation of a fabrication planning
- Feasibility and alternative proposal study
- Study of the technical details and enquiries on subcontracted disciplines
- Collection of quotations for price and delivery times of the Material Take Off's (MTO) of the materials for the tender
- Quality, safety and environmental check
- Preparation of the final cost estimate by the tender coordinator
- Preparation of the price matrix schedule showing quantities and manhours per discipline
- Risk assessment of the tender
- Verification of the final tender package by the commercial manager that all required documents are included in accordance with the requirements
- Review of the tender in a final meeting with senior management, commercial manager and tender coordinator and approval of the tender after required adjustments
- Submission of the tender package to the client by commercial manager

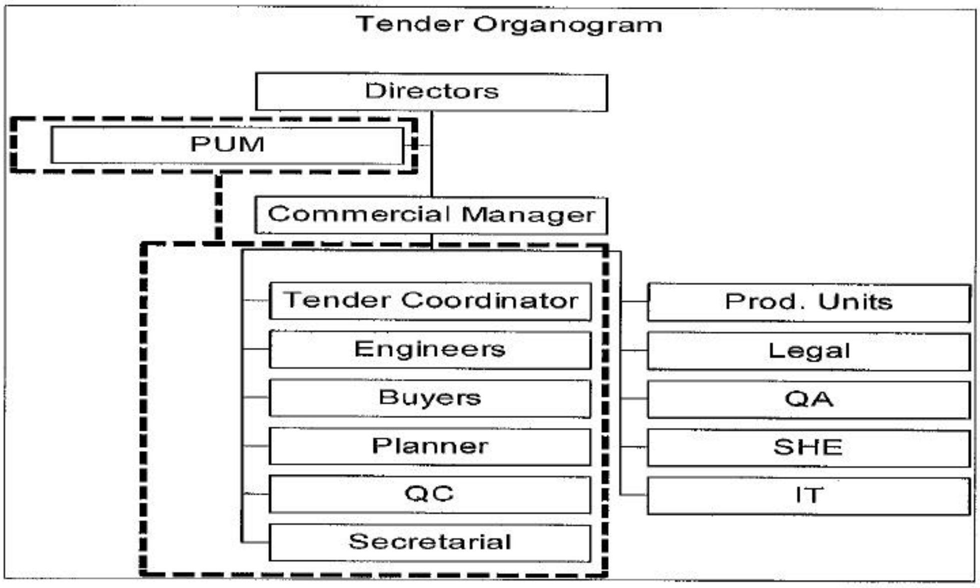

Figure 2. Example of Tender Organization

As can be seen from the procedure, the preparation of a successful bid requires special study together with the combination of different departments which is time consuming and costly. The preparation of tender documents, the feasibility studies needed and the man-hours spent on the preparation of the tender package is very expensive both in terms of time and money. The total cost of a bid preparation of tender also varies according to the contract type. For EPC (Engineering, Procurement, and Construction) and EPIC (Engineering, Procurement, Installation and Commissioning) types of contract, assuming the pre-engineering work is detailed, then the cost varies between €500.000 - €1.000.000. For AFC (Approved For Construction) types of contract where pre-engineering work is provided, the total cost varies between €100.000 - €250.000.

As the number of tenders the company is planning to bid for increases, the time and money needed for these tenders also increases, because each tender requires its own tender plan according to the characteristics of the tender. Furthermore, there is no information gathered about the probability of winning the bid. There is the possibility of not winning any of the tenders bid for or winning more tenders than the fabrication company has the capacity to handle. Therefore, if a study can be organized before the tender procedure begins which will provide information about the chance of winning the bid within an acceptable error level; the company can choose to ignore a number of tender invitations so that the unnecessary cost and time that might otherwise be spent on those tenders is avoided.

In this research, three decision-to-bid models; Regression Analysis Method, Neural Network Method and Fuzzy Neural Network Method will be utilized to compare a previous study of an offshore petroleum platform fabrication company in which an evaluation method is constructed to find out the probability of winning the tenders according to the ranking factors determined by the company. The comparison will be based on the results of the 10-Fold Cross Validation Analysis of each method. The aim of this research is to find the most suitable method to be able to understand in the most accurate terms whether the company will win the tender or not, before the tender procedure starts within the company. The application of the most successful method will enable the company to save unnecessary time and expenditure on tenders where the chance of being successful is low.

In this research there are four chapters:

- Chapter One – Introduction: The main problem is defined and the aim of the research is identified.

- Chapter Two – Literature Review: The previous studies related to the solution of the main problem will be summarized. The utilized methods will be introduced and previous studies about these methods will be reviewed.

- Chapter Three – Research Methodology: The details of the analyses and the utilization of the methods will be explained. The results of the analyses will be introduced.

- Chapter Four – Conclusion: An extensive review of the results of the models will be presented and possible future developments will be specified.

CHAPTER 2

LITERATURE REVIEW

2.1. General

To overcome the difficulties observed in the tendering phase of a project in the construction industry, crucial studies have been carried out since the 1950s. These studies have been prepared from the perspective of both contractor and client part of the projects. From the client point of view, the area of focus is the methodology of contractor selection and evaluation. Hunt et al. (1966); Hardy et al. (1981); Diekman (1983); Nguyen (1985); Moore (1985b); Juang et al. (1987); Harp (1990); Moselhi and Martinelli (1990); Russell and Skibniewski (1990a, b); Herbsman and Ellis (1992); Russell et al. (1992); Holt et al. (1994b); Holt (1998); Hatush and Skitmore (1997b); Lam et al. (2000) developed their investigations to create a support system on selection of contractors.

The basis of this study relies on the perspective of contractors; thus research into bidding/no bidding situations is carried out to understand the dynamics of bidding concerned in the construction industry whilst taking the previous studies into consideration. According to Chua et al. (2001), bidding is a highly sophisticated decision which requires simultaneous evaluation of various interrelated variables to have an outcome. Deng (1994) believes that it is a complex issue for a decision maker to consider all related variables from a bounded rationality and lack of capacity of information process.

For Chua et al. (2001), the bidding decision is a subjective, significantly unstructured and dynamically changing process which has a high level of uncertainty. They consider the decision of bidding as the product assessed in terms of risk status and competitiveness of the company and accept that the decision of bidding is affected by various kinds of factors. Dozzi et al. (1996) define the dilemma of competitive bidding as the hardness of optimization of the bid level in order to bid low enough to win the tender and high enough to make a profit. Therefore, according to their understanding, bidding models are major tools which help to determine the maximum expected level and minimum acceptable amount to bid. Moselhi et al. (1993) examine bidding decision in relation to markup estimation. They find the process of markup estimation challenging, hard to analyze and difficult to find a sufficient solution technique, because this process is time-consuming and difficult to detect all parameters effective in bidding decision and markup estimation.

From the contractor point of view, studies are focused mainly on two significant criteria during the evolution of the industry:

- Diversities in ranking factors considered for a decision-to-bid
- Goals determined for the ranking factors and decision-to-bid models created for these goals

2.2 Diversities in Ranking Factors Considered for a Decision-to-bid

In order to understand the decision mechanism of contractors in bidding, significant studies have been published since 1950s. Among these studies, surveys by Flanagan and Norman (1982a), Ahmad and Minkarah (1988), Shash and Abdul-hadi (1992), Odosute and Fellows (1992), Shash (1993) and Fayek et al. (1999), Chua and Li (2000) aim to find out the key elements on decision process.

Flanagan and Norman (1982a) classify the measurable factors which have effect on the decision of bidding as:

- Size and value of the contract
- Type of client
- Current and projected workload of bidder
- Type of project
- Regional market conditions

Additionally, a study about the difference of bidding behaviours between small, medium and large bidders by Flanagan and Norman (1982b) shows that small bidders focus on more project type and contract value, where large bidders are interested in large projects; while on the other hand medium bidders have no exact criteria on bidding for type and size of the projects. Results of similar research by Lynn and Reinsch (1990) and Krishma et al. (1993) also show that environmental uncertainty makes small and medium bidders passive on markets outside their boundaries in terms of culture, specification and market requirements; which results in a decrease in new investments and resource commitment of these companies.

Skitmore (1989) proposes that the bidding strategy of a contractor would be affected by actions of competitors, type-size and location of the project and economic conditions of both contractor and market. In addition, Neufville et al. (1977) express the relationship between market conditions and bidding behavior of contractors and find a link between the number of bidders for a specific project and the condition of the market. In a similar manner, Odosute and Fellows (1992) find out that instead of bidding for every project they have, contractors prefer choosing the ones with the higher potential to win the bid by evaluation of the factors that change continuously according to market conditions.

According to Shash (1993), there are two significant decisions that contractors have to make during the tendering phase:

- Decision to bid or not to bid for a specific project

- Designation of the bid price for the project

He states that, when the contractor decides not to bid, he should encounter the possible opportunity loss. Respectively, when the contractor decides to bid, estimation of the direct and indirect costs for that project should be calculated. If the contractor is willing to tender, then he should have an estimate for the utilization of his resources, i.e. the financial consequences like bidding documents or the hours of the estimator.

The Ahmad and Minkarah (1988) study on bid decision by investigating top U.S. contractors according to 31 factors considered can be seen in Table 1. They utilize in their study the data gathered from a questionnaire which has been prepared for a multi attribute utility model study of Ahmad. The results of the questionnaire help them understand the current situation of the market in those years. According to the results of the questionnaire, there are more important factors for companies for bidding and markup decision than profitability and competition. Furthermore, 80% of the contractors admit that they do not use any kind of methods or techniques in bidding situation. Companies rely quite often on their experience on decision stage and mainly relationships with the clients or owners. One of the surprising results is that contractors are generally subjected to their subcontractors if they are willing to have a high performance for a long time. Also they think that bid price is affected highly by the time spent for preparation of the bid and quality of the design of the project. Instead of competitive bidding, contractors prefer to have negotiations with the client.

According to the results of the questionnaire, Ahmad (1990) concludes that bid decision factors are considered to be certain, whereas markup decision factors are uncertain.

Table 1. Factors Affecting Bid/No Bid Decisions by Ahmad and Minkarah (1988)

Rank [a] (1)	Factors (2)	Percent of respondents scoring 4 or higher [b] (3)	Score [b] Mean (4)	Median (5)	Mode (6)
1	Type of job	95.6	5.089	5.0	5.0
2	Need for work	93.3	4.888	5.0	5.0
3	Owner	91.0	4.607	5.0	4.0
4	Historic profit	89.7	4.621	5.0	4.0
5	Degree of hazard	87.8	4.800	5.0	6.0
6	Location	85.6	4.589	5.0	5.0
7	Labor environment	84.4	4.644	5.0	5.0
8	Strength of the firm	83.3	4.589	5.0	5.0
9	Size of the job	82.2 [c]	4.422	4.0	4.0
10	Economic condition	82.2 [c]	4.367	4.0	4.0
11	Competition	80.0	4.456	5.0	5.0
12	Risk of investment	79.5	4.580	5.0	5.0
13	Current work load	78.9	4.422	5.0	5.0
14	Degree of difficulty	77.8	4.400	5.0	5.0
15	Rate of return	74.2	4.045	4.0	4.0
16	Confidence in workforce	73.3	4.233	4.0	4.0
17	Uncertainty in estimate	72.4	4.322	5.0	5.0
18	Supervisory persons	70.0	4.056	4.0	5.0
19	Design quality	67.8	3.911	4.0	4.0
20	Reliability of subcontractors	63.3	3.889	4.0	5.0
21	Project cash flow	55.6	3.656	4.0	4.0
22	Contingency	50.0	3.330	3.5	4.0
23	Duration	44.9	3.169	3.0	4.0
24	Subcontracted amount	43.8	3.112	3.0	4.0
25	Capital requirement	41.1	3.067	3.0	2.0
26	Job start time	38.9	2.944	3.0	2.0
27	Labor requirement	37.8	2.989	3.0	3.0
28	General overhead	35.2	2.841	3.0	2.0
29	Equipment requirement	28.9	2.589	2.0	1.0
30	Tax liability	27.0	2.551	2.0	2.0
31	Season	20.0	2.278	2.0	1.0

[a] Ranked on the basis of percent of respondents scoring 4 or higher.

[b] Score scale 1-6: 1 = low importance, 6 = high importance.

[c] Same score, ranked on the basis of mean score.

The conclusion of the study by Ahmad and Minkarah (1988) is that the decision to bid is highly affected by criteria like the need for work owner, subcontractors, degree of difficulty, type, location and size of the job, which are assessed in a subjective manner. They find bid decisions heuristic since the decisions are made according to experience, judgment and perception of the evaluators.

Ahmad (1990) thinks the decision of bidding/no bidding depends on the position of the company in the market, the future goals of the company, resource availability and the condition of the market. He utilizes the worth-assessment technique which concentrates on determining the value of each factor and the weights of these factors respectively to find the worth of the bidding decision. As shown in Figure 3, Ahmad (1990) summarizes these factors in four headings.

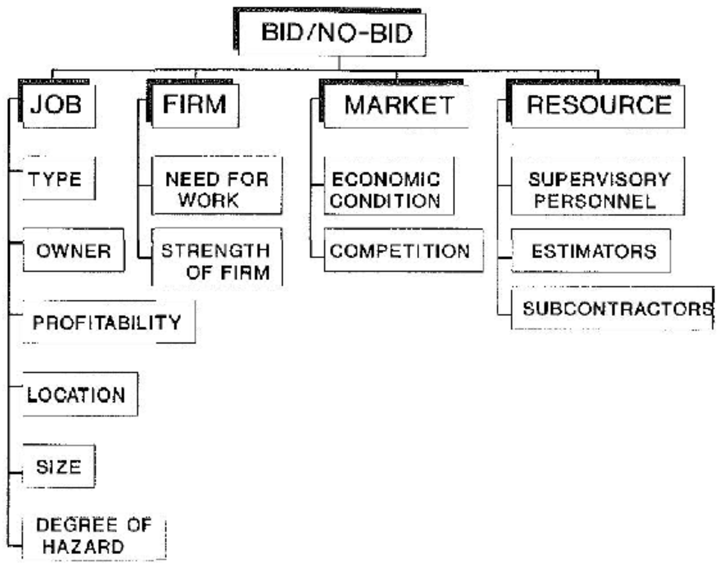

Figure 3. Significant factors on worth-assessment technique by Ahmad (1990)

Shash and Abdul-hadi (1992) have made a research on contractors in Saudi Arabia and the United Kingdom to identify the relationship between the factors and the result of bidding. 35 extensive factors are considered in this research. However, these extensive factors are examined only in general, without going into detail to identify the goals lying behind the bidding mechanism.

Later on, Shash (1993) defines 55 factors for the bid decision-making process and finds out that three factors, the need for work, the number of competitors and experience are the crucial factors in the decision for bidding. Whereas the degree of difficulty, the risk involved in the work and current workload are seen as the leading factors for the markup size decision.

Fayek (1998) believes that internal factors like the availability of resources, the need for work and external factors like availability of future work or economic conditions and the appropriateness of the project for the company may cause the company to have different goals in bidding. According to Fayek (1998), it may not be the main goal or the only goal to win the project for which they are bidding.

Hillebrandt (2000) declares the importance of factors like the size of the project, the geographical area, the degree of complexity and the type of contractual arrangement.

Chua and Li (2000) classify the factors of the bid decision process as internal and external factors, as seen in Table 2. Internal factors refer to the factors directly related to the company like experience, resource, workload, expertise, financial ability, relationship with the owner and share of market. External factors refer to the factors related to the nature of the work like site accessibility, size and type of project, project timescale and the degree of technological difficulty. External factors also include environmental factors like government regulations, availability of equipment; and bidding requirements referring to the factors like bidding method, time allowed for bid preparation and the completeness of specification.

Table 2. List of Factors Proposed in Bidding Model by Chua and Li (2000)

Category (1)	Reasoning subgoals and factors (2)
External factors	
Job related	Nature of work
	1. Type of project
	2. Size of project
	3. Degree of technological difficulty
	4. Cash flow requirement
	5. Type and number of supervisory required
	6. Type and number of labor required
	7. Type and number of equipment required
	8. Site accessibility
	9. Project public exposure and prestige
	10. Project timescale and penalty for noncompletion
	11. Degree of subcontracting
	12. Identity of owner/consultant
	13. Safety hazards
	14. Site space constraints
	15. Consultant's interpretation of the specification
	16. Delay or shortage on payment
	Bidding requirement
	17. Required bond capacity
	18. Prequalification requirement
	19. Bidding method (open/close)
	20. Time allowed for bid preparation
	21. Completeness of drawing and specification
Environmental	Social and economic condition
	22. Availability of other projects
	23. Availability of qualified labor
	24. Availability of qualified staffs
	25. Availability of equipment
	26. Availability of qualified subcontractor
	27. Government regulation
	28. Degree of difficulty in obtaining bank loan
	29. Resource price fluctuation
Internal factors	Firm related factors
	30. Expertise in management and coordination
	31. Similar experience
	32. Familiarity with site condition
	33. Reliability of subcontractors
	34. Current workload in bid preparation
	35. Competence of estimators

Table 2 (Continued)

	36. Adequacy of resource market price information 37. Current workload of projects 38. Promotion of company reputation 39. Required rate of return in investment 40. General office's overhead recovery 41. Need for continuity in employment of key personnel and work force 42. Relationship with owner 43. Share of market 44. Financial ability 45. Strength of business partner/subsidiaries 46. Possession of qualified staffs 47. Possession of qualified labor 48. Possession of qualified subcontractor 49. Possession of required equipment 50. Company's ability in design involvement and innovation 51. Company's ability in required construction technique

Lo et al. (2004) analyze the contractor pricing parameters considering three main aspects which are cost, market competition and Beyond Contractual Reward(BCR) where BCR is defined as all compensations gained by the contract. In the study of Lo et al. (2004), the following assumptions are made to identify the dynamics of the pricing behaviors of contractors:

- Contractor's cost is defined as constant opportunity cost; where Maher (1997) states the opportunity cost as the benefit lost that could have been gathered from the best alternative action instead of the action followed.

- The award prices of previous projects are important references indicating competitor's price. It is assumed that the first aim of the contractors is to increase the profit range; and in order to do that, it is crucial to have information about the price of competitors. Lo et al. (2004) consider the best way to get information about competitors is to check previous projects that competitors were awarded.

- The level of competition is measured by the number of competitors and contractor's pricing will reflect changes in the number of competitors. Carr (1983) claims that the change in competition level also attracts the markup level of the contractors for a project.

As a result, Lo et al. (2004) find that the price level is considerably higher for the construction projects that have strict clients than projects that have responsive clients. Furthermore, to sustain the quality in the projects, the authors reflect the need of improvement in the construction management system to limit the opportunistic bidding of competitors.

Oo et al. (2008) have a study focusing on unique bid/no-bid preferences of construction companies and four bidding variables which are the number of bidders, market conditions, project type and project size whereas other factors like contract type, client, project duration are held constant. They state that contractors would have different bidding behaviors under the effect of defined bidding variables because of diversities in bidding preferences, and diversities in responses for the same bidding variables; where these diversities have effects on decision-to-bid strategies of contractors. They also point out that contractors would keep themselves out of tenders which are larger than their size, require more experience and available resource (i.e. cash) than they have.

2.3 Goals Determined for Ranking Factors and Decision-to-bid Models Created for Determined Goals

Friedman (1956) finds that companies bid for several reasons and summarizes the most important reasons as:

- To maximize total expected profit
- To gain at least a certain percentage of the investment

- To minimize expected losses
- To minimize profits of competitors
- To keep production ongoing, even in loss situations

Starting from Friedman (1956), there are several decision-to-bid models generated to help contractors to either simplify the path of bidding decision or predicting bid/no bid decisions.

In the first model that Friedman (1956) creates, he suggests the bidder choose the mark-up percentage in order to maximize the profit expected. Thus the equation is:

$$E(\pi) = (C+(M*C)).\ P(\text{Win}) \qquad [1]$$

where;
π = profit (bid amount less cost) if the bid is accepted
M = markup percentage to maximize the expected profit
C =expected (i.e., estimated) cost
P (Win) = probability that the bid will be the winning (i.e., lowest) bid

According to Seydel (2003), Friedman's model does not directly aim to find an answer for bid/no bid decision; it rather refers to the result of the bidding in terms of cost. Like King and Mercer (1988) mention profit maximization as the only criteria evaluated in the determination of optimal markup; Seydel and Olson (1990) also find that profit is the unique factor assessed quantitatively in competitive bidding, whereas other criteria like capital exposure, work force continuity and risk reduction should also be considered.

Traditional bidding models like those of Friedman (1956), Gates (1967) and Carr (1982) are based on statistics and probability theory. However, they have differences with respect to each other in the calculation of joint probability of winning a bid over competitors as pointed out by Chua and Li (2000). They also claim that even taking into account the joint probability of winning would not be enough since it would be an oversimplification of the process of bidding decision. Furthermore, Chua et al. (2001), by approving the comments of Gates (1983), rely on the fact that usage of earlier models would not be adequate in practice, since each project has its own economic condition and working environment within its unique properties. Moselhi and Hegazy (1992) also admit that the utilization of models created after 1950s are practically limited since there is a lack of understanding of the nature of the problem and they make a comparison between these models as can be seen in Figure 4.

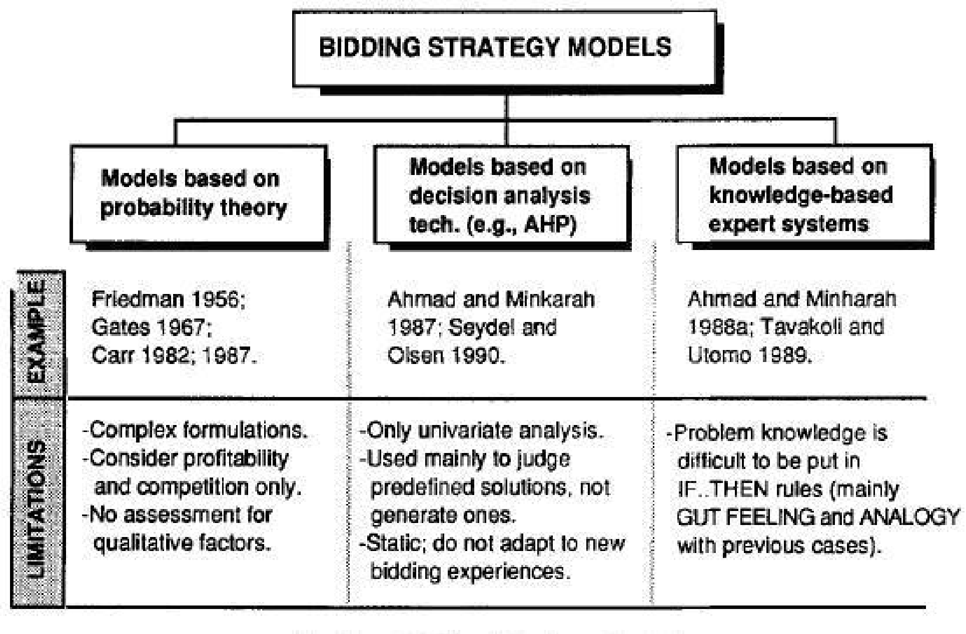

Figure 4. Comparison of Bidding Strategy Models by Moselhi and Hegazy (1992)

Oo et al. (2008) classify previously created models in three parts, which are:

- Multi-Attribute Decision Models
- Statistical Models
- Artificial Intelligence-Based Models

2.3.1 Multi-Attribute Decision Models

To create a bidding decision model, Ahmad (1990) applies a utility value approach in his research. According to this approach, he determines the key elements and defines the overall bid utility referring to these chosen key elements. While preparing his model, Ahmad (1990) refers to the decision analysis cycle of Breese (1988), which is composed of construction, evaluation and refinement of a decision model. The decision analysis cycle can be seen in Figure 5.

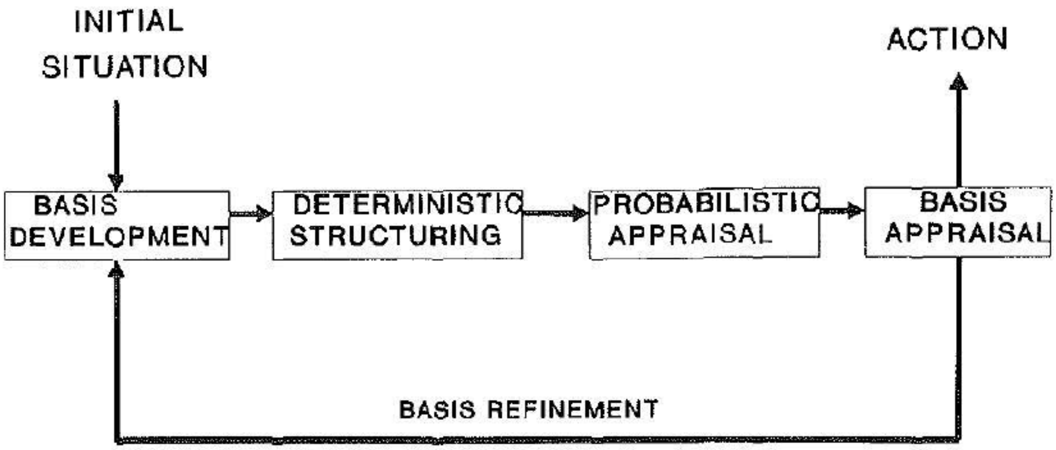

Figure 5. Decision Analysis Cycle of Breese (1988)

In the basis development level, Breese (1988) assumes that the model gathers the information from the decision maker and other preferable decisions. In deterministic structuring level, the factors which are important for decision stage in probabilistic perspective are identified. This probabilistic appraisal is composed of evaluation of risk attitude, creation of new alternatives, and/or improvement of probability measurements. In the basis appraisal stage, interpretation of the decision model and results of this model are included.

Seydel and Olson (1990) utilize Analytical Hierarchy Process (AHP). They define the procedure as analyzing the bidding problem from different perspectives –several criteria-, checking the effects of selected markup ratios for these several criteria and calculating a multi-criteria score –weight- for each selected markup ratio by AHP. According to this method, the problem of decision is introduced as a hierarchy of criteria and alternatives, and the top level of hierarchy is usually the main goal of the company. Then the following level is made up of the decision criteria, while the bottom level of hierarchy is composed of markup ratios. The decision hierarchy is shown in Figure 6. As Chua and Li (2000) state, the main idea of AHP is to bring the key criteria out and rank these key criteria, while defining the relative significance of them towards the sub-goals; which makes Analytical Hierarchy Process different from previous methods.

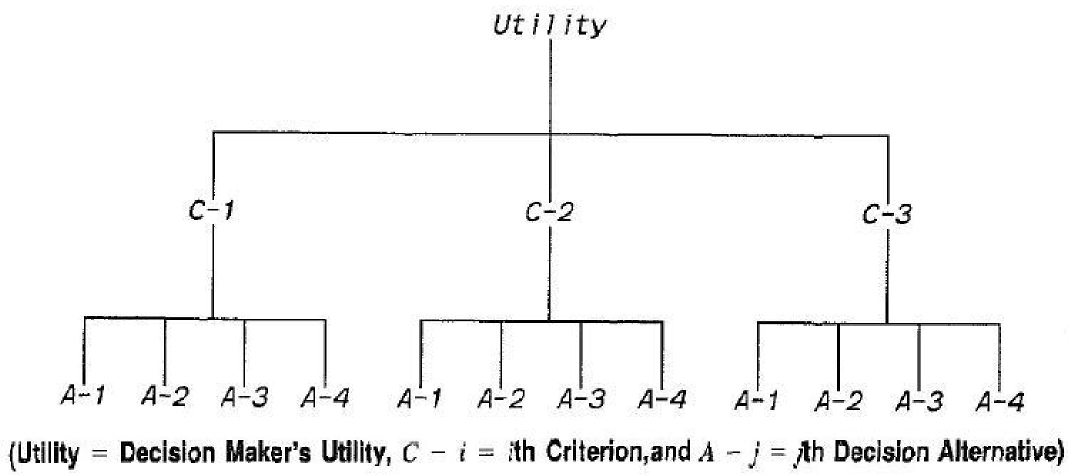

Figure 6. Decision Hierarchy by Seydel and Olson (1990)

Dozzi et al. (1996) apply a multi-criteria utility model to bidding and markup decision in which every criterion considered should be introduced with a proper utility function, so that general utility value of the project and the markup value would be reached. The flowchart of the utility theory model, the hierarchical structure of the bidding criteria can be seen in Figure 7 and Figure 8 respectively, whereas definition and scale of bidding criteria is stated in Table 3.

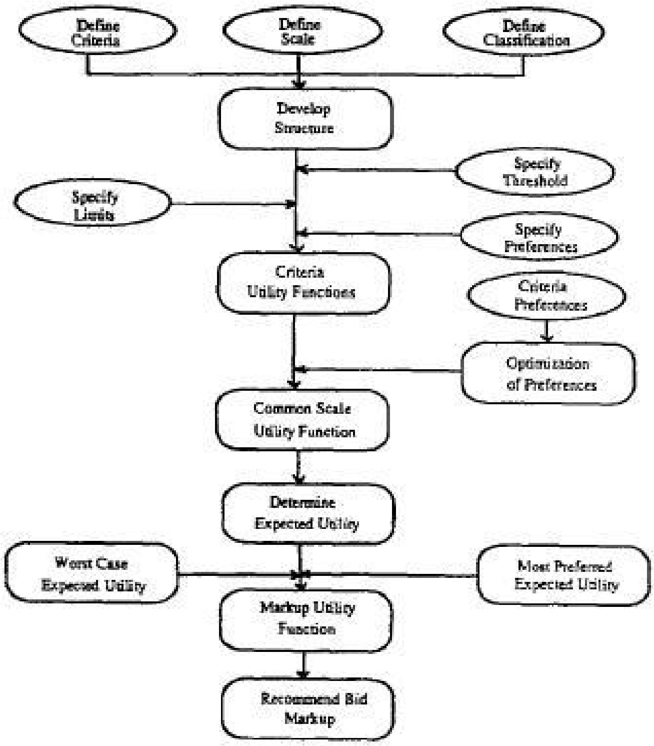

Figure 7. Flowchart of Utility Theory Model by Dozzi et al. (1996)

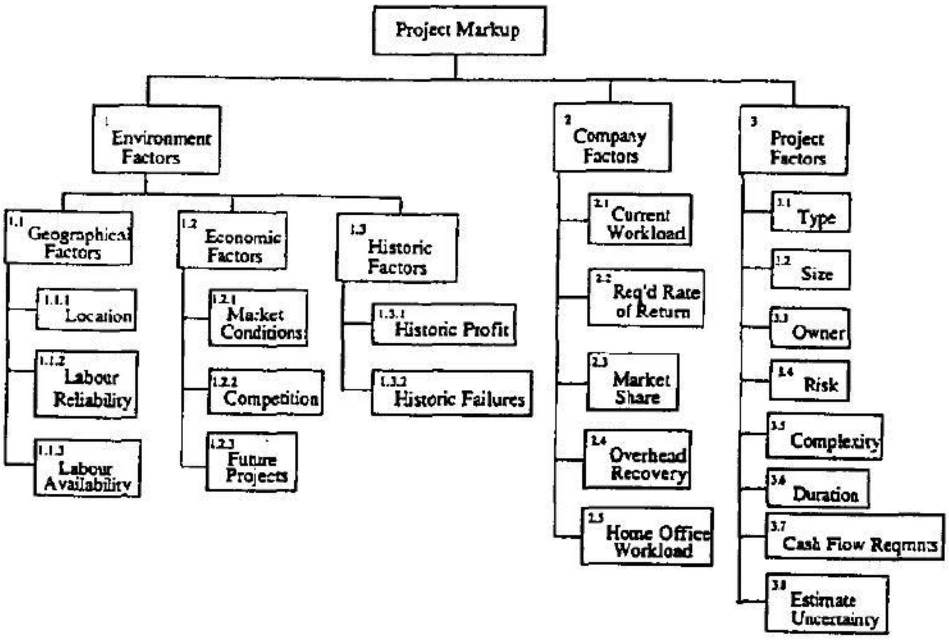

Figure 8. Hierarchical Structure of Bidding Criteria by Dozzi et al. (1996)

Chua and Li (2000) claim that these models are more in parallel to the real time conditions since a greater number of different significant factors are involved in the models discussed.

Table 3. Definition and Scale of Bidding Criteria by Dozzi et al. (1996)

Hierarchy block (1)	Criterion name (2)	Definition (3)	Criterion scale (4)
1.1.1	Location	Is project within company boundaries	Yes = 100 No = 0
1.1.2	Labor reliability	Is local labor well trained, skilled	Good = 100 Fair = 50 Poor = 0
1.1.3	Labor availability	Is local labor available or difficult to obtain	Easy =100 Difficult = 50 Impossible = 0

Table 3 (continued)

1.2.1	Market conditions	Other projects are currently out for tender (relative to number of competitors bidding)	Many =100 Average = 50 Few = 0
1.2.2	Competition	Expected number of serious competitors bidding on the project	Number (#)
1.2.3	Future projects	Forecast of upcoming projects	Many =100 Average = 50 Few = 0
1.3.1	Historic profit	Amount of profit obtained on past projects of similar nature	Percent (%)
1.3.2	Historic failures	Past known failures for this project type/owner, etc.	Many =100 Few = 50 None = 0
2.1	Current workload	Volume of all current projects relative to capacity of firm	High =100 Medium = 50 Low = 0
2.2	Required rate of return	Required rate of return on investment required by firm	Percent (%)
2.3	Market share	Ratio of current market share to expected share	Percent (%)
2.4	Overhead recovery	Indirect overhead recovered this annum (relative to forecasted)	Percent (%)
2.5	Home office	Amount of project to be completed by home office forces	Percent (%)
3.1	Project type	Project type (is type within the scope of the firm)	Yes = 100 No = 0
3.2	Project size	Estimated project dollar volume	Dollars ($)
3.3	Owner	Relationship between owner and firm	Good = 100 Average = 50 Poor = 0
3.4	Other risk	Other risk factors of project to be included and their effect on the project outcome	High =100 Medium = 50 Low = 0
3.5	Project complexity	Is complexity of the project beyond capability of firm	Yes = 100 No = 0
3.6	Project duration	Expected duration of project	Months
3.7	Cash flow requirements	Average project cash flow requirements for each period	Dollars ($)
3.8	Estimate uncertainty	Uncertainty in the cost estimate (may be due to insufficient information, etc)	High =100 Medium = 50 Low = 0

Chua and Li (2000) believe that each factor would help in the choice of sub-goals in different ways. Thus, according to the internal and external factors identified previously, they come up with four important key elements. Their model, as seen in Figure 9, defines these key elements as competition, risk, need for work and position in bidding, which can be classified as sub-goals for a company on a tender phase. As Chua and Li (2000) state, the profit can increase as markup level increases, but at the same time the chance of winning the bid decreases. To increase the chance of winning the bid, an optimum markup level that will change according to the competition level for that bid should be decided. Factors like the number and competitiveness of competitors have a significant potential on determination of markup, thus on the chance of winning. A contingency part, which reflects the risk elements that cannot be identified precisely, is also included in this markup level. However, Chua and Li (2000) claim that actual costs of the construction will be always more than estimated, which will cause a reduction in the markup level desired. Selected markup percentage concerning the competition and risk level can still change when company's need of work is considered. A study of Neufville and King (1991) shows that a company can choose a lower markup if they have a high need of work and the risk of the project is low. Additionally, Chua and Li (2000) indicate the effect of the position of the company in bidding. A company can take more risk than normal if the project is well matched with the resources and expertise of the company. At this stage, Chua and Li (2000) warn the companies not to ignore the mutual effects of internal and external factors on key elements. As a result, the markup level should be interpreted keeping the combined result of the key elements in mind.

Han et al. (2005) give importance to the bid decision process of international projects and the effect of risk on this decision. They claim that a misunderstanding in analyzing the risk nature of political, cultural or the economic situation for an international tender will certainly have an impact on the strategic plan of the company for that project. Moreover, because companies are not willing to take more risk for a project, only a small percentage of the companies are really interested in international projects because international construction projects are more risky than domestic ones.

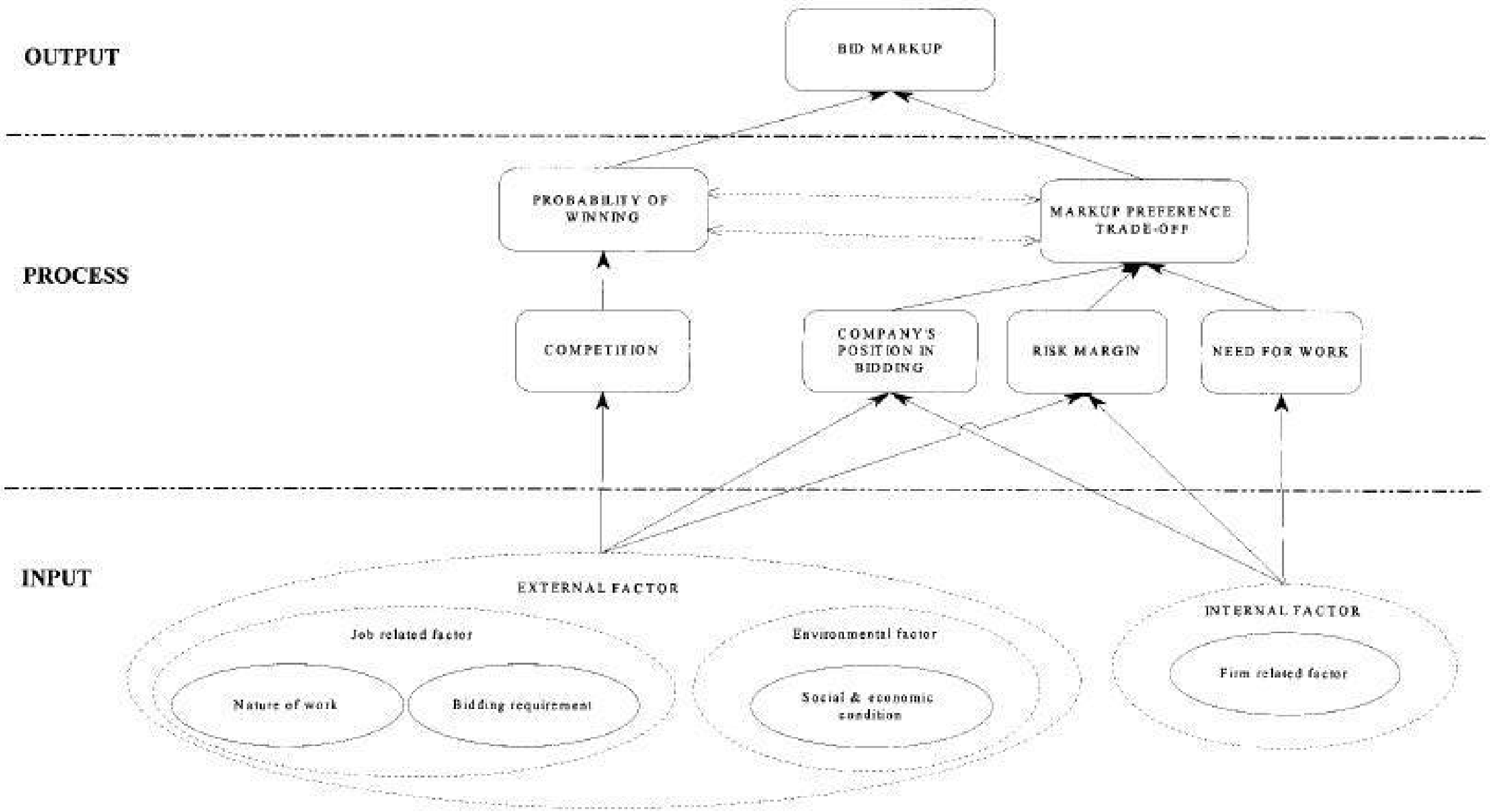

Figure 9. Bidding Model of Chui and Li (2000)

2.3.2 Statistical Models

2.3.2.1 Multiple Regression Analysis

Multiple regression analysis is a well-known approach which identifies the relationship between a set of dependent and independent variables using statistical methods. This method looks for the relations between the dependent variable and number of independent variables in the form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n \quad [2]$$

Where Y denotes the dependent variable, X_n denotes independent variables with number of n and β_n denotes the regression coefficient for each independent variable.

In order to eliminate the insignificant variables, there are several regression statistics established in this analysis, where the most used ones are significance level (P value) and coefficient of determination (R^2), according to the study of Lam et al. (2008). Elimination of insignificant variables gives better results as Sonmez and Rowings (1998) state in their study about labor productivity. They find that the model created by small number of significant parameters give more accurate forecasts. Therefore a backward elimination method is utilized in the model of Sonmez (2004) taking all independent variables into account for the first regression model formed.

After each run of the model, the most insignificant independent variable for the model is determined according to the regression statistics used and taken out of the model. Then the next model is prepared with the remaining variables. This backward elimination method continues till all the outstanding variables have enough significance for the model.

There are various studies which try to make use of the regression analysis in order to find solutions for the problems of construction industry. According to Sonmez (2008), this method is frequently performed in the prediction of construction project costs by

Karshenas (1984) and Lowe et al. (2006) and also in offshore decommissioning projects by Kaiser (2006).

However, Trost and Oberlender (2003) take the multicollinearity problem into attention for the ones introducing regression models in their studies. In a multicollinearity situation, a linear combination can be generated between one or more of the independent variables so that another independent variable can be predicted by this linear combination. Furthermore, even in a normal situation without multicollinearity, Sonmez (2004) believe that the results of the analysis may not still provide the desired outcome because there may be nonlinear relations between the dependent and independent variables which cannot be detected and included in regression model.

2.3.2.2 10-Fold Cross Validation

Cross validation is a method used to select a model with respect to the prediction capability of the models. This method is based on resampling, and all possible distinctive ways of data splitting are considered in the calculation of the prediction capability of the models, as Shao (1993) mentions.

If n data sets are assumed to be present for modeling in cross validation, one part of this available data (n_c) is utilized in model construction. The rest of the data sets ($n_v = n - n_c$) is composed of the reserved part to understand the prediction capability of the model which is called as model validation. In the model validation stage, all data sets (n) are used but $C(n,n_v)$ different ways can be implemented to separate the data set. Shao (1993) reflects that researchers give their attention mainly to the situation when $n_v = 1$ because of the increase in the complexity in computations of the method as n_v gets larger.

Leave-one-out cross validation and k-fold cross validation are the frequently used types of cross validation method. In leave-one-out cross validation, i'th data set is deleted from the whole data where i = 1,2,3,…,n. Then variables are determined with the calculations done by using the rest of the data (*n-1*). The same calculations are carried out separately for each data so that all data is predicted by utilization of the method. According to Breiman and Spector (1992) leave-one-out cross validation is a computer intensive process since it requires the calculation of all data sets. Also Breiman (1996) states that this method can create problems with different model selection methods such as lack of continuity. A little change in the data set can lead to a big effect in the selected model.

In K-fold cross validation, a small integer *k* is determined and the data set is separated into *k* equal groups. Breiman and Spector (1992) suggest that the separation can be done totally random or according to a mechanism.

After the separation level, the same procedure is applied to these groups as in leave-one-out case, but this time in a more aggregated and less intensive manner. One of the newly created subgroups is picked up and assigned as the validation set and the rest is considered as training sets. Then the prediction of the validation set chosen will be calculated by the model based on the training sets. This application will be repeated for each subgroup until all the data is predicted by the model.

Several studies and tests have been implemented to find out the optimum number of groups to be created for k-fold cross validation, which would also give better results than leave-one-out cross validation. Breiman and Spector (1992) show in their research that 10-fold and 5-fold cross validation come up with better results when compared to leave-one out. Also Kohavi (1995) manage to find successful outcomes with 10-fold cross validation in his study containing cross validation and empirical decision trees.

2.3.3 Artificial Intelligence-Based Models

2.3.3.1 Neural Network

The introduction of artificial neural networks (ANN) was first made by McCulloch and Pitts (1943) and since then this concept has been widely used in problems where extended information process is needed. Bendana et al. (2008) describe ANN as "*massively parallel distributed processor*" which can store information taken from a data set that is supplied out of the network. Additionally ANN can use the information to create a similar behavior with respect to the data supplied. The primary process units of ANNs, called neurons, are connected to each other with synapses which can have different weights or strengths called synaptic weight. These neurons are leveled in different layers and the number of the neurons and layers are open to change in order to increase the performance of the ANN system. A simple neural network model can be seen in Figure 10.

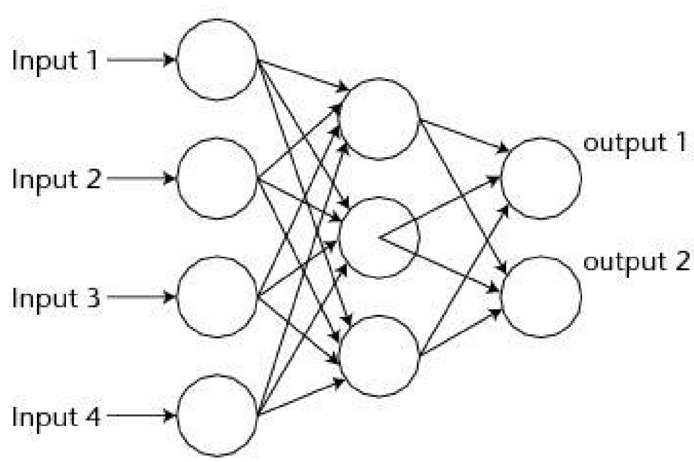

Figure 10. A Simple Neural Network

According to Bendana et al. (2008), this system works well with nonlinear problems which have large input data sets with known relationships between inputs and outputs for certain number of data cases. Thus, the main goal is to generalize the relationship between inputs and outputs of the system so that ANN can calculate needed outputs for the inputs which are newly introduced to the system in addition to the database it has. Bendana et al. (2008) state that ANN can work best if:

- The problem is nonlinear and multivariable
- The relation between inputs and outputs cannot be modelled with a mathematical formula
- The system behavior is environment dependent
- There is enough data to cover all possibilities

Skapura (2000) gives information about the types of learning mechanisms for ANNs as back-propagation, counter-propagation and adaptive resonance theory and highlights that the most frequently used type is back-propagation since this type gives more accurate results than the others. In back-propagation, the difference between the output value of the neural network and the output value that is desired to find by changing the synaptic weights is reduced. If the difference is less than a previously determined value, then the system is ready to answer questions about a new data which is totally different from the data used in training.

Dikmen and Birgonul (2004) define the neural networks as artificial intelligence tools built up by a large number of processing elements called neurons, where each element receives and transfers the input from an element to another element through connections. These elements are organized in different layers in order to constitute the neural network, and each distinct and logical arrangement of the neurons could create diverse neural networks. Dikmen and Birgonul (2004) classify neural networks as:

- Classification models
- Association models
- Optimization models
- Self-organization models

Neural network concept was first introduced with construction management in 1990s. According to Adeli (2001), neural network is mainly utilized in four divisions of construction which are construction scheduling and management, construction cost estimation, resource allocation and construction litigation. Dikmen and Birgonul (2004) believe that neural networks are helpful tools to support decision making at both project and corporate level of the companies. There are several crucial researches which show that ANNs are utilized in the strategic decision making stage at corporate level such as bidding/no bidding decision of a contractor.

Moselhi et al. (1993) also define the neural networks as information processing system whose design originated from neural system of human beings. They prepare a Decision Support System (DSS) to help the companies in preparing their bids, which utilizes the back propagation neural network concept for markup decision. In the DSS prepared, two ANN models, the single-network model and hierarchical model are performed. The single-network model can be seen in Figure 11. In their previous study, Moselhi and Hegazy (1992) also mentioned that problems like markup decision or bidding decision can be solved more on analogy-based solutions like neural networks.

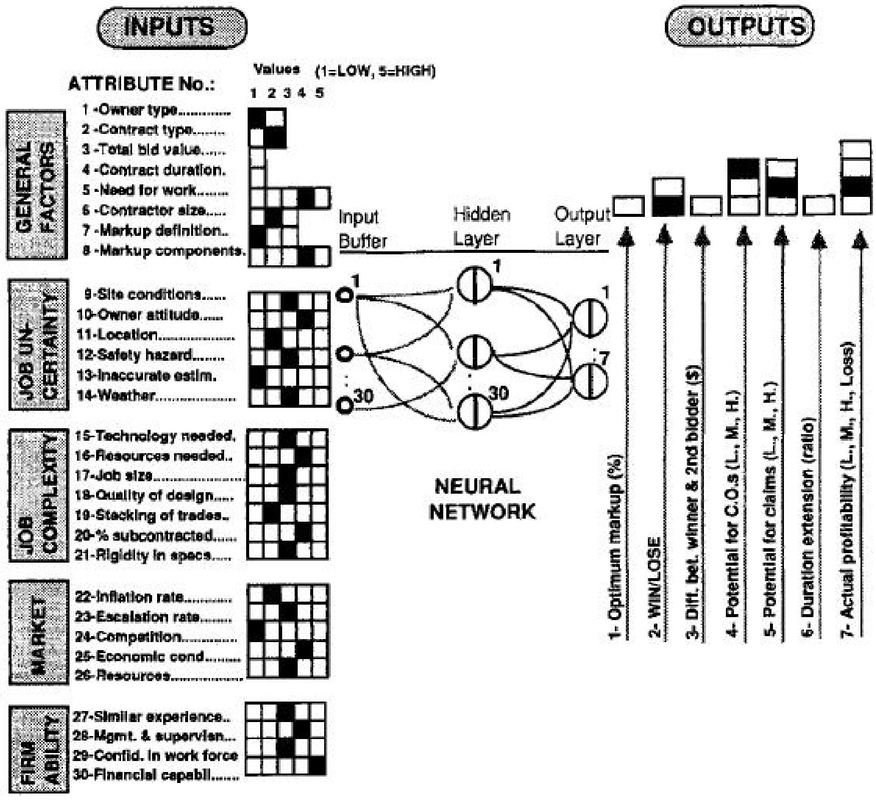

Figure 11. Single-Network Model by Moselhi et al. (1993)

2.3.3.2 Fuzzy Set Theory

Fuzzy Set Theory was first introduced by Zadeh (1965). According to him, the theory is based on the utilization of fuzzy sets in order to describe the linguistic values (e.g., low, high) related with the variables; thus it ensures a theoretical foundation for linguistic modeling. These fuzzy sets are determined identically by their membership functions which can be either linear or nonlinear. These membership functions numerically show the degree to which an element belongs to a set. Nguyen (1985) reflects that fuzzy set theory is not an alternative for probability theory but good at finding solutions to problems which do not have the mathematical consistency the probability theory should have. An example of fuzzy set diagram can be seen in Figure 12.

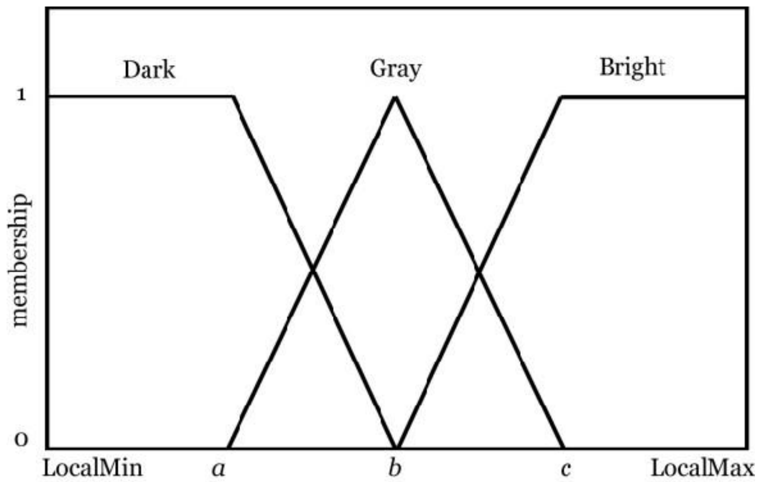

Figure 12. An example of Fuzzy Set Diagram with 3 Triangular Fuzzy Numbers

Ayyub and Haldar (1984) initiate the fuzzy set theory in the construction industry to interpret the affect of qualitative variables and they concentrate on weather and site conditions, experience of labour on activity cost and duration.

This theory is also taken into consideration during detailed research about different categories of construction such as activity duration (Dubois and Prade 1980; Wu and Hadipriano 1994), and the selection of equipment and machinery (Hanna and Lotfallah 1999). Lorterapong and Moselhi (1996) make an evaluation about the activity durations with fuzzy set theory, also including a new method called Fuzzy Network Scheduling (FNET), which acquires a reasonable result whereas the computations are found to be more difficult than Program Evaluation and Review Technique (PERT).

Bendana et al. (2008) point out that fuzzy concept is composed of four parts which are:

- Input pre-processor (fuzzifier)
- Rule base that shows the capability of the system

- Conclusion engine according to the approximate reasoning
- Output post-processor (defuzzifier)

According to Bendana et al. (2008), this concept is applicable for the problems which cannot be solved with a mathematical formula since fuzzy controllers can have the benefit of knowledge of human beings and be flexible.

2.3.3.3 Fuzzy Neural Network Theory

Dissanayake and Fayek (2008) point out that the membership functions of fuzzy concept depend on the context, which prevents them being implemented in practical applications. They think that the crucial factors while choosing the appropriate membership function are the type of the variable and the type of measurement of that variable for practical applications like construction management.

As Hanna et al. (2002) mention, regression analysis and neural network methods have a problem with qualitative input variable; furthermore fuzzy concept creates limitations on the definition stage of the membership functions when the system gets more complicated.

Thus, Dissanayake et al. (2005) focus on finding another possible method to solve the problem of membership function indication which would combine fuzzy set theory, neural networks and generic algorithms as Fuzzy Adaptive Generalized Regression Neural Network (FA-GRNN) Theory. Foundation of this theory relies on the Generalized Regression Neural Network (GRNN) study prepared by Specht (1991).

As shown in Figure 13, Dissanayake et al. (2005) defines the architecture of FA-GRNN method as it is composed of multi-input and single-output system. It has five layers which are input layer, fuzzy neurons layer, pattern layer, summation layer and output layer.

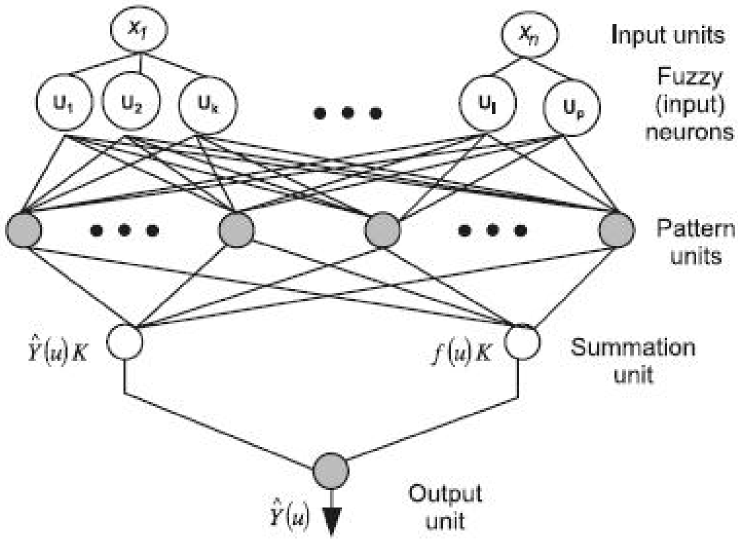

Figure 13. Fuzzy Adaptive Generalized Regression Neural Network (FA-GRNN) by Dissanayake et al. (2005)

One of the significant conclusions of Dissanayake et al. (2005) is that the utilization of FA-GRNN approach brings the possibility to analyze both quantitative and qualitative variables which have an effect on the performance of the model. Additionally, the application does not need large data sets to start working which makes it easier to develop the application.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. General

This thesis provides a comparison of models to help offshore petroleum platform fabrication companies to decide whether or not to bid when an invitation to tender (ITT) document is received from the client. This comparison is based on certain parameters determined by the fabrication company and classified data according to the historical experience of the company.

The offshore industry, when compared to the overall construction world, is composed of various kinds of different projects, with significantly less chance of finding any similarity between projects in terms of the structure, requirements and the final outcome. Therefore, determination of the parameters of the method which will enable dissimilar offshore projects to be investigated in specific common points is the most crucial step in this analysis in obtaining a more accurate result.

In this study, the overall aim is to find alternative ways to improve the results of the fabrication company's own assessment by using regression analysis, neural network method and fuzzy neural network method with a comparison based on 10-fold cross validation method. The forecast performance of these methods is compared with the assessment of the fabrication company.

3.2 Assessment of the Fabrication Company

The existing evaluation method of the fabrication company was developed to analyze the historical data of the company relating to previous tenders the company had bid for. This evaluation method was prepared by a responsible team consisting of experienced technical staff who had worked in the preparation stage of the tenders considered and senior level commercial and project managers.

The team identified the most significant parameters to be considered in the bidding stage by taking into account their level of experience and the current situation of the offshore industry at the time of the study. These parameters are:

1) Scope Fit (F): Compatibility of the project and company scope

2) Political Position (PS): Coherence of the political position of company and client

3) Safety Appreciation (S): The safety level required for the project

4) Track Record (T): The level of the data collected about the project and client

5) Personal Relation (R): Previous experiences with the client

6) Yard Location (L): Assessment of the location of the project in terms of accessibility and/or usability

7) Know-How (K): The required level of know-how to be utilized in the project

8) Ultimate Price Level (U): The assessment of the budget of the project

Each tender was ranked between 1 and 5 according to the determined parameters, where “1” stands for “low”, “3” means “normal” and “5” is “excellent”. After ranking all the tenders for each parameter, weights to these parameters were assigned accordingly and the total probability of winning each tender was calculated for the company.

As a result, by utilizing its own weighted average evaluation, the company study managed to guess the result of 19 tenders correctly, where the total number of tenders utilized in the study was 40. This result represented a success rate of 47.5% (19/40) for the evaluation method of the fabrication company.

3.3 Regression Analysis

In regression analysis, the overall aim is to develop a model including the significant parameters defined by the company for the data set created. The backward elimination method is utilized to understand the important parameters. In backward elimination, the aim is to eliminate in each run one of the independent variables in the regression model which does not have the required significance level. P value is taken into account as an indicator for the significance of the parameters included in the model. If the P value of one parameter is higher than the determined significance level of the value, the parameter should be eliminated and a new regression model should be prepared. If the P value of more than one parameter is higher than the determined significance level of the P value, the parameter with the highest P value should be eliminated. The elimination process continues until all remaining parameters have P values less than the determined significance level of the P value.

The first regression equation which includes all the parameters is constructed in the form:

$$Y = \beta_0 + \beta_1.F + \beta_2.PS + \beta_3.S + \beta_4.T + \beta_5.R + \beta_6.L + \beta_7.K + \beta_8.U \qquad [3]$$

Where Y denotes the probability of winning the tender, F, PS, S, T, R, L, K, U are the independent parameters and β_i values are the corresponding regression coefficients of the independent parameters.

The Regression Model 1 (RM 1) is built and run considering the first regression equation. P value is taken as 0,100 in order to indicate the significance level of the parameters. In Table 4, all parameters with their regression coefficients and P values are listed for the first regression model.

Table 4. Regression Coefficients and P Values for Regression Model 1

RM 1	*Coefficients (β_i)*	*P- value ($\leq$0,100)*
Intercept	0,459	0,631
X Variable 1 - F	-0,077	0,289
X Variable 2 - PS	0,094	0,318
X Variable 3 - S	-0,385	0,233
X Variable 4 - T	0,121	0,209
X Variable 5 - R	0,211	0,021
X Variable 6 - L	-0,008	0,924
X Variable 7 - K	-0,113	0,312
X Variable 8 - U	0,082	0,430

As highlighted in the table, in the first regression model variable 6 which is the parameter “Yard Location (L)” has the highest P value. In fact all parameters except “Personal Relation (R)” have a P value higher than 0,100 but the highest P value of the table is 0,924 for “Yard Location (L)”. Therefore this parameter is deleted from the model. The regression model is updated and run again with 7 parameters and Regression Model 2 (RM 2) is formed as in Table 5.

Table 5. Regression Coefficients and P Values for Regression Model 2

RM 2	*Coefficients (β_i)*	*P- value (≤0,100)*
Intercept	0,474	0,610
X Variable 1 - F	-0,077	0,281
X Variable 2 - PS	0,090	0,280
X Variable 3 - S	-0,390	0,215
X Variable 4 - T	0,118	0,189
X Variable 5 - R	0,212	0,019
X Variable 7 - K	-0,112	0,306
X Variable 8 - U	0,078	0,411

In the second regression model the parameter "Ultimate Price Level (U)" has the highest P value within the independent parameters and seen as Variable 8 with a P value of 0,411 in Table 5. Thus this parameter is deleted from the model and new regression model is built. Regression Model 3 (RM 3) is run with 6 parameters and P values of RM 3 is shown in Table 6.

Table 6. Regression Coefficients and P Values for Regression Model 3

RM 3	*Coefficients (β_i)*	*P- value (≤0,100)*
Intercept	0,450	0,626
X Variable 1 - F	-0,081	0,252
X Variable 2 - PS	0,060	0,420
X Variable 3 - S	-0,331	0,276
X Variable 4 - T	0,108	0,221
X Variable 5 - R	0,250	0,001
X Variable 7 - K	-0,093	0,383

In the third regression model Variable 2 is highlighted as the parameter to be deleted because the highest P value in Table 6 is seen as 0,420 for Variable 2 which is “Political Position (PS)”. After deletion of this parameter, regression model is updated and Regression Model 4 (RM 4) is run with 5 parameters. In Table 7, the result of the analysis of RM 4 can be seen.

Table 7. Regression Coefficients and P Values for Regression Model 4

RM 4	*Coefficients (β_i)*	*P- value (≤0,100)*
Intercept	0,530	0,562
X Variable 1 - F	-0,078	0,266
X Variable 3 - S	-0,328	0,277
X Variable 4 - T	0,090	0,288
X Variable 5 - R	0,271	0,0003
X Variable 7 - K	-0,075	0,468

In the fourth regression model, the parameter “Know-How (K)” has the highest P value as 0,468 which is higher than 0,100. Thus “Know-How (K)” that is seen as Variable 7 in Table 7 is eliminated from the regression model. The new regression model is formed and Regression Model 5 (RM 5) is run again with 4 parameters left. The result of RM 5 is listed in Table 8.

Table 8. Regression Coefficients and P Values for Regression Model 5

RM 5	*Coefficients (β_i)*	*P- value (≤0,100)*
Intercept	0,260	0,753
X Variable 1 - F	-0,093	0,162
X Variable 3 - S	-0,269	0,350
X Variable 4 - T	0,061	0,408
X Variable 5 - R	0,271	0,000

According to the results listed, parameter “Track Record (T)", which is seen as Variable 4 in Table 8, has the highest P value as 0,408. Therefore “Track Record (T)” should be eliminated and regression model must be updated. Regression Model 6 (RM 6) is prepared and run with 3 parameters. The new P values for the rest of the parameters are shown in Table 9.

Table 9. Regression Coefficients and P Values for Regression Model 6

RM 6	*Coefficients (β_i)*	*P- value (≤0,100)*
Intercept	0,168	0,837
X Variable 1 - F	-0,068	0,246
X Variable 3 - S	-0,219	0,433
X Variable 5 - R	0,288	5,34733E-05

As seen in Table 9, the highest P value is for Variable 3 which is “Safety Appreciation (S)” with a value of 0,433. After the elimination of “Safety Appreciation (S)”, Regression Model 7 (RM 7) is built with the two remaining parameters. The results of RM 7 are shown in Table 10.

Table 10. Regression Coefficients and P Values for Regression Model 7

RM 7	*Coefficients (β_i)*	*P- value (≤0,100)*
Intercept	-0,450	0,047
X Variable 1 - F	-0,073	0,208
X Variable 5 - R	0,281	5,78985E-05

The results of RM 7 show that still one of the outstanding two parameters has a P value larger than 0,100 which is “Scope Fit (F)” and can be seen as Variable 1 in Table 10. Consequently “Scope Fit (F)” is also deleted from the model. Regression Model 8 (RM 8) is formed and run, results of which are reflected in Table 11.

Table 11. Regression Coefficients and P Values for Regression Model 8

RM 8	*Coefficients (β_i)*	*P- value ($\leq$0,100)*
Intercept	-0,560	0,009
X Variable 5 - R	0,2439	7,93999E-05

Table 11 shows that "Personal Relation (R)" has a P value less than 0,100 which means that the significant parameter of the regression model created is "Personal Relation (R)" that is seen as Variable 5 in Table 11. The regression equation is finalized as:

$$Y = -0,560 + (0.2439 * R) \quad [4]$$

This equation means that "Personal Relation" is the most significant criteria to evaluate the probability of winning the tender, when the significance level of the P value is defined as 0,100. The list of the regression models showing the corresponding eliminated parameters and P values of these parameters are shown in Table 12.

Table 12. Regression Models for P = 0,100 Significance Level

Model	Independent variables	Parameter with the highest P value	P value
RM 1	F, PS, S, T, R, L, K, U	L	0.924
RM 2	F, PS, S, T, R, K, U	U	0.411
RM 3	F, PS, S, T, R, K	PS	0.420
RM 4	F, S, T, R, K	K	0.468
RM 5	F, S, T, R	T	0.408
RM 6	F, S, R	S	0.433
RM 7	F, R	F	0.208
RM 8	R	-	-

After the first regression model set, the significance level of P value is determined as 0,200 for the regression analysis and the models are recreated. For the new the results of the first six regression models (RM 1, RM 2, RM 3, RM 4, RM 5, RM 6), eliminated parameters are the same as in the previous models in each step. For Regression Model 7, P value of “Scope Fit (F)” is “0,208” which can be accepted in the range $P \leq 0.200$. The results of Regression Model 7 for the second case can be found in Table 13.

Table 13. Regression Coefficients and P Values for Regression Model 7 (P<0,200)

RM 7	*Coefficients (β_i)*	*P- value ($\leq$0,200)*
Intercept	-0,450	0,047
X Variable 1 - F	-0,073	0,208 (~0,200)
X Variable 5 - R	0,281	5,78985E-05

As seen in Table 13, all outstanding parameters have a P value in the desired range, so there is no need to do more elimination and form a new regression model. The significant parameters for $P \leq 0,200$ criteria are “Scope Fit (F)” and “Personal Relation (R)”. As a result, the second regression equation is finalized as:

$$Y = -0,450 - (0,073 * F) + (0,281 * R) \qquad [5]$$

The list of the regression models for P = 0,200 Significance Level and the corresponding eliminated parameters with their P values are listed in Table 14.

Table 14. Regression models for P = 0,200 Significance Level

Model	Independent variables	Parameter with the highest P value	P value
RM 1	F, PS, S, T, R, L, K, U	L	0.924
RM 2	F, PS, S, T, R, K, U	U	0.411
RM 3	F, PS, S, T, R, K	PS	0.420
RM 4	F, S, T, R, K	K	0.468
RM 5	F, S, T, R	T	0.408
RM 6	F, S, R	S	0.433
RM 7	F, R	-	-

The results of the regression analysis in which all the data are utilized show that there are two models to be investigated further on:

1) One Parameter (Personal Relation) Model

2) Two Parameters (Personal Relation and Scope Fit) Model

3.4 Prediction Analysis by 10-Fold Cross Validation Method

In 10-Fold Cross Validation Method, the aim is to evaluate and compare the prediction performance of all of the models utilized. Firstly, two regression models created in the regression analysis section will be analyzed. For the evaluation and comparison, the data set is divided into smaller test sets such that each test set has (*n * %10*) data where *n* is the total number of the data. These test sets are generated randomly by using an Excel sheet which produces random numbers. The crucial point is that no data should be considered in two different test sets. After all test sets are generated, the first test set is taken out of the whole data set, a new regression model is formed and run with the rest of the data and the regression equation is gathered for the new regression model.

Then the results of the data in the first test set are calculated by using the regression equation. Lastly the actual results for the test set are compared with these calculated results. This process is repeated for each test set created to be able to compare all the actual and calculated values of the data. In other words:

Total number of test sets:	$\frac{n}{(n * \%10)}$	=	10
Total number regression models created:	$\frac{n}{(n * \%10)}$	=	10
Data considered in each regression model:	n - (n * %10)	=	0,9 n
Data tested in each regression model:	(n * %10)	=	0,1 n

3.4.1 One Parameter (Personal Relation) Model

For the cross validation of the first regression model created in the regression analysis section, only "Personal Relation (R)" is taken into consideration. The results of the cross validation are shown In Table 15.

Table 15. Cross Validation Check for the First Regression Model

Data	Test Set	Regression Equation	Actual	Calculated
1	2	Y = - 0.65706 + (0.266571 * R)	1	0
2	3	Y = - 0.60689 + (0.267057 * R)	1	1
3	7	Y = - 0.56712 + (0.249315 * R)	1	1
4	6	Y = - 0.51425 + (0.230570 * R)	1	1
5	1	Y = - 0.49413 + (0.226683 * R)	1	1
6	4	Y = - 0.58155 + (0.247563 * R)	1	0

Table 15 (Continued)

7	5	Y = - 0.55693 + (0.242574 * R)	1	0
8	8	Y = - 0.53618 + (0.232558 * R)	1	0
9	10	Y = - 0.56331 + (0.238419 * R)	1	0
10	10	Y = - 0.56331 + (0.238419 * R)	1	0
11	7	Y = - 0.56712 + (0.249315 * R)	1	1
12	8	Y = - 0.53618 + (0.232558 * R)	1	1
13	9	Y = - 0.54749 + (0.245810 * R)	0	0
14	3	Y = - 0.60689 + (0.267057 * R)	0	0
15	1	Y = - 0.49413 + (0.226683 * R)	0	0
16	5	Y = - 0.55693 + (0.242574 * R)	0	0
17	4	Y = - 0.58155 + (0.247563 * R)	0	0
18	10	Y = - 0.56331 + (0.238419 * R)	0	0
19	6	Y = - 0.51425 + (0.230570 * R)	0	0
20	8	Y = - 0.53618 + (0.232558 * R)	0	0
21	9	Y = - 0.54749 + (0.245810 * R)	0	0
22	6	Y = - 0.51425 + (0.230570 * R)	0	0
23	2	Y = - 0.65706 + (0.266571 * R)	0	0
24	9	Y = - 0.54749 + (0.245810 * R)	0	0
25	5	Y = - 0.55693 + (0.242574 * R)	0	0
26	7	Y = - 0.56712 + (0.249315 * R)	0	1
27	4	Y = - 0.58155 + (0.247563 * R)	0	0
28	3	Y = - 0.60689 + (0.267057 * R)	0	1
29	7	Y = - 0.56712 + (0.249315 * R)	0	0
30	3	Y = - 0.60689 + (0.267057 * R)	0	0
31	9	Y = - 0.54749 + (0.245810 * R)	0	0
32	1	Y = - 0.49413 + (0.226683 * R)	0	0
33	6	Y = - 0.51425 + (0.230570 * R)	0	0
34	2	Y = - 0.65706 + (0.266571 * R)	0	0
35	8	Y = - 0.53618 + (0.232558 * R)	0	0
36	1	Y = - 0.49413 + (0.226683 * R)	0	0
37	5	Y = - 0.55693 + (0.242574 * R)	0	0
38	10	Y = - 0.56331 + (0.238419 * R)	0	0
39	2	Y = - 0.65706 + (0.266571 * R)	0	0
40	4	Y = - 0.58155 + (0.247563 * R)	0	0

In Table 15, the highlighted items show the data which are predicted wrongly. The total number of wrongly predicted data is found as 8 out of 40 data as shown in Table 15. This figure gives a prediction performance of 80.0% (32/40) for One-Parameter (Personal Relation) Model.

3.4.2 Two Parameters (Personal Relation and Scope Fit) Model

On the second regression model created in the regression analysis section, two parameters, “Personal Relation (R)” and “Scope Fit (F)” are taken into consideration. The results of the second cross validation are shown in Table 16.

Table 16. Cross Validation Check for the Second Regression Model

Data	Test Set	Regression Equation	Actual	Calculated
1	2	Y = - 0.49240 - (0.10332 * F) + (0.315551 * R)	1	0
2	3	Y = - 0.51013 - (0.05668 * F) + (0.290813 * R)	1	1
3	7	Y = - 0.48712 - (0.05333 * F) + (0.275982 * R)	1	1
4	6	Y = - 0.35504 - (0.10058 * F) + (0.278515 * R)	1	1
5	1	Y = - 0.37131 - (0.08113 * F) + (0.265969 * R)	1	1
6	4	Y = - 0.47433 - (0.07097 * F) + (0.282011 * R)	1	0
7	5	Y = - 0.47026 - (0.05836 * F) + (0.272908 * R)	1	0
8	8	Y = - 0.48492 - (0.04619 * F) + (0.262633 * R)	1	0
9	10	Y = - 0.45225 - (0.07942 * F) + (0.281982 * R)	1	0
10	10	Y = - 0.45225 - (0.07942 * F) + (0.281982 * R)	1	0
11	7	Y = - 0.48712 - (0.05333 * F) + (0.275982 * R)	1	1
12	8	Y = - 0.48492 - (0.04619 * F) + (0.262633 * R)	1	1
13	9	Y = - 0.43379 - (0.07209 * F) + (0.280578 * R)	0	0
14	3	Y = - 0.51013 - (0.05668 * F) + (0.290813 * R)	0	0
15	1	Y = - 0.37131 - (0.08113 * F) + (0.265969 * R)	0	0
16	5	Y = - 0.47026 - (0.05836 * F) + (0.272908 * R)	0	0
17	4	Y = - 0.47433 - (0.07097 * F) + (0.282011 * R)	0	0

Table 16 (Continued)

18	10	Y = - 0.45225 - (0.07942 * F) + (0.281982 * R)	0	0
19	6	Y = - 0.35504 - (0.10058 * F) + (0.278515 * R)	0	0
20	8	Y = - 0.48492 - (0.04619 * F) + (0.262633 * R)	0	0
21	9	Y = - 0.43379 - (0.07209 * F) + (0.280578 * R)	0	0
22	6	Y = - 0.35504 - (0.10058 * F) + (0.278515 * R)	0	0
23	2	Y = - 0.49240 - (0.10332 * F) + (0.315551 * R)	0	0
24	9	Y = - 0.43379 - (0.07209 * F) + (0.280578 * R)	0	0
25	5	Y = - 0.47026 - (0.05836 * F) + (0.272908 * R)	0	0
26	7	Y = - 0.48712 - (0.05333 * F) + (0.275982 * R)	0	1
27	4	Y = - 0.47433 - (0.07097 * F) + (0.282011 * R)	0	0
28	3	Y = - 0.51013 - (0.05668 * F) + (0.290813 * R)	0	1
29	7	Y = - 0.48712 - (0.05333 * F) + (0.275982 * R)	0	0
30	3	Y = - 0.51013 - (0.05668 * F) + (0.290813 * R)	0	0
31	9	Y = - 0.43379 - (0.07209 * F) + (0.280578 * R)	0	0
32	1	Y = - 0.37131 - (0.08113 * F) + (0.265969 * R)	0	0
33	6	Y = - 0.35504 - (0.10058 * F) + (0.278515 * R)	0	0
34	2	Y = - 0.49240 - (0.10332 * F) + (0.315551 * R)	0	0
35	8	Y = - 0.48492 - (0.04619 * F) + (0.262633 * R)	0	0
36	1	Y = - 0.37131 - (0.08113 * F) + (0.265969 * R)	0	0
37	5	Y = - 0.47026 - (0.05836 * F) + (0.272908 * R)	0	0
38	10	Y = - 0.45225 - (0.07942 * F) + (0.281982 * R)	0	0
39	2	Y = - 0.49240 - (0.10332 * F) + (0.315551 * R)	0	0
40	4	Y = - 0.47433 - (0.07097 * F) + (0.282011 * R)	0	0

The results of the cross validation for the second regression model show that there are again 8 data highlighted which have different actual and calculated values as an outcome. Therefore 10-fold cross validation of the Two-Parameters (Personal Relation and Scope Fit) Model gives a prediction performance of 80,0% (32/40) which is the same result gathered from 10-fold cross validation of One-Parameter (Personal Relation) Model. Compared to the study of the company which has a prediction performance of 47,5% (19/40), 10-fold cross validation shows that both regression models have significantly better results.

3.5 Neural Network Method

The results of regression analysis based on 10-fold cross validation method present the parameters which have considerable effect on the tender. However, these methods generated a linear relationship between the parameters and the probability of winning the tender. Neural Network Method is utilized in this study to understand whether to create just a linear relationship between dependent variable and independent variables is enough to decide bidding/no bidding or not.

In the regression analysis section, the parameters were eliminated by using backward elimination method and the decision criteria to eliminate the parameters were the P values of the parameters. In neural network method, there is no decision criteria like a P value to find the significance of the parameters. Therefore, beginning with Regression Model 1 (RM 1) until Regression Model 8 (RM 8), each model created in regression analysis must be analyzed in a neural network method. Models to be analyzed in a neural network method and corresponding equations can be found in Table 17.

Table 17. List of the Regression Models to be Analyzed in Neural Network Method

	Equation
Regression Model 1	$Y = \beta_0 + \beta_1.F + \beta_2.PS + \beta_3.S + \beta_4.T + \beta_5.R + \beta_6.L + \beta_7.K + \beta_8.U$
Regression Model 2	$Y = \beta_0 + \beta_1.F + \beta_2.PS + \beta_3.S + \beta_4.T + \beta_5.R + \beta_7.K + \beta_8.U$
Regression Model 3	$Y = \beta_0 + \beta_1.F + \beta_2.PS + \beta_3.S + \beta_4.T + \beta_5.R + \beta_7.K$
Regression Model 4	$Y = \beta_0 + \beta_1.F + \beta_3.S + \beta_4.T + \beta_5.R + \beta_7.K$
Regression Model 5	$Y = \beta_0 + \beta_1.F + \beta_3.S + \beta_4.T + \beta_5.R$
Regression Model 6	$Y = \beta_0 + \beta_1.F + \beta_3.S + \beta_5.R$
Regression Model 7	$Y = \beta_0 + \beta_1.F + \beta_5.R$
Regression Model 8	$Y = \beta_0 + \beta_5.R$

Additionally, as in 10-fold cross validation method, test sets should be applied to determine the prediction performance of every model one by one. A crucial fact which should not be ignored at this level is that exactly the same test sets must be used while comparing different methods. Thus, the test sets created in 10-fold cross validation method are also used in the neural network method.

As presented in Table 17, firstly the model with 8 parameters will be analyzed for each test set and the calculated values for the test sets will be derived. Then the prediction performance of an 8-parameter model for the whole test sets will be evaluated. Secondly the same procedure will be applied for the model with 7 parameters. Then the prediction of all the test sets according to the7-parameter model will be identified and the prediction performance of the 7-parameter model will be found. If the prediction performance of the 7-parameter model is better or equal to the prediction performance of the previous model created, a 6-parameter model will be analyzed. Then respectively the analyses and calculations will continue until the analyzed model gives a worse prediction performance than the previous model. Obviously, the parameter reduction order will be the same as the order followed in regression analysis.

The neural network model used in the analyses gives different results according to the options of the model chosen. These options are classified as architecture options and training options.

3.5.1. Neural Network Model Architecture Options

Number of inputs:

This is the number of parameters in the model. It can have a value between 2 and 50.

Number of outputs:

This is the number of desired outcomes after the analysis. It can be between 1 and 10.

Number of hidden layers:

In hidden layer, inputs are recoded. There may be either 1 or 2 hidden layers.

Hidden Layer sizes:

This is the number of the units in a hidden layer. This can be at most 20 and be defined separately for each hidden layer.

Learning parameter:

This is the coefficient to decide the learning curve of the model. It may be between 0 and 1.

Momentum:

This is the option which increases the speed of learning.

Initial weight range:

The model can generate the starting weights randomly but this option allows assigning the initial weights manually.

3.5.2. Neural Network Model Training Options

Total number of rows in the data:

This is the total number of the data to be analyzed in the model. There must be at least 10 data in the model.

Presentation of inputs in random order while training:

This option introduces the inputs randomly in training session of the model.

Number of training cycles:

This is the number of the cycles the model will create during training session. The limit of the cycles is 500.

Save network weights:

The weights calculated by the model can be saved with least Mean Square Error (MSE) of the training data or MSE of the validation data.

Training/Validation set:

This option allows using all the selected data as a training data or partly validation and training data.

Selection of the validation set:

If the data is selected to be used as partly validation and training data, validation data can be selected in two ways. The first way is to randomly select a specific percentage of the data as validation set which must be between 1% and 50%. The second way is to define a specific amount of the data as a validation set.

Save model in a separate workbook:

This option lets the user save the results of the model in another Excel workbook.

The options of the model can be seen in Figure 14.

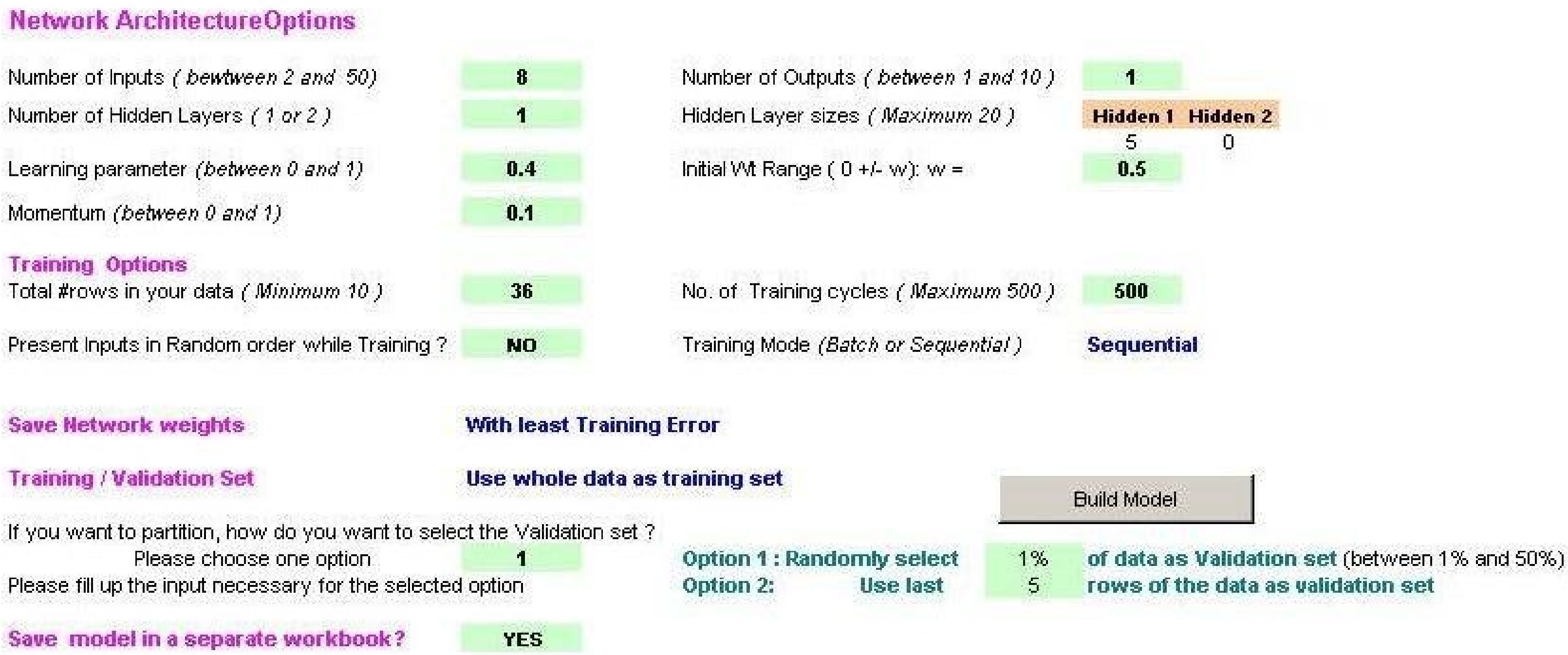

Figure 14. Options of the Neural Network Model

As shown in Figure 14, selection of the options is made accordingly. The number of inputs is selected according to the number of parameters in each model which starts from 8 and decreases until the maximum prediction performance is reached in the model. There is only one output that is the probability of winning the tender. The number of hidden layers is selected as “1” since this is considered to be enough for such a range of inputs. Hidden layer size is taken as “5” which is found as:

$$\frac{(\text{Number of inputs} + \text{Number of outputs})}{2} = \frac{(8 + 1)}{2} = 5 \qquad [6]$$

There is only 1 hidden layer selected so the hidden layer size of the second hidden layer is not considered and can be filled as “0”. Learning parameter option and initial weight range option are taken as the default values which are “0.4” and “0.5” respectively. Momentum is considered as “0.1” to define the rate of learning. Since one of the test sets consisting of 4 data are analyzed in each run, the analyzed test set will be out of the data set of the model and the total number of rows in the data will be “36”. The number of training cycles is taken as “500” to get as accurate results as possible. Additionally, inputs are not chosen to be presented in random order while training. The training mode is selected as “sequential” to sustain the continuous order in learning stage. The whole data is used as training set, there is no validation set therefore network weights are saved with least training error. Since there is no partition on data as validation and training set, there is no need to consider the selection of the validation set option.

As a result, the first neural network model created has 8 parameters with 5 hidden layer neurons and an output, which can be seen in Figure 15.

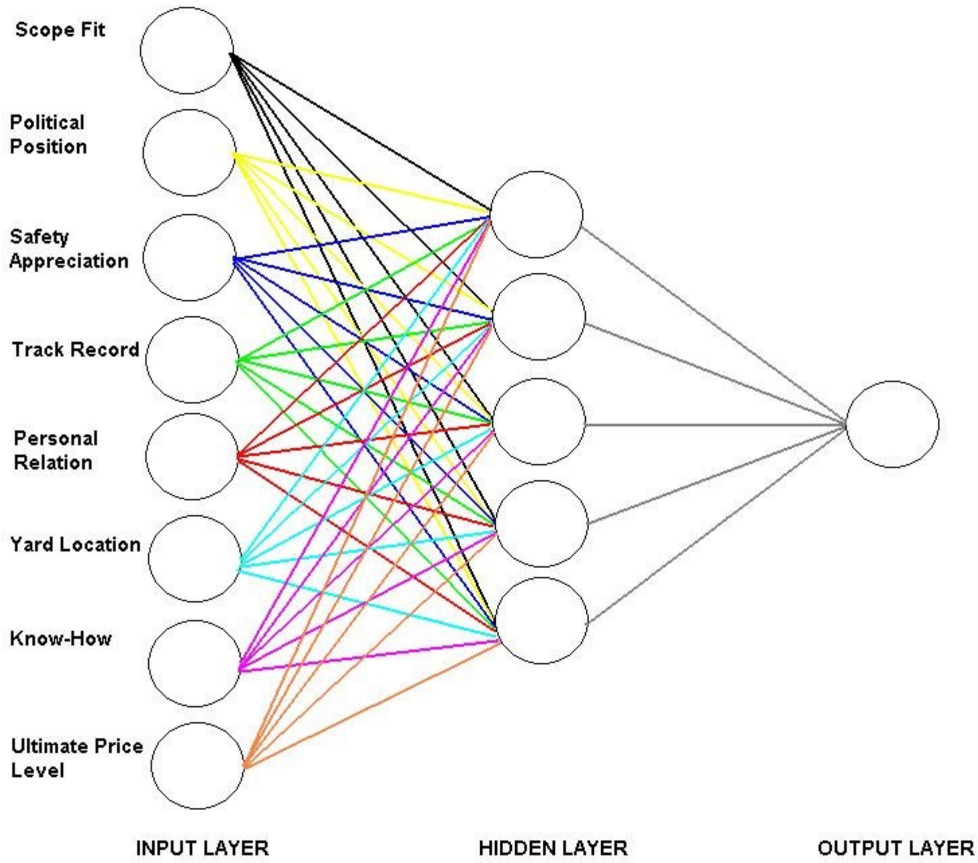

Figure 15. The First Neural Network Model of the Data

3.5.3 Neural Network Models

In 8-parameter neural network model, each test set is analyzed separately and all of the data are predicted by using the model. The results of the 8-parameter neural network model are shown in Table 18.

Table 18. Results of the 8-Parameter Neural Network Model

Data number	Actual Data	Program Data
1	1	0
2	1	1
3	1	1
4	1	1
5	1	1
6	1	0
7	1	1
8	1	1
9	1	0
10	1	0
11	1	1
12	1	1
13	0	0
14	0	1
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	1
27	0	0
28	0	1
29	0	0
30	0	1
31	0	1
32	0	0
33	0	0
34	0	0
35	0	1
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0

The results of the first neural network show that 10 of the data are estimated incorrectly, which shows a prediction performance of 75% (30/40) for 8-parameter neural network model. To be able to compare this result, a 7-parameter neural network model is formed by eliminating “Yard Location (L)”, changing the options accordingly and the model is run. The results can be found in Table 19.

Table 19. Results of the 7-Parameter Neural Network Model

Data Number	***Actual Data***	***Program Data***
1	1	1
2	1	1
3	1	1
4	1	1
5	1	0
6	1	0
7	1	1
8	1	1
9	1	0
10	1	0
11	1	1
12	1	1
13	0	0
14	0	1
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	1
27	0	0
28	0	1
29	0	1
30	0	1
31	0	1

Table 19 (Continued)

32	0	0
33	0	0
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0

The results of a 7-parameter neural network model show that the number of incorrectly estimated data is again 10, which leads to 75% (30/40) prediction performance. This prediction performance is the same with an 8-parameter neural network. Therefore the process can continue by eliminating the next parameter which is "Ultimate Price Level (U)", forming a 6-parameter neural network model and changing the options of the model. The new model is run and the results which can be seen in Table 20 are gathered.

Table 20. Results of the 6-Parameter Neural Network Model

Data Number	***Actual Data***	***Program Data***
1	1	0
2	1	1
3	1	1
4	1	1
5	1	0
6	1	0
7	1	1
8	1	1
9	1	0
10	1	0
11	1	1
12	1	1
13	0	0

Table 20 (Continued)

14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	1
27	0	0
28	0	1
29	0	0
30	0	1
31	0	1
32	0	0
33	0	0
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0

According to the results shown in Table 20, the model predicted 9 data incorrectly which means that 77.5% (31/40) prediction performance is achieved. This performance is better than the previous one so the 5-parameter neural network model is to be prepared as the next step. In the new model, “Political Position (PS)” is disregarded, the options are corrected and the model is run accordingly. The outcome of the 5-parameter neural network model is reflected in Table 21.

Table 21. Results of the 5-Parameter Neural Network Model

Data Number	***Actual Data***	***Program Data***
1	1	0
2	1	1
3	1	1
4	1	1
5	1	1
6	1	0
7	1	1
8	1	0
9	1	0
10	1	0
11	1	0
12	1	1
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	1
27	0	0
28	0	1
29	0	0
30	0	1
31	0	0
32	0	0
33	0	0
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0

5-parameter neural network model predicted 9 of the data incorrectly, which results in 77.5% (31/40) prediction performance. This percentage is the same with the results of the previous model. Therefore the next neural network model is generated after deleting the parameter “Know-How (K)”. The corresponding changes in the options of the model are done and the 4-parameter model is run. The results of the model are shown in Table 22.

Table 22. Results of the 4-Parameter Neural Network Model

Data Number	***Actual Data***	***Program Data***
1	1	0
2	1	1
3	1	1
4	1	1
5	1	1
6	1	0
7	1	0
8	1	0
9	1	0
10	1	0
11	1	1
12	1	1
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	1
27	0	0
28	0	1

Table 22 (Continued)

29	0	0
30	0	1
31	0	0
32	0	0
33	0	0
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0

Table 22 shows that the data that are predicted incorrectly differ from the previous model but the total number of incorrectly predicted data is still the same with the 5-parameter neural network model, which are 9. Thus the prediction performance of the 4-parameter neural network model is also same, 77.5% (31/40). Therefore the analysis process continues and a 3-parameter neural network model is developed. In the development of the next model, "Track Record (T)" is eliminated. After the required changes to the model options, the model is run and the results of the model are presented in Table 23.

Table 23. Results of the 3-Parameter Neural Network Model

Data Number	***Actual Data***	***Program Data***
1	1	0
2	1	1
3	1	1
4	1	1
5	1	1
6	1	0
7	1	0
8	1	0
9	1	0
10	1	0

Table 23 (Continued)

11	1	1
12	1	1
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	1
27	0	0
28	0	1
29	0	0
30	0	0
31	0	0
32	0	0
33	0	0
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0

The results of the 3-parameter neural network show that there are 8 data that were predicted incorrectly which results in a prediction performance 80% (32/40). This prediction performance is higher than the previous predictions, which show that the inputs utilized in this analysis are extremely effective on the output. A new model is generated after removing "Safety Appreciation (S)" and changing the options. A 2-parameter neural network model is run and the outcome is listed in Table 24.

Table 24. Results of the 2-Parameter Neural Network Model

Data Number	***Actual Data***	***Program Data***
1	1	0
2	1	1
3	1	1
4	1	1
5	1	0
6	1	0
7	1	0
8	1	0
9	1	0
10	1	0
11	1	1
12	1	1
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	1
27	0	0
28	0	1
29	0	0
30	0	0
31	0	0
32	0	0
33	0	0
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0

Table 24 shows that the number of incorrectly predicted data is 9, which means the prediction performance of the model is 77.5% (31/40). This prediction performance is less than the previous one; therefore there is no need to continue the analysis further on. If the prediction performance of the 2-parameter neural network model had given a better result than, or at least equal to the result of the 3-parameter model, the neural network analysis would have continued with the analysis of the 1-parameter neural network model.

In Table 25, the summary of the results according to the prediction performance and the eliminated inputs are provided.

Table 25. The Summary of the Neural Network Model Results

Model	**Number of Wrong Estimates**	**Prediction Performance (%)**	**Input Eliminated**
8-Parameter NN Model	10	75%	Yard Location (L)
7-Parameter NN Model	10	75%	Ultimate Price Level (U)
6-Parameter NN Model	9	77.5%	Political Position (PS)
5-Parameter NN Model	9	77.5%	Know-How (K)
4-Parameter NN Model	9	77.5%	Track Record (T)
3-Parameter NN Model	8	80%	Safety Appreciation (S)
2-Parameter NN Model	9	77.5%	-

As can be seen from Table 25, the best prediction performance is achieved in the 3-parameter Neural Network Model with parameters “Safety Appreciation (S)”, “Scope Fit (F)” and “Personal Relation (R)”. Table 25 also shows that the prediction performance of the neural network (80%) gives much better result than the evaluation method of the company (47.5%).

3.6 Fuzzy Neural Network Method

The objective in the utilization of fuzzy neural network method is to check for a better prediction performance than that achieved in a neural network method. Since the 3-parameter neural network model gives the best results in prediction, this model is taken into consideration for further improvements in fuzzy neural network method.

In the construction of the fuzzy neural network model, the first step is to determine the sets which will be used to define the input variables. Three sets will be created for the model as low, normal and high. Then the membership functions for each set will be determined for each parameter ranking. The membership functions of the fuzzy sets can be seen in Figure 16.

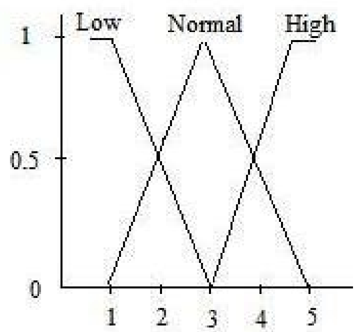

Figure 16. The Membership Functions of Fuzzy Sets

As shown in Figure 16, the x axis shows the ranking of parameters and the y axis presents the corresponding membership functions for different rankings of a parameter. Thus, in a fuzzy neural network approach, the parameters are redefined in terms of membership functions and each parameter is replaced with corresponding sub-parameters which are determined as “parameter-low”, “parameter-normal” and “parameter-high”. As an example, a parameter that has a ranking “1” is replaced by fuzzy set rankings parameter_low “1”, parameter_normal “0” and parameter high “0”. For ranking “2”, fuzzy set rankings are constructed as parameter_low “0.5”, parameter_normal “0.5” and parameter high “0”. The constructed example fuzzy sets for all of the ranking scores can be found in Table 26.

Table 26. Equivalent Fuzzy Set Rankings per Ranking of a Parameter

Ranking	***Parameter_low***	***Parameter_normal***	***Parameter_high***
1	1	0	0
2	0.5	0.5	0
3	0	1	0
4	0	0.5	0.5
5	0	0	1

As previously stated, the 3-parameter neural network model will be analyzed by a fuzzy neural network model. In the 3-parameter neural network model, the significant parameters were determined as “Safety Appreciation (S)”, “Scope Fit (F)” and “Personal Relation (R)”. Since each parameter is substituted by 3 sub-parameters in this model, there will be a total of 9 parameters to be considered which are “Safety Appreciation_low”, “Safety Appreciation_normal”, “Safety Appreciation_high”, “Scope Fit_low”, “Scope Fit_normal”, “Scope Fit_high”, “Personal Relation_low”, “Personal Relation_normal”, “Personal Relation_high”. The fuzzy neural network model is generated with the aforementioned parameters and corresponding fuzzy set rankings are utilized with the parameters. Then the model is run and the results of the fuzzy neural network are obtained. The outcome is listed in Table 27.

Table 27. Results of the Fuzzy Neural Network Model

Data number	*Actual Data*	*Program Data*
1	1	0
2	1	1
3	1	1
4	1	1
5	1	1
6	1	0
7	1	0
8	1	0
9	1	0
10	1	0
11	1	1
12	1	1
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	1
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	1
27	0	0
28	0	1
29	0	0
30	0	0
31	0	0
32	0	0
33	0	0
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0

According to the results of the fuzzy neural network model shown in Table 27, the prediction performance is calculated as 77.5% (31/40) with 9 wrong estimates made by the model. This model is also run with the same options as used in the neural network model, the only differences are the number of parameters and the ranking factors. When compared to the results of the previous models calculated before, this prediction performance is lower than the prediction performance of the neural network model.

3.7 Results of Analyses

The results of the models incorporated in this study are presented in Table 28.

Table 28. Results of All Incorporated Models

Method	Prediction Performance (%)	Significant Parameters
Assessment of the Company	% 47,5	Scope Fit Political Position Ultimate Price Level
Regression Analysis (P=0,100)	% 80,0	Personal Relation
Regression Analysis (P=0,200)	% 80,0	Personal Relation Scope Fit
Neural Network	% 80,0	Personal Relation Scope Fit Safety Appreciation
Fuzzy Neural Network	% 77,5	Personal Relation Scope Fit Safety Appreciation

Table 28 shows that all methods utilized in this study produce significantly better results than the assessment of the company. The prediction performances of the methods utilized increased to 77,5% for Fuzzy Neural Network and to 80,0% for Regression Analysis and Neural Network methods, whereas the prediction performance of the company evaluation method was only 47,5% and significantly less than the results of the methods utilized in this study.

The most crucial parameters of this study are observed as “Personal Relation” and “Scope Fit” since these two parameters are part of the final equations of both Regression Analysis, Neural Network and Fuzzy Neural Network methods. The “Political Position” and “Ultimate Price Level” parameters were considered as major variables in the assessment of the company.

CHAPTER 4

CONCLUSION

In this thesis, three decision-to-bid methods for the offshore petroleum platform fabrication industry were presented. The decision-to-bid procedure used by a petroleum platform fabrication company was revealed, and the models were created using the data compiled by utilizing a statistical approach and an artificial intelligence approach.

The method of the company was based on the weights assigned by the expert team composed of experienced engineers and senior level managers. Meanwhile, regression analysis aimed to determine the parameters which have a significant effect on the outcome on linear basis. Neural network analysis and fuzzy neural network analysis focused on generating nonlinear relationships between the significant parameters and the outcome by using the historical data

The methods developed in this thesis has managed to increase the prediction performance from 47,5% to 77,5%-80,0% prediction level. Thus the results showed that the methods developed are much better than the method of the company in the decision of bidding/no bidding. Therefore any of the utilized methods can be substituted with the company assessment. To find out which method would suit best instead of the method of the company, the most convenient way is to check the prediction performance of the methods. According to the analyses, both neural network method and regression analysis have the same prediction performance which is 80,0%.

Neural network method utilized its nonlinearity capability to identify the relationship between the parameters and the result, which includes complex steps between inputs and output. This reflects an expectation to have a higher prediction performance than the linear-based methods assuming a higher level of nonlinear relationship between the dependent parameters and the independent parameter. However, regression analysis managed to have the same prediction performance as neural network method by generating a linear relationship between inputs and output, which is rather easier to understand or explain. This situation points out that there is not such a high level of nonlinear relationship in the data. Therefore regression analysis is more suitable for the provided data among the three methods considered.

In regression analysis, the two models were created as one parameter model and two parameters model, which also have the same prediction performance. Since dropping of the parameter "Scope Fit" did not improve prediction performance of the regression model, it can be concluded that two parameters model is an adequate model. As a result, "Two Parameters (Personal Relations and Scope Fit) Regression Model" is seen as the most appropriate model for this study.

The results show that decision-to-bid models can produce a beneficial outcome for contractor companies that are willing to bid for a tender. However, the level of benefit is subject to change according to the parameter selection. The most crucial step in the analyses is seen as the selection of correct parameters. During the analyses, the most significant parameter is seen as "Personal Relation" and the results of the analyses differ drastically according to the ranking of this parameter. For another company in the offshore petroleum platform fabrication industry, the important parameters may be selected differently. Therefore, at this stage it does not seem possible for a model to be utilized generally by all of the companies in the industry.

In the offshore petroleum platform fabrication industry in particular, the projects are so unique that the properties of each project and tender are highly dependent on the client company, as a result of which the importance of selection of the parameters increases. Additionally, since the projects are unique in this industry, the amount of historical data that has been recorded in the company database gains significance.

The more historical data the company has, the greater the chance that an adequate decision-to-bid model to be used in the tendering phase.

This study is prepared generally for the petroleum platform fabrication industry but it can be also utilized for the sectors which have high amount of costs especially during the tender phase of the project.

Further studies can be implemented on creating new decision-to-bid models for the offshore petroleum platform fabrication industry. These will be able to evaluate the importance level of the parameters for the historical data given as input and create subgroups for parameters according to their importance level. During the analysis stage this will enable the model itself to decide the significant parameters itself for each data set to be analyzed.

Additionally, logistic regression analysis is not mentioned in this study but it can be utilized in further studies since this is also a common method considered in prediction performance studies.

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APPENDIX A

“BIDDING FOR TENDER” PROCEDURE OF THE COMPANY

Originating department: Project Management

Procedure:	QAD 77.02	Rev. C	Page: 1 of 14
Title:	Aanbiedingen en contracten	Tenders and contracts	Date: July 2005

Inhoud:

Contents:

Note: The latest revision of this QAD procedure is not due to a change in the procedure related work activities, but mainly due to the applicable references to the updated production organisation.

1.0. Doel
Om de methode vast te leggen waarmee alle aanbiedingen worden verwerkt en de behandeling na opdracht.

2.0. Definities

2.1. Aanvraag: door de opdrachtgever verstrekte informatie die de inhoud van het werk of de dienst vastlegt waarvoor een aanbieding moet worden gemaakt.

2.2. Aanbieding: voor de opdrachtgever opgesteld document dat de kosten, tijd en andere gevraagde details aangeeft, benodigd om een gevraagd werk of dienst uit te voeren.

2.3. Aanbiedingsdocumenten: alle informatie, zowel commercieel als technisch, waarop de kosten en manuren werden gebaseerd bij het opstellen van de aanbieding.

2.4. Algemene "kick-off"-vergadering: een eerste vergadering waarop de afdelingshoofden en projectgroep aanwezig zijn die bij het contract worden betrokken.

2.5. Specifieke "kick-off"-vergadering: een specifieke vergadering waarop gerichte afdelingen en personeel aanwezig zijn die betrokken zijn om actie te nemen op specifieke eisen.

2.6. Budget: vaststellen/verdelen contractprijs in het bestaande kostencoderingssysteem.

1.0. Purpose
To specify the method by which all tenders will be prepared and the handling after contract award.

2.0. Definitions

2.1. Enquiry: client supplied information which defines the contents of the work or service for which a tender has to be prepared.

2.2. Tender: prepared document for submittal to client showing cost, time and requested details necessary to execute the required work or service.

2.3. Tender documents: all information, both commercial and technical, on which costs and man-hours were based in the preparation of the tender.

2.4. General kick-off meeting: a general meeting at which all department heads and the project team required to participate in the contract are present.

2.5. Specific kick-off meeting: a specific meeting at which directed departments and personnel are present which are involved to action on specific requirements.

2.6. Budget: determine/breakdown contract price into the existing account coding system.

3.0.	Verantwoordelijkheden De verantwoordelijkheden voor het tender proces zijn in detail vastgelegd in de matrix (zie aanhangsel 6.1). Hoofdpunten staan hieronder vermeldt.	3.0.	Responsibilities The responsibilities for the tendering process have been defined in a matrix (see attachment 6.1). Key issues are giving below.
3.1.	De commerciële manager is verantwoordelijk voor het managen van het tender proces.	3.1.	The commercial manager is responsible for managing the tender process.
3.2.	De project management unit manager (PUM) is verantwoordelijk voor de toewijzing van het PMU personeel aan de tender.	3.2.	The project management unit manager (PUM) is responsible for the allocation of PMU personnel to the tender.
3.3.	De tender coördinator is verantwoordelijk voor het verzamelen van de kosten informatie van de gehele tender.	3.3.	The tender coordinator is responsible for collecting all the cost information for the complete tender.
3.4.	De cost engineer is verantwoordelijk voor het begroten van de eigen disciplines.	3.4.	The cost engineer is responsible for estimating of our own disciplines.
4.0.	Beschrijving	4.0.	Description
4.1.	Tender ontvangst	4.1.	Tender receipt
4.1.1	De tender wordt ontvangen door de afdeling Marketing & Sales (M&S).	4.1.1	The tender is received by the Marketing & Sales department (M&S).
4.1.2	De aanvraag wordt door de commerciële manager gecontroleerd op volledigheid aan de hand van de begeleidende brief.	4.1.2	The enquiry is checked by the commercial manager for completeness against the accompanying transmittal note.
4.1.3	Als de directie besluit aan te bieden, wordt de aanvraag verder behandeld en worden de projectmanager en het tender-team vastgesteld door de PUM.	4.1.3	If senior management decides to tender, the enquiry is further processed and the project manager and the tender team will be appointed by the PUM.

4.1.4 De aanvraag krijgt een uniek identificatienummer. Dit nummer wordt gegeven door de PMU-secretaresse. Zij schrijft de aanvraag ook in op de aanvragenlijst.

4.1.4 The enquiry is provided with a unique identification number. This number is given by the PMU secretary. She also registrates the tender on the tender list.

4.1.5 Als de aanvraag volledig is, wordt door de desbetreffende commerciële manager een bevestiging van ontvangst naar de afzender verzonden.

4.1.5 If found complete, an acknowledgement of receipt is returned to sender by the applicable commercial manager.

4.2. Tender plan

4.2. Tender plan

4.2.1 De commerciële manager stelt een tender plan op. Dit tender plan geeft minimaal aan:

- welke afdelingen deel hebben aan het tendering proces, wat van hen wordt verwacht en binnen hoeveel tijd zij moeten antwoorden;
- financiële/risico-aspecten;
- omschrijving van het werk.

Als kick-off van de tender worden de betrokken personen uit het tender-team waarin de commerciële manager de aanvraag bespreekt, de acties benoemt en een vergaderschema bepaalt.

4.2.1 The commercial manager prepares a tender plan. This tender plan specifies as a minimum:

- which departments need to participate in the tendering process, what is expected of them and the time frame within which they need to reply;
- financial/risk aspects;
- scope of work.

As kick-off for the tender, all involved persons from the tender team will be briefed by the commercial manager about the tender, the actions indicated and about a meeting schedule.

4.2.2 Voor "kleine" aanbiedingen dient minimaal een tender-informatieblad te worden ingevuld t.b.v. HFG juridische afdeling.

4.2.2 For "small" scope of tenders shall as a minimum a tender information sheet to be filled in for HFG legal department.

4.2.3 In overeenstemming met het tender-plan ontvangen alle betrokken partijen dat deel van de aanvraag benodigd voor hun bijdrage of ze worden geïnformeerd dat de aanbiedingsdocumenten ter inzage beschikbaar zijn in de project management unit.

4.2.3 In accordance with the tender plan all involved receive relevant parts of the enquiry for their input or they are informed that the enquiry documents are available for their review in the project management unit.

4.3.	<u>Tender beoordeling en evaluatie</u> De commerciële manager neemt actie op en stuurt de betreffende delen van een aanvraag door naar de volgende afdelingen om, wanneer van toepassing, op de volgende aspecten actie te nemen.	4.3.	<u>Tender review and evaluation</u> The commercial manager takes action and issues the relevant parts of the enquiry to various departments for action, when applicable, on the following aspects.
4.3.1	<u>Financiën & administratie</u> Controleren van en opgave van kosten voor betalingen, valuta, bankgaranties, retentie e.d.	4.3.1	<u>Finance & administration</u> Checking and providing costs relating to the payments, currency, bank guarantees, taxation, etc.
4.3.2	<u>Verzekeringen</u> Deze afdeling (Den Haag) controleert en geeft kosten door van de verzekeringsaspecten via de juridische afdeling.	4.3.2	<u>Insurances</u> This department (The Hague) checks and provides costs related to the insurance aspects through the legal department.
4.3.3	<u>Juridisch (HFG)</u> Controleert alle juridische consequenties van de aanbieding.	4.3.3	<u>Legal (HFG)</u> Checks all legal implications of the tender.
4.3.4	<u>Tender coördinator / cost engineer</u> Begroot de uren/kosten van het werk dat door Heerema Zwijndrecht wordt uitgevoerd.	4.3.4	<u>Tender coordinator / cost engineer</u> Estimates the enquiry package for all the work, which is performed by Heerema Zwijndrecht.
4.3.5	<u>Productie</u> Neemt initiatieven voor de te ontwikkelen bouwwijzen en de te volgen lasprocessen. Stelt een fabricageplanning op in overleg met de PMU-planner.	4.3.5	<u>Production</u> Take initiatives for the fabrication method development and the weld processes to be used. Prepares a fabrication planning together with the PMU planner.
4.3.6	<u>Research & development groep:</u> Toetst de haalbaarheid en eventuele alternatieven van voorstellen (studie) en bepaalt de benodigde voorzieningen.	4.3.6	<u>Research and development group:</u> studies the feasibility and eventual alternatives of proposals and determine the required provisions.

4.3.7 Project Management Unit

De commerciële manager zal met de tender coördinator en de discipline engineers de technische details van het project bestuderen en coördineert het opstellen van aanvragen voor de uitbestede disciplines (subcoördinator), voert evaluaties uit en stelt een advies op.

De inkoper verkrijgt van erkende leveranciers prijsopgave en opgave van levertijden aan de hand van de materiaal uittrekken (MTO's) en bestudeert deze op volledigheid en juistheid.

De technische evaluatie wordt door de discipline engineers verzorgd, die deze aan de inkoper aanleveren welke de volledige evaluatie afrond.

4.3.7 Project Management Unit

The commercial manager will together with the tender coordinator and the discipline engineers study the technical details and initiates enquiries on subcontracted disciplines, carries out evaluations and prepares an advise.

The buyer obtains quotations for prices and delivery against MTO's for materials and products from recognised suppliers and evaluates those on completeness and correctness.

The technical evaluation is handled by the discipline engineers and delivered to the buyer, who finalise the complete evaluation.

4.3.8 Kwaliteit, veiligheid en milieu

Controleert met de QC, indien van toepassing, de aanvullende kwaliteits-, veiligheids- en milieumaatregelen, benodigd om het werk te kunnen uitvoeren.

4.3.8 Quality, safety and environment

Checks with the QC, when applicable, the additional quality, safety and environment measures, required to carry out the works.

4.4. Prijs en kostenbegroting

4.4. Pricing and cost estimate

4.4.1 De tender coördinator moet de definitieve kostenbegroting opstellen. De begroting moet gebaseerd zijn op ontvangen gegevens van de afdelingen en uit te besteden activiteiten.

De begroting moet zijn opgebouwd volgens de unit structuur, d.w.z. kosten moeten te herleiden zijn naar de verschillende cost centers.

4.4.1 The tender coordinator shall prepare the final cost estimate. The estimate shall be based on all received information from the departments and subcontracted activities.

The estimate shall be structurised according the unit structure i.e. costs to be related to the several cost centres.

4.4.2	Een standaard prijs matrix schema moet worden opgesteld, dat manuren en kosten per discipline aangeeft.	4.4.2	A standard price matrix schedule shall be prepared showing quantities and manhours per discipline.
4.4.3	Het prijzenformaat, als vereist door de opdrachtgever, wordt samengesteld uit het standaard prijzen matrix schema.	4.4.3	The pricing format, as required by the client, shall be compiled from the standard price matrix schedule.
4.5.	Risico beoordeling Elke tender zal worden beoordeeld op aanwezig risico niveau. Afhankelijk van het aanwezige risico niveau zal een risico inventarisatie plaatsvinden.	4.5.	Risk assessment Every tender will be assessed on available risk levels. Depending on the available risk level a risk inventory will be performed.
4.6.	Goedkeuring en indienen	4.6.	Approval and submission
4.6.1	Verificatie De commerciële manager verzekert zich ervan dat het uiteindelijke aanbiedingspakket alle benodigde documenten bevat en in overeenstemming is met de eisen. De PUM verzekert zich ervan dat de tender van de juiste kwaliteit is.	4.6.1	Verification The commercial manager verifies whether the final tender package contains all required documents and is in accordance with the requirements. The PUM will ensure that the tender is of the applicable quality.
4.6.2	Tender-vergadering Een speciale tender vergadering zal worden gehouden met de directie, commercieel manager, tender coördinator en andere afdelingshoofden, als en wanneer benodigd. In deze vergadering worden alle aspecten doorgenomen, bediscussieerd en indien nodig worden aanpassingen uitgevoerd.	4.6.2	Tender meeting A special tender meeting will be held with senior management, commercial manager, tender coordinator and other heads of department, if and when required. In this meeting all aspects are reviewed, discussed and when required adjustments will be performed.

4.6.3	Goedkeuring In een definitieve tender vergadering keurt de directie de aanbieding goed tekent deze voordat deze wordt overhandigd aan de opdrachtgever. Aanbiedingen dienen verder ook goedgekeurd te worden door HFG zoals beschreven in PD 06.01.	4.6.3	Approval In a final tender meeting senior management approves the tender by signing prior to submission to the client. Tenders shall further also be approved by HFG as described in PD 06.01.
4.6.4	Overhandiging De commerciële manager draagt het aanbiedingspakket over aan de opdrachtgever.	4.6.4	Submission The commercial manager hands over the tender package to the client.
4.7.	Opvolging aanbieding Alle benodigde correspondentie, uitleg/ophelderingen en onderhandelingen dienen verder te worden behandeld door de commerciële manager in overleg met de tender coördinator en de verantwoordelijke afdelingsmanagers en directieleden.	4.7.	Follow-up tender All correspondence, clarifications and negotiations required shall be further handled by the commercial manager, consulting the tender coordinator and the responsible department managers and directors.
4.8.	Contractonderhandeling en opdracht	4.8.	Contract negotiations and award
4.8.1	Alle contractonderhandelingen dienen te worden gehouden met de commerciële manager, aangevuld met de benodigde en relevante unit/afdelingspersoneel.	4.8.1	All contract negotiations shall be held with the commercial manager, supported by the required and applicable unit/department personnel.
4.8.2	De juridische zaken dienen te worden besproken in het bijzijn van een afgevaardigde van de HFG juridische afdeling.	4.8.2	The legal affairs shall be discussed with the attendance of a representative of the HFG legal department.
4.8.3	In geval van een opdracht, dient de ondertekening te worden gedaan door de geautoriseerde personen (directie), zoals weergegeven in de autorisatie matrix.	4.8.3	In case of contract award, the signing shall be carried out by an authorised person (director) as indicated in the authorisation matrix.

4.9. "Kick-off"-vergaderingen

4.9.1 Zodra bekend is dat het contract is toegewezen, moet de projectmanager een vergadering bijeen roepen van alle vertegenwoordigers van de betrokken afdelingen en de projectgroep.

4.9.2 Het doel van de vergadering is het aangeven en bespreken van het bestek van het werk, waarbij belangrijke zaken met betrekking tot de productie, contractuele verplichtingen, enz., en de noodzaak tot het terugkoppelen van informatie zullen worden benadrukt.

4.9.3 Onderwerpen die besproken/toegelicht worden, zijn, hoewel niet beperkt tot:

- algemene zaken
- financieel/budget
- planning
- technisch/kwaliteit
- veiligheid/milieu
- onderaannemers
- informatie/rapportage
- overdracht documenten
- projectdoelstellingen.

4.9.4 Wanneer het nodig wordt geacht, kunnen de volgende specifieke "kick-off"-vergaderingen worden gehouden:

- kosten
- planning
- tekenwerk/inkoop
- informatiesystemen
- kwaliteit
- veiligheid, gezondheid en milieu.

4.9. Kick-off meetings

4.9.1 As soon as contract award has been assigned, the project manager shall call a meeting of all relevant department representatives and the project team.

4.9.2 The object of the meeting is to advise and discuss the scope of work of the contract, highlighting any important points with regard to fabrication, contract obligations, etc., and the necessity for feedback on information.

4.9.3 Subjects to be discussed/explained will be, but are not limited to:

- general issues
- financial/budget
- planning
- technical/quality
- safety/environment
- subcontractors
- information/reporting
- transfer documents
- project objectives.

4.9.4 If required, the following specific kick-off meetings can be arranged:

- costing
- planning
- engineering/procurement
- information systems
- quality
- safety, health and environment.

4.10. Contractbeoordeling

4.10.1 Het contract, en eventuele wijzigingen, wordt in eerste instantie beoordeeld in de aanbiedingsfase.

4.10.2 Wanneer het als contract wordt toegekend, zal de projectmanager alle van toepassing zijnde contractdocumenten distribueren naar de desbetreffende afdelingen.

4.10.3 De projecteisen worden verder aangegeven in het Project Management Plan en Project Specifieke Procedures zodat:

- alle eisen ondubbelzinnig en op de juiste wijze zijn gedefinieerd en op schrift zijn gesteld;
- een oplossing is gevonden voor elke eis die afwijkt van die in de aanbieding;
- alle eisen zoals vermeld, kunnen worden nagekomen.

4.10.4 De projectmanager dient een registratie bij te houden welke documenten naar wat voor afdelingen zijn verstuurd, met het eventueel ontvangen commentaar.

4.10.5 De projectmanager dient in samenwerking met de tender manager en cost engineer het budget vast te stellen/te verdelen volgens een bestaand kostencoderings-systeem.

4.10. Contract review

4.10.1 In first instance the contract review is carried out during the tender evaluation.

4.10.2 When there is a contract awarded the project manager shall distribute all relevant contract documents to the applicable departments.

4.10.3 The project requirements shall be further indicated in the Project Management Plan and Project Specific Procedures to ensure that:

- all requirements are correctly understood, defined and documented;
- a solution will be found for requirements which differ from those in the tender documents;
- all defined requirements can be adhered to.

4.10.4 The project manager shall maintain a registration which documents are reviewed by which departments with any received comments.

4.10.5 The project manager shall in co-operation with the tender manager and cost engineer determine/breakdown the budget according the existing account coding system.

Nederlands		English	
5.0.	Verwijzingen	5.0.	References
5.1.	QAD's	5.1.	QAD's
	75.03 Autorisaties		75.03 Authorisations
	76.01 Marketing en verkoop		76.01 Marketing and Sales
	77.01 Project Management Unit		77.01 Project Management Unit
	77.03 Projectorganisatie en –beheer		77.03 Project organisation and control
	77.04 Ontwerp en uitwerking		77.04 Design & Engineering
	77.05 Inkoop		77.05 Procurement
	77.06 Uitbesteding		77.06 Subcontracting
	77.07 Innovatie		77.07 Innovation
	77.10 Document controle		77.10 Document control
	77.11 Project risicomanagement		77.11 Project risk management
5.2.	Standaardformulieren Tender informatieblad.	5.2.	Standard forms Tender information sheet.
5.3.	Andere HFG beleidsdocumenten	5.3.	Others HFG policy documents
	PD.01.03 Authorisation levels		PD.01.03 Authorisation levels
	PD.02.01 Business Ethics		PD.02.01 Business Ethics
	PD.02.02 Code of conduct		PD.02.02 Code of conduct
	PD.02.03 Global competition compliance policy		PD.02.03 Global competition compliance policy
	PD.02.11 Risk management		PD.02.11 Risk management
	PD.05.03 Insurances		PD.05.03 Insurances
	PD.05.05 Bank policy		PD.05.05 Bank policy
	PD.06.01 Bidding and contracting directory		PD.06.01 Bidding and Contracting directory
	PD.06.02 Bidding and contracting philosophy		PD.06.02 Bidding and contracting philosophy
	PD.06.03 Legal policy		PD.06.03 Legal policy
6.0.	Aanhangsels	6.0.	Exhibits
6.1.	Tender proces verantwoordelijkheden matrix.	6.1.	Tender process responsibilities matrix.
6.2.	Tender organogram	6.2.	Tender organisation

6.1. Tender proces verantwoordelijkheden matrix.

6.1. Tender process responsibilities matrix.

Tender proces / Verantwoordelijkheden 22-Jul-2003 13:35

	Commercieel	PMU								Other Departments	
	CM	PUM	TC	CE	Eng	QC	Buyer / Subc	Secr	P&S Mgr	Legal	Production Units
Pre-qualificatie											
Pre-qualificatie ontvangen	R										
Evaluatie of we indienen	R										
Bevestiging indienen vd pre-qual	R										
Pre-qual managen	R										
Pre-qual data verzamelen	R										
Pre-qual document maken	R										
Pre-qual indienen	R										
File pre-quals	R										
Tender											
Algemeen											
Controle op proces, volledigheid & juistheid		R									
Controle kwaliteit tender (diepgang, risico beheersing, ..)		R									
Strategie met begroten (uren uittrekken / kengetallen hoger niveau, aanvragen subcons, externe resources, ...)		R									
Definitie van de Resources for the Tender		R									
Tender ontvangen	R										
Bevestiging van ontvangst	R										
Evaluatie of we indienen	R										
Tender nummer aanmaken, mailbox, distributiematrix, vaultstructuur,...								R			
Tender team selecteren		R									
Tender documenten copieren en distribueren			R								
Legal documenten distribueren			R								
Tenderplan maken	R										
Tenderplan bespreken / kick-of	R										
Tenderproces managen	R										
Tender strategie bepalen	CM + Dir										
Voortgangs vergaderingen	R										
Controle voortgang (alle aspecten , technisch, eigen disciplines, aanvragen, bock, risico mgmnt, ..)	R										

6.1. Tender proces verantwoordelijkheden matrix (vervolg).

6.1. Tender process responsibilities matrix (cont'd).

Tendercorrespondentie in Project wise								R			
Correspondentie naar klant & partner	R										
Correspondentie naar third parties (eg Subcons)			R								
Costmatrix maken			R								
Costengineering own disciplines				R							
Costcollection third parties			R								
Tenderboek coordineren			R								
Tenderboek typen								R			
Qualifications	R										
Legal										R	
Technical - Engineering					R						
Technical - Fabrication											R
Quality - Specifications						R					
Subcon's / Vendors							R				
Commercial	R										
Technische support					R						
Productie details					(R)						R
Shop layouts											R
Fabricage methode					(R)						R
P & S -									R		
enquiry info scope - technisch					R						
enquiry legal - commercieel							R				
keuze aan te vragen partijen									R		
enquiry uitsturen							R				
evaluatie technisch					R						
evaluatie commercieel (volledigheid & prijsstelling)							R				
evaluatie naar tender coordinator							R				
Risico Evaluatie											
Proces (volledigheid, kwaliteit)		R									
Risico Overleg / Matrix			R								
Bespreken Costmatrix & Risicomatrix	R										
Proces		R									
Costmatrix			R								
Aanbieding (boek, prijs, ...)	R										
Tender negotiations											
Clarification meetings	R		(R)								
Project award / Handover to Projectteam											
Handover	R										
Handover proces (volledigheid)		R									

6.2. Tender organogram

6.2. Tender organisation