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MODELLING THE COMPETITIVENESS STRATEGIES OF CONTRACTORS IN PALESTINE

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ABSTRACT

Contractor competitiveness strategies are one of the most important factors that contribute to the success of Construction Company. This research is to develop a model to enable contractors to measure the company competitiveness strategies. Factors that affect contractor competiveness strategies were evaluated through structured questionnaire. Nine groups of factors that affect contractor competitiveness strategies were developed. Relative Importance Index (RII) was used to identify the most important factors. The most 25 important factors (MIFs) that contribute to the company competitiveness were identified. The MIFs were modelled using multiple regressions. Factor Analysis technique was used followed by measuring the correlation and multiple regression analysis. The model that has the highest R^2, which represents the best values, was selected. The model was successfully able to measure the company's competitiveness in the Gaza Strip.

Keywords: Contractor Competitiveness, Most Important Factors, Model, Gaza Strip

INTRODUCTION

Construction industry has a great importance in developing countries. It affects and interrelates with industrial, commercial and services activities. Its importance makes it one of the principle economical motors. The construction industry in Palestine is considered one of the main sectors that contribute strongly to the Palestinian economy. In year 2007, for example, the sector contributed about 11.6 % to the Palestinian labour forces in the West Bank and Gaza Strip (PASSIA, 2008).

Flanagan, et al. (2007) defined company competitiveness as the ability to design, produce, and (or) market products superior to those offered by competitors, considering the price and non price qualities. Competitiveness can be understood as the ability of companies,

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industries, regions, and nations to generate while remaining exposed to international competition, relatively high factor income and employment on a sustainable basis. The subject of contractor's competitiveness has been attracting research interests from many scholars (Shen and Liu, 2003).

Typical competition strategies in construction practice is to identify factors affecting the choice of individual strategies, which are tender price, tightness of master programme, financial conditions, contract type, payment terms, managerial ability. These are factors which provide guidance for contractors in identifying better competition strategies by considering their own strengths. Contractors should consider the advantages embodied in different types of competition strategies to improve the possibility of winning in a competition (Tan et al., 2008).

The clear relationship between bidding decisions and the competitiveness strategies was addressed by many researchers. To cover the concept, this study investigated both areas in parallel. Contracting project is the norm in a wide range of business activities. A significant amount of engineering construction work is let through competitive bidding (Drew et al., 2001).

Direct competition through bidding is the most common method of job distribution in construction industry. Contractors need to make strategic decisions in respect of: (i) Whether or not to bid for a job; (ii) Determination of bid price if contractors opt to bid (Oo et al., 2007).

With limited time for response to different bidding opportunities, contractors need to strive for projects that put them at an advantage in terms of pricing efficiency. The study focuses on the bidders' competitiveness strategies during the procurement stage in the project life cycle. The factors affecting bidders' competitiveness in Gaza Strip were investigated.

Studying the relationship between bidders' ethical behaviours and the competitiveness strategies is one of most important position to be studied. Under several circumstances, there are high levels of participation, but weak competitiveness among two or three bidders only. Such case will reflect unhealthy bidding practice. Collusion; cover prices, weak competitiveness strategies, is considered in a highly important position to be studied.

The aim is to improve competitiveness strategies in construction projects through evaluating contractor's perspective regarding the most important factors that affect the competitiveness and propose best fit model for measuring competitiveness strategies of contractors.

CONTRACTOR COMPETITIVENESS FACTORS

The competitiveness of a contractor is determined by large number of factors. It is difficult to satisfy all factors at the same time as management practices always have to face limited resources such as money, manpower, time, and management efforts. Therefore, identifying a list of the most important factors is valuable for helping contractors to be more focused in order to develop their competitiveness and work with limited resources at the same time (Lu et al., 2008).

With the development of multi-criteria selection in competitive bidding practices, some researchers (e.g. Flanagan et al., 2007; Drew and Skitmore, 1993, 1997; Fu et al., 2003)

adopted the concept of competitiveness to represent a contractor's overall capacity to compete for a project.

They contend that competitiveness is a more informative concept to synthesize various ideas arising from the competitive bidding (Drew and Skitmore, 1993).

Tan et al. (2008); Chan and Au (2009); classified contractors competitiveness into: Employer selection, Tenderer's cost planning, Project conditions, Contractual mechanism, Tenderer's external relationship, Tenderer's internal strength, Competitors' situation, Project characteristics, Employer characteristics, Contractor related issues, Contract documentation/administration, Bidding, Economic and social situation. Functional department, Risk-management, Quality management, Strategic awareness and perspective, Site management, and Contract type.

RELATIONSHIP BETWEEN BIDDING DECISION AND COMPETITIVENESS STRATEGIES

There is a strongly relationship between bidding decision and competiveness'. Bid decisions are heuristic in nature as they are made on the basis of experience, judgment, and perception (Ahmad and Minkarah, 1988). From the comprehensive literature which were studied.

It was observed that, factors influencing bidding behaviour were grouped by Drew and Skitmore (1993) into: (1) The behaviour of contractors as a group (eg. market conditions, number and identity of competitors); (2) Individual contractor behaviour (eg. contractor size, work and tenders in hand, availability of staff); (3) Behaviour toward the characteristics of the contract (eg. type and size of construction work, client, location). The underlying factors affecting the bid/no bid decision and bid mark-up decision is essential before attempting to develop a realistic bidding strategy.

Lifson and Shaifer (1982) [cited in Dulaimi and Shaifer (2002)] argued that knowing the importance of the factors influencing the decision-making process would allow key and major decisions to be reviewed and discussed regularly.

TYPICAL COMPETITION STRATEGIES

Many research works have been done to investigate various competition strategies in the construction market. Tan et al., (2008), and Kumaraswamy and Walker (2000) classified competition strategies into five types which are:

LOWER BID STRATEGY

By adopting a lower bid strategy, the contractor will offer a much lower bidding price than other competitors in order to increase the chance of winning the contract. On the other hand, it should be noted that the adoption of this strategy is in sacrifice of the contractor's profit margin (Tan et al., 2008).

JOINT VENTURE STRATEGY

Adopting a joint venture strategy to compete in the construction market means that several contractors form a joint organization to tender for a contract. Since the construction projects are becoming more complex and risky, there is increasing demand for contractors with diverse strengths and weaknesses to form joint ventures to collectively bid for projects (Kumaraswamy and Walker, 2000).

Public Relations Strategy

Public relations are the practice of managing the communication between an organization and other stakeholders in the construction market. The public relations strategy is used to help contractors in communicating effectively and positively to the public, to clients and to consultants. The communication can be in different ways, such as by attending conferences, winning industry awards or establishing long-term cooperation with clients. The strategy will help improve the contractor's image, thus increasing the chances of winning in competitions in the market (Tan et al., 2008).

Risk Control Strategy

Risk control strategy in the completion is considered one of the means to assess and manage the risks related to a project. Contractors can demonstrate that they have the best skill in risk control if they adopt the proper strategy. Thus they can gain better credits from clients. The risk control strategy includes avoiding the risk, reducing the effects of the risk, transferring the risk to other parties, or accepting the consequences of a particular risk (Tan et al., 2008).

Claim Strategy

The claim strategy is used when an expectation is that there are potential changes in the design of a project, or there are uncertainties existing in the project which may lead to claims in the future. The adoption of this strategy depends on the characteristic of the project. For example, a small project with a detailed design is not appropriate for selecting this strategy, but a large complex project without a detailed design may be a good choice for implementing this strategy (Tan et al., 2008).

COMPETIVENESS MODEL IN CONSTRUCTION PROJECTS

Much of bidding research is concerned with modelling bidding behaviour by considering competitiveness relationships. Competitiveness strategies in bidding can be modelled by analyzing: (1) entire bid distributions; (2) competitiveness within bids; (3) competitiveness between bids for either a single or series of construction contracts (Drew and Skitmore, 2001). In developing this notion, Drew and Skitmore (1997) used regression analysis to

model competitiveness between bids of competing contractors. Shen et al. (1999) have developed an optimal bid model. The model is focuses on two major factors: price and time. In fact, there are many other factors affecting the contractor competition strategy, such as contract type and payment terms. The awareness of these factors will be essential for developing effective competition strategies in bidding for contractors operating in construction industry. Lowe and Parvar (2004) generated the factors' weights from historical data projects, which had been collected from a collaborating organization. Their study aimed to predict the bid/no bid decision by investigating the relationship between the factors affecting the bid/no bid decision and the decision made by the company.

Other three models were introduced and developed (Wanous et al., 2000; 2003). An artificial neural network (ANN) technique on the bid/no bid and the Neuro-fuzzy 'bid no/bid' model were tested on real life projects to generate weights of the factors considered. The third model (a parametric solution model) has used the weights of factors that were generated from a questionnaire survey among Syrian contractors. That research generated weights and rank order of the listed factors from results of quantitative analysis. Shen et al. (2004) identified the model adopted to award construction contracts on multi-criteria basis in China by taking into account both the contractor's competitiveness and the defined project objectives. This model presented a comprehensive list of competitiveness parameters.

RESEARCH METHODOLOGY

The studied population includes the contracting companies operating in the construction industry in the Gaza Strip. The contracting companies that have a valid registration in the Contractors Union were targeted. A quantitative approach is selected to understand the perception of contractors towards competitiveness strategies in constructions. A quantitative model was extracted from the data obtained from questionnaires which was used as mathematical tool to improve and enhance the management of bidders' competitiveness strategies in construction projects. The questionnaire was distributed to 120 contractors. It was designed based on numerous researchers such as, Lu et al. (2008); Tan et al. (2008); Tan et al., (2007); Shen et al. (2006); Dulaimi and Shan (2002); Chua and Li (2000); and Wanous et al. (2000).

Eighty eight valid questionnaire were received. The questionnaire was designed through a comprehensive literature search which was conducted to determine and explain some cornerstones that relate to the typical competition strategies, competitive advantage, bidders' competitiveness strategies, measuring competitiveness in bidding, groups of competiveness, and factors affecting competitiveness.

Factors affecting contractors competition strategy in construction projects, that was grouped into nine major groups which are: Project characteristics, Owner changes, Consultant factors, Contractor factors, Social and economic condition, Bidding situation, Contract documentation/administration factors, Tenderer's internal relationship, Tenderer's external relationship.

The survey results and the discussion output from contractor's perspectives and attitudes were presented. The results obtained are compared with the relevant literatures and the researcher comments.

To determine the relative ranking of the factors, these scores were transformed to importance indices based on the following formula:

Egemen and Mohamed (2007) Relative Importance Index (RII) = $\frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$

where W is the weighting given to each factor by the respondent, ranging from 1 to 5 (n_1 = Strongly disagree, n_2 = disagree, n_3 = neutral , n_4 = agree , n_5 = strongly agree). (A) is the highest weight and (N) is the total number of samples. The RII ranges from 0 to 1.

RESULTS

The position of respondents is shown in Table 1. About 42 % of respondents were owners of the company, 35 % were contractors project managers, 23 % were contractor site engineers, and 2% were others.

Experience of respondents shows that 27% from clients have experience between 1-5 years (Figure 1), 22 % have experience between 6-10 years. 17% have experience between 11-15 years, and 34% have experience more than 15 years.

Experience of the organization in constructions is illustrated in (Figure 2) 1% of the organizations have less than 3 years, 6 % have an experience between 3-5 years, 23% have an experience between 6-10 years, and 70% from the organizations have an experience more than 10 years. From above company's structures, most of companies have good experience, long stay in construction. This indicates that the results of the questionnaire are reliable enough to build the model.

Table 1. Company profiles

No	Description	Respondent characteristics	% of respondents
1	Position of respondent	Contractors	42
		Project manger	35
		Site engineer	23
		Others	2

From the literatures and the adopted pilot study, it was found that, the factors affecting contractor's competitiveness strategies can be categorized into nine groups. 20 Project characteristics, 13 Client characteristics, 6 Consultants characteristics, 30 Company's characteristics, 9 Social and economic condition factors, 20 Bidding situation factors, 13 Contract documentation/administration factors, 8 Tenderers internal relationship and 6 Factors related to tenderers external relationship were identified. 125 factors were ranked per each group by 88 contractors who responded to the questionnaire survey. Only top five factors are illustrated.

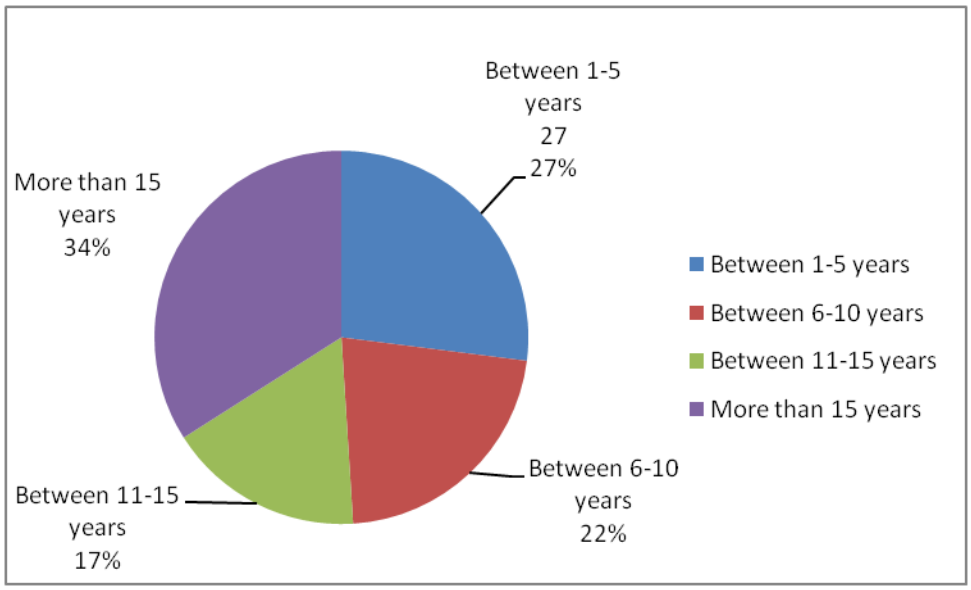

Figure 1. Experience of respondent.

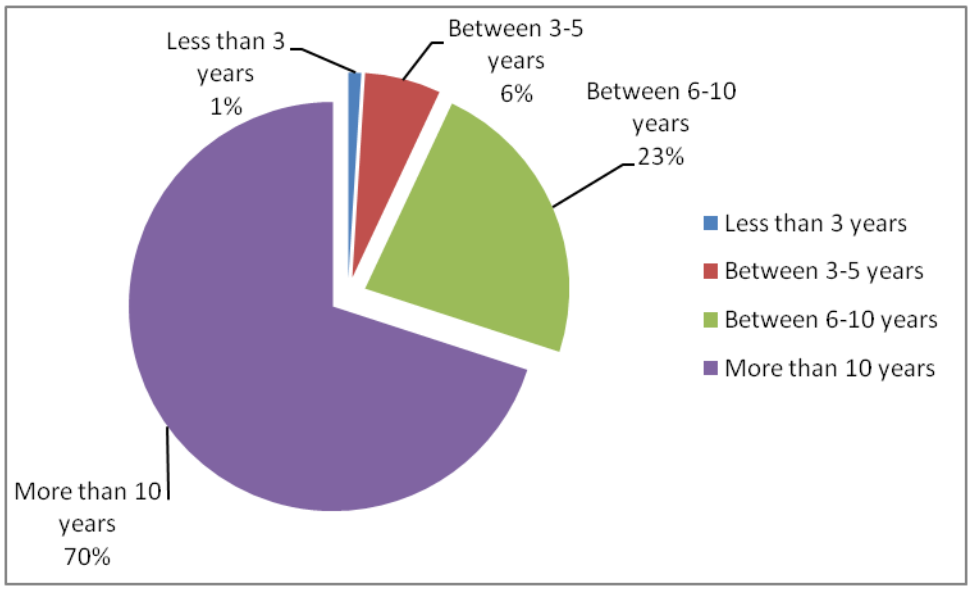

Figure 2. Experience of organizations in construction.

Project Characteristics Group

This group is shown in Table 2. “Project cash flow” was ranked in the first position with Relative Importance Index (RII) of (85.68 %). The obtained result is agreed with Chan et al. (2009) who found this factor in highest position. These results emphasized the importance of project cash flow at contractors' competitiveness strategies. Site clearance of obstructions was shown in the 2nd important position with RII of (82.05%). The results indicate that as the

construction site being clear without any obstacles, the contractor will have a strong willingness and tendency to reduce the risk margin which in turn supports his competitiveness strength.

The Project size was also observed as an important factor which was ranked in the 3rd position with RII of (80.68%). This factor was ranked in the 4th position with RII of (73.17%) by Wanous et al. (2000).

Table 2. Project characteristics

No	Project characteristics factors	Sum	Mean	Std. Deviation	RII %	Rank
1	Project cash flow	377	4.284	0.946	85.68	1
2	Site clearance of obstructions	361	4.102	0.947	82.05	2
3	Project size	355	4.034	0.964	80.68	3
4	Coordination difficulties	348	3.955	1.203	79.09	4
5	Project duration	346	3.932	0.907	78.64	5

Client Characteristics Group

Thirteen factors are listed in this group. Table 3 shows the top five. The financial capability of the client is ranked in the first position by the respondents as a critical factor affecting contractor's competitiveness strategies with RII of (92.05%). This result is compatible with El Karriri (2008) who found that 23.40% from the contractors returned the reasons for their highest participation and strong competition with certain clients to the strong technical, managerial and financial capabilities of those clients.

Table 3. Client characteristics

No	Client characteristics	Sum	Mean	Std. Deviation	%	Rank
1	Financial capability of the client	405	4.602	0.67	92.05	1
2	Employer’s reputation to honour payment on time	381	4.33	0.893	86.59	2
3	Size of owner firm	379	4.307	0.889	86.14	3
4	Relations with and reputation of the client	375	4.261	0.809	85.23	4
5	Coordination and administration skills of project team	340	3.864	0.886	77.27	5

The results shown in Table 3 illustrate also that the factor of Employer's reputation to honour payment on time was ranked in the 2nd position with RII of (86.59%). This result is very close to El Karriri (2008) who found this factor in the 1st position with RII of 93.1% as a critical factor affecting contractor's participation and competitiveness.

Consultants' Characteristics Group

Six factors are listed in this group. The Consultants' interpretation of the specification (Table 4) is ranked the first by the respondents as a critical factor with RII of (86.36%). This factor was added during the pilot study. Although it was not mentioned in the literatures, it is observed in this research as a very important factor affecting contractors' competitiveness strategies. Considering this factor in this top position could be returned to the fact that clear specifications and tender documents will absolutely lead to mitigate the risk level taken by contractors which in turn represent strength competitiveness tendency of bidders. Consultant Experiences was ranked in the 2nd position as an important factor affecting contractors' competitiveness strategy. This factor was rated with RII of (82.95%). Adding consultant experience to consultant interpretation of specification means that the strongest consultant will improve the chance to get new job.

Table 4. Consultant characteristics

No	Consultant characteristics	Sum	Mean	Std. Deviation	RII%	Rank
1	Consultants' interpretation of the specification	380	4.318	0.81	86.36	1
2	Consultant experience	365	4.148	0.965	82.95	2
3	Design quality	353	4.011	0.977	80.23	3
4	Character of consultant (e.g. Strictness)	345	3.92	0.874	78.41	4
5	Relationship with consultant	342	3.886	0.915	77.73	5

Company's Characteristics Group

Thirty (30) factors affecting contractors' competitiveness strategies are listed within company's characteristics group. The result revealed that (Table 5) Adequacy of resource about market price information was ranked in the 1st with RII of (91.36%). The results obtained from Lu et al. (2008) are very close to this result as they found the score mean of this factor as (4.2 out of 5) (RII around 85%). This result gives a high credit for updated data base for the relevant information which will help direct to increase the chance of winning tenders. Fluctuation in labour and materials price factor was ranked in the second with RII of (90.45%). This factor was found by Wanous et al. (2000) with a very weak RII (15%). The deviation between result may return to the fact that Palestine has not political and economical stability that other countries have. This instability creates a huge inflation and disturbance in the materials and workmanship prices. The Financial resources of the companies was observed as a critical factor affecting company's competitiveness strategy. It was ranked in

the 3rd position with RII (88.86), which was found very important by several researches such as [Tan et al., 2008 (RII 86%) and Lu et al., 2008 (RII 83.4%)].

Table 5. Company's characteristics

No	Company's characteristics	Sum	Mean	Std. Deviation	RII%	rank
1	Adequacy of resource market price information	402	4.568	0.603	91.36	1
2	Fluctuation in labour and materials price	398	4.523	0.742	90.45	2
3	Financial resources	391	4.443	0.725	88.86	3
4	Capability of gathering and processing information of new projects contracts	390	4.432	0.814	88.64	4
5	Past experience in similar project company strength in the industry	382	4.341	0.741	86.82	5

Social and Economic Condition Group

In Table 6, it is found that "risk of fluctuation in labour or material prices" was ranked in the 1st position with RII of (83.41%). Ling and Liu (2005) found that the score mean (Importance) of the risk of fluctuation in labour prices as (3.103 out of 5) and the risk of fluctuation in material prices as (3.724 out of 5) as an important factors affecting bidding decision.

Table 6. Social and economic condition

No	Social and economic condition	Sum	Mean	Std. Deviation	RII%	Rank
1	Risk of fluctuation in labour or material prices	367	4.17	0.887	83.41	1
2	Availability and quality of supervisory persons, quality of labour, materials and equipment	360	4.091	0.853	81.82	2
3	Risk involved in investment	335	3.807	0.92	76.14	3
4	Availability of work in the market	335	3.807	0.993	76.14	4
5	Employer's rate of return on the project	322	3.659	0.856	73.18	5

This research gives more importance to these factors than ling and Liu (2005). However, in general, these factors seem not critical. The "availability and quality of supervisory person's, labours, materials, and equipment" was ranked in the 2nd position with RII of

(81.82%). The result is close to Lu et al. (2008) who found that the availability of product and price information of labour, materials, plants, and other resources as an important factor affecting contractors' competitiveness strategy with a score mean of (4.2out of 5.0) (RII of 84.0%).

Bidding Situation Group

The results shown in Table 7 illustrate that "Present commitment of competitors" was ranked in the 1st position with RII of (92.95 %). This factor was found by Tan et al. (2008) within the key most important factors, as well with RII of (78.0%). Therefore, this factor is interconnected with the ethical behaviour of the bidders and their trends to bid and compete honestly and ethically. Such phenomenon pushes all contractors to set out a clear competition strategy as all the participants will compete in transparent manner. "Competitiveness of competitors" was ranked in the 2nd position by the respondents as being important factor with RII of (82.05%), also was shown by Ling and Liu (2005) and Tan et al. (2008) as an important and critical factor affecting bidder's competitiveness strategies with RII of (83.5 and 80.5%) respectively. It is very important to win a tender to consider who is compete you, what his seriousness and his current workload which may affect your decision to bid.

Table 7. Bidding situation

No	Bidding situation	Sum	Mean	Std. Deviation	RII%	rank
1	Present commitment of competitors	409	4.648	7.795	92.95	1
2	Competitiveness of competitors	361	4.102	0.788	82.05	2
3	Projects available in the market	358	4.068	0.894	81.36	3
4	Availability of other projects in hand	343	3.898	0.91	77.95	4
5	Competence of the expected competitors	343	3.898	0.959	77.95	5

Contract Documentation/Administration Group

The results shown in Table 8 illustrate that, "Specifications of contract conditions" was ranked in the 1st position with RII of (97.77%). This factor was recorded by Chan and Au (2009) who explained that small contractors may try to maintain their competitiveness by keeping their tender prices low as the contract specifications are clearly understood. El Karriri (2008) found that Clarity of the contract clauses is considered critical factor affecting contractors bidding strategy. This factor was ranked in the 3rd position with RII of (82.8%). Such result illustrates the important and influence of this factor at companies trends and competition strategy. Insurance and bond requirement was ranked in the 2nd position with RII of (77.5%).

Table 8. Contract documentation

No	Contract documentation/administration factors	Sum	Mean	Std. Deviation	RII %	rank
1	Specifications of contract conditions	351	3.989	0.977	79.77	1
2	Insurance and bond requirement	341	3.875	0.907	77.5	2
3	Completeness of document	340	3.864	0.925	77.27	3
4	Type of contracts(lump sum, DandB)	335	3.807	0.969	76.14	4
5	Design quality	335	3.807	0.945	76.14	5

Tenderers Internal Relationship Group

Table 9 illustrate that "Financial conditions of the tenderers who participated in project" was ranked in the 1st position with RII of (87.05%). This factor was found within the KMIF affecting contractor's competition strategy by Tan et al. (2008) in the 3rd position with RII of (86.0%). "Relevant work experiences of the competitors" was ranked in the 2nd position with RII of (84.77%). This factor was found also within the KMIF affecting contractor's competition strategy by Tan et al. (2008) with a RII of (80.0%).

Table 9. Tenderers internal relationship

No	Tenderers internal relationship	Sum	Mean	Std. Deviation	RII%	Rank
1	Financial conditions	383	4.352	0.898	87.05	1
2	Relevant work experiences	373	4.239	0.727	84.77	2
3	Availability of qualified human resources	361	4.102	0.935	82.05	3
4	Managerial ability	354	4.023	0.897	80.45	4
5	Present job commitment	335	3.807	1.153	76.14	5

Tenderers External Relationship Group

Table 10 shows that the "Relationship between the contractors and the Resident supervision staff (client and or consultant)" was ranked 1t ranked position and RII of (80.91%). This factor was found within KMIF by Tan et al. (2008) with RII of (78.0%) and by Lu et al. (2008) with RII of (74%). The relationship between "Plants providers and the competitors" plays an important role in the company's trends and competitiveness strategies. This factor was ranked in the 2nd position with RII of (80%). It is believed that such factor could be more important than the first factor as the relationship with the plants providers is

considered kid of vertical integrations which means decrease the chain management entities in bringing materials and equipment to the projects.

Table 10. Tenderers external relationship

No	Tenderers external relationship	Sum	Mean	Std. Deviation	RII%	Rank
1	Resident supervision staff (client and or consultant)	356	4.045	0.993	80.91	1
2	Plants providers	352	4	0.947	80	2
3	Employer's personnel	334	3.795	1.008	75.91	3
4	Consultants	332	3.773	0.979	75.45	4
5	Insurance company	288	3.273	1.152	65.45	5

Importance of Groups

This part discusses the RII of the main groups of the contractor competitiveness strategy. The results shown in Table 11 illustrated that Consultant Characteristics group was ranked in the 1st position among the nine groups of factors affecting contractors competitiveness strategy with RII of (79.70%). This gives very high importance to the consultant role. This is gained from previous practices with specific consultants. The behaviour and attitude of consultants affect significantly the decision for bidding. The "Company's characteristics group" was ranked in the 2nd position with RII of (79.54%). "Social and economic condition group" was shown in the last position with RII (75.62%). The observable issue is that RII of all the nine groups is below 80%. From this result we can conclude that this concept is critical and need to be highlighted and illustrated to the contractors who participated in the construction projects by increasing their awareness and attention to the competitiveness strategies and aspects that should be applied. Moreover, these results raise a fag sign that give an alarm that the majority of contractors did not have a clear or comprehensive understanding about the competitiveness strategies although their trust the importance of these factors at the competitiveness strategies.

Ranking of Most Important Factors

The first step in developing the model of this research is the analysis and ranking the nominated factors based on the Relative Importance Index (RII). If two or more factors have the same RII, the one with the lowest standard deviation would be assigned the highest importance ranking among these factors. The factor with RII exceeding or equal to 82.00 was recognized as MIFs based on the consensus of the respondents to be used in factor analysis. Twenty five factors were identified as Most Important Factors affecting contractor's competitiveness strategies in construction projects. Table 12 shows the ranking of these factors according to the value of their means, standard deviation and importance index.

Table 11. Ranks of groups

Groups of Factors	# of Factors	Sum	Mean	Std. Deviation	RII %	Rank
Consultant characteristics	6	2104	23.909	4.081	79.70	1
Company's characteristics	30	10499	119.307	15.125	79.54	2
Tenderers internal relationship	8	2785	31.648	6.036	79.12	3
Client characteristics	13	4328	49.182	7.892	75.66	4
Bidding situation	20	6533	74.239	14.523	74.24	5
Tenderers external relationship	6	1946	22.114	4.385	73.71	6
Project characteristics	20	6413	72.875	11.600	72.88	7
Contract documentation/administration	13	4133	46.966	8.944	72.26	8
Social and economic condition	9	2849	32.375	5.734	71.94	9
Total	125	41590	472.614	60.645	75.62	

Factor Analysis

The factor analysis is used therefore to explore the underlying constructs of the identified most important factors that affecting contractor's competitiveness strategies in construction projects. 25 identified MIFs were subjected to factor analysis using principal components analysis and Varimax rotation. Principal components analysis is commonly used in factor analysis, and involves generating linear combinations of variables through factor analysis so that they explain as much of the variance present in the collected data as possible. The first stage of the factor analysis is to determine the strength of the relationship among the variables, i.e., the 25 identified MIFs, measured by the correlation coefficients of each pairs of the variables. The twenty five variables identified that affecting contractors' competitiveness strategy were rated by the respondents, and their ratings were evaluated through factor analysis. The correlation matrix showed that all the variables have a significant correlation at the 5% level.

Factor Extraction

The factors are extracted based on the fundamental theorem of factor analysis which says that every observed value can be written as a linear combination of hypothetical factors. The base of factors is chosen in a way that the base vector is an element which is most responsible for occurring variances.

Table 12. Most important factors that affecting contractor's competitiveness strategies

No	Most Important Sub-Factors (MIFs)	Mean	Std. Deviation	I.I	Rank
1	Present commitment of competitors (MIF1)	4.648	7.795	92.95	1
2	Financial capability of the client (MIF2)	4.602	0.670	92.05	2
3	Adequacy of resource market price information (MIF3)	4.568	0.603	91.36	3
4	Fluctuation in labour/material prices (MIF4)	4.523	0.742	90.45	4
5	Financial resources of the contractor (MIF5)	4.443	0.725	88.86	5
6	Capability of gathering and processing information of new projects (MIF6)	4.432	0.814	88.64	6
7	Financial conditions of the bidders (MIF7)	4.352	0.898	87.05	7
8	Past experience in similar project/company strength in the industry(MIF8)	4.341	0.741	86.82	8
9	Employer's reputation to honour payment on time (MIF9)	4.330	0.893	86.59	9
10	Consultants' interpretation of the specification (MIF10)	4.318	0.810	86.36	10
11	Size of owner firm (MIF11)	4.307	0.889	86.14	11
12	Project cash flow (MIF12)	4.284	0.946	85.68	12
13	Availability of qualified site management staff (MIF13)	4.261	0.780	85.23	13
14	Relations with and reputation of the client (MIF14)	4.261	0.809	85.23	14
15	Availability of skilled workers (MIF15)	4.261	0.903	85.23	15
16	Company's ability in required construction technique (MIF16)	4.250	0.699	85.00	16
17	Relevant work experiences (MIF17)	4.239	0.727	84.77	17
18	Organization culture and size (MIF18)	4.216	0.837	84.32	18
19	Availability of construction equipment owned by the contractor (MIF19)	4.193	0.945	83.86	19
20	Need for continuity in employment of key personnel (MIF20)	4.182	0.736	83.64	20
21	Risk of fluctuation in labour or material prices (MIF21)	4.170	0.887	83.41	21
22	Consultant experience (MIF22)	4.148	0.965	82.95	22
23	Competitiveness of competitors (MIF23)	4.102	0.788	82.05	23
24	Availability of qualified human resources (MIF24)	4.102	0.935	82.05	24
25	Site clearance from obstructions (MIF25)	4.102	0.947	82.05	25

The components are sorted according to their contribution to the variance. Statistical Package of Social Science (SPSS) has identified 25 linear components within the data. The eigen values associated with each factor represent the variance explained by that particular linear component and SPSS also displays the eigen value in terms of the percentage of variance explained (so, factor 1 explains 28.09% of total variance as shown in Table13). Table 15 shows the final statistics of the principal component analysis, and the clusters extracted account for 71.38% of the variance. The value for the discarded factors are ignored hence, the Table is blank after the eight factors with Eigen value less than 1.

Table 13. Eigen value for the 25 variables

No	Most Important Sub-Factors(MIF)	Eigen values	% of Variance	Cumulative %
1	Present commitment of competitors (MIF1)	7.022987	28.09195	28.09195
2	Financial capability of the client (MIF2)	2.472762	9.891048	37.98299
3	Adequacy of resource market price information (MIF3)	1.76199	7.047961	45.03096
4	Fluctuation in labour materials price (MIF4)	1.711244	6.844976	51.87593
5	Financial resources of the contractor(MIF5)	1.437567	5.750269	57.6262
6	Capability of gathering and processing information of new projects (MIF6)	1.248921	4.995684	62.62188
7	Financial conditions if the bidders (MIF7)	1.169793	4.679172	67.30106
8	Past experience in similar project company strength in the industry (MIF8)	1.020894	4.083574	71.38463
9	Employer's reputation to honour payment on time (MIF9)	0.893416	3.573663	74.95829
10	Consultants' interpretation of the specification (MIF10)	0.849081	3.396325	78.35462
11	Size of owner firm (MIF11)	0.766864	3.067455	81.42207
12	Project cash flow (MIF12)	0.676324	2.705297	84.12737
13	Availability of qualified site management staff (MIF13)	0.57496	2.299839	86.42721
14	Relations with and reputation of the client (MIF14)	0.522161	2.088646	88.51586
15	Availability of skilled workers (MIF15)	0.444392	1.777569	90.29342
16	Company's ability in required construction technique (MIF16)	0.399589	1.598357	91.89178
17	Relevant work experiences (MIF17)	0.375588	1.502351	93.39413
18	Organization culture and size (MIF18)	0.333737	1.334946	94.72908
19	Availability of construction equipment owned by the contractor (MIF19)	0.290617	1.162468	95.89155
20	Need for continuity in employment of key personnel and work force (MIF20)	0.251529	1.006117	96.89766
21	Risk of fluctuation in labour or material prices (MIF21)	0.218332	0.873329	97.77099
22	Consultant experience (MIF22)	0.190818	0.763272	98.53427
23	Competitiveness of competitors (MIF23)	0.164808	0.659232	99.1935
24	Availability of qualified human resources (MIF24)	0.103867	0.415467	99.60896
25	Site clearance of obstructions (MIF25)	0.097759	0.391036	100

Factor Rotation

Varimax rotation is the most commonly used method of orthogonal rotation. It maximizes the variance of factors across the variables, which produces a simpler solution. Factor loadings less than 0.4 have not been displayed because we asked for these loading to be suppressed. The variables are listed in the order of size of their factor loading because we asked for the output to be sorted by size. Table 14 shows the factor rotation between new clusters and all factor affection in competitiveness. It also shows the strength of correlation between new factor and their variables.

Interpretation of Clusters

In order to prevent confusion between the extracted factors which represent the relationships among the 25 MIFs and the same word used in previous sections (which indicates the attributes for the contractors' competitiveness strategies studied), it is necessary to rename the extracted group as a ‘‘cluster’’ in the interpretation of the results of the analysis based on an examination of the inherent relationships among the MIFs under each of the clusters, the eight extracted clusters can be reasonably interpreted as follows:

Cluster 1: Company influence; Cluster 2: Project and construction parties influence; Cluster 3: Financial influence; Cluster 4: Experience influence; Cluster 5: Management requirement; Cluster 6: Client influence; Cluster 7: Political situation influence; Cluster 8: Competitiveness influence.

Table 14. Cluster Matrix after Varimax Rotation

MIF	Clust.1	Clust.2	Clust.3	Clust.4	Clust.5	Clust.6	Clust.7	Clust.8
MIF5	0.783							
MIF13	0.415							
MIF15	0.822							
MIF19	0.557							
MIF20	0.535							
MIF1		-0.843						
MIF9		0.66						
MIF12		0.708						
MIF25		0.5						
MIF2			0.651					
MIF7			0.533					
MIF8			0.607					
MIF16			0.698					
MIF17				0.796				
MIF22				0.438				
MIF24				0.713				
MIF6					0.655			
MIF10					0.765			
MIF18					0.579			
MIF11						0.83		
MIF14						0.83		
MIF4							0.877	
MIF21							0.709	
MIF3								0.823

Cluster 1: Company Influence

Cluster 1 includes the issues of financial resources, availability of qualified site management staff, availability of skilled workers, availability of construction equipment and

material owned by the contractor, and Need for continuity in employment of key personnel and work force. All these five variables are associated with enhancing company internal circumstances and conditions. These factors are very close to each others as all of it contributes to be essential and interrelated factors to increase the competitiveness strategies of the companies.

Cluster 2: Project and Construction Parties Influence

Cluster 2 includes the issues of present commitment of competitors, employer's reputation to honour payment on time, project cash flow, and site clearance of obstructions. All these four variables are associated with measures that interconnected with project influence and characteristics. Although there are some mathematical correlations between these factors, the difficulty to unify these four factors is observed. The closeness naming of this group could be interrelated with project and construction parties influence.

Cluster 3: Financial Influence

Cluster 3 includes the issues of financial capability of the client, financial conditions, past experience in similar project, company strength in the industry, and company's ability in required construction technique. The past experience for similar projects may be explained as financial indicator as the contracting company able to predict their costs. All these four variables are associated with measures that may relate to the financial considerations and influences. These factors illustrate the importance of the financial factors in respect to its impact on the contractors' competitiveness strategies. The importance's of these results encourage all parties to investigate in details such factors during the practical cases.

Cluster 4: Experience Influence

Cluster 4 includes the issues of relevant work experiences, consultant experience, and availability of qualified human resources. All these three variables are associated with enhancing the experience of the parties operating in the projects. These factors could be named as experiences influence at contractors' competitiveness strategies.

Cluster 5: Management Requirement

Cluster 5 includes the issues of capability of gathering and processing information of new projects contracts, consultants' interpretation of the specification, and organization culture and size. All these three variables are associated with management requirement. These factors illustrate that the managerial skills and administrative capabilities play a crucial role in supporting the contractors' competitiveness strategies. These factors were named as management influence requirements.

Cluster 6: Client Influence

Cluster 6 includes the issues of size of owner firm and relations and reputation of the client. These two variables are associated directly with Client influence. This group was named as client influence at companies' competitiveness strategy.

Cluster 7: Political Situation Influence

Cluster 7 includes the issues of fluctuation in labour materials price, and risk of fluctuation in labour or material prices. These two variables are associated with measuring the impact of the political situation at the contractor's competitiveness strategies. These factors have relatively high correlation after the Varimax rotation with variables of (0.877 and 0.709). This illustrates the importance of such factors and the interrelation impact at the dependent variable that was studied.

Cluster 8: Competitiveness Influence

The last cluster is cluster 8 that includes the issues of adequacy of resource market price information, and competitiveness of competitors. These two variables are associated with measures that enhance of competitiveness' influence. The cluster was named competitiveness' influence.

Multiple Regression Analysis

Multiple regressions are a statistical technique that allows us to predict someone's score on one variable on the basis of their scores on several other variables. Regression analysis includes any techniques for modelling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables as shown in equ.1.

$$Y = a0 + a1Fi + a2\,Fii + a3\,Fiii \ldots a\,nFn \qquad \text{equ. 1}$$

where:

a0 ,a1,a2, …a n are predictor
Fi+ Fii + Fiii …Fn are critical factors (independents variable which are MIFs)
Y is dependent variable (competitive strategies)

More specifically, regression analysis helps us understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. Regression analysis is widely used for prediction and forecasting. This statistical technique is used when exploring linear relationships between the predictor and criterion variables.

The aim of this method is to define the most important factor that affecting on competitiveness strategies in the construction project through developing a model to predict the percentage of competitiveness in the construction projects. As shown in Table 14, the 25 critical success factor contribute on competitiveness's were utilized as independent variables to determine their usefulness for predicting changes in the dependent variable, which is competitiveness strategy. Stepwise multiple regression analysis was applied to determine the relationships between 25 factors affecting competitiveness strategies. A summary of the regression results can be seen in Table (15).

Table 15. Multiple regression analysis results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Significant
1	0.723	0.523	0.518	42.118	0.000*
2	0.789	0.623	0.614	37.675	0.000*
3	0.829	0.688	0.676	34.493	0.000*
4	0.856	0.733	0.720	32.111	0.000*
5	0.874	0.763	0.749	30.404	0.000*

P less than 0.05

a	Predictors: (Constant), Clust.4
b	Predictors: (Constant), Clust.4, Clust.1
c	Predictors: (Constant), Clust.4, Clust.1, Clust.2
d	Predictors: (Constant), Clust.4, Clust.1, Clust.2, Clust.6
e	Predictors: (Constant), Clust.4, Clust.1, Clust.2, Clust.6, Clust.3

Multiple Regressions - Selecting the Best Equation

When fitting a multiple linear regression model, a researcher was likely considering independent variables that are not important in predicting the dependent variable Y. In the analysis, a trial made to eliminate these variables from the final equation. The objective in trying to find the best equation was to find the simplest model that adequately fits the data. This was not necessarily the model that explains the most variance in the dependent variable Y (the equation with the highest value of R^2). This is the equation with all of the independent variables. Our objective is to find the equation with the least number of variables that still explain a percentage of variance in the dependent variable that is comparable to the percentage explained with all the variables in the equation.

Table 15 shows five models, which include different factors. To choose the appropriate model, the different meaning between R, $R^{2,}$ and R adjusted should be discussed. R is a measure of the correlation between the observed value and the predicted value of the criterion variable. R Square (R^2) is the square of this measure of correlation and indicates the proportion of the variance in the criterion variable which is accounted for by the proposed model. This is a measure of how good a prediction of the criterion variable which was made by knowing the predictor variables. However, R square tends to somewhat over-estimate the

success of the model when applied to the real world, so an Adjusted R Square value is calculated which takes into account the number of variables in the model and the number of observations (participants) the model is based on. This Adjusted R Square value gives the most useful measure of the success of our model. For example model five we have an Adjusted R Square value of 0.749 hence, can say that our model has accounted for 74.9% of the variance in the criterion variable.

To choose the appropriate model, the value of R^2 is used as a guide. R^2 is the percent of variance in the independent variables to variance of the dependent variable. The value of R^2 equal 0.763 will be taken as indication of the appropriate model. This means that any change in the independent variables represent 76.3% of change in the dependent variable. Other values of R^2 could be used for choosing other models, but the value of R^2 equal 0.763 is sufficient to represent the most factors affecting in competitiveness' strategies. Model number 5 is chosen as the appropriate model with the highest R^2 equal 0.763.

Competitiveness model = (-12.704 +12.351 C4+5.221C1+2.654C2+
+ 8.331C6 +5.824C3)*(100/159.201) Equ. 2

where:

C4, C1, C2, C6, C3 are average weighted scores resulted from collecting the ranking scores of the factors explained as the following:

C4: Average weighted scores (AWS) of factors in cluster 4 which are MIF17, MIF22, MIF24.

C1: AWS of factors included in cluster 1 which are MIF5, MIF13, MIF15, MIF19, MIF20.

C2: AWS of factors included in cluster 2 which are MIF1, MIF9, MIF12, MIF25.

C6: AWS of factors included in cluster 6 which are MIF11, MIF14.

C3: AWS of factors included in cluster 3 which are MIF2, MIF7, MIF8, MIF16.

159.201= the summation of the formula if each factor has the maximum score, which is 5.

100 = the expected result of major factors contribute in competitiveness' strategy in construction projects in the Gaza Strip.

MODEL APPLICATION

Two forms were used to apply the model. In the first form, the project manager is asked to rank the degree of their agreement of attributes of these factors on competitiveness strategy. The second form was developed in Excel Sheet to calculate average weighted scores for each cluster.

Model Verification and Validation

Model verification and validation (V&V) are essential parts of the model development process if models to be accepted and used to support decision making. Validation ensures that

the model meets its intended requirements in terms of the methods employed and the results obtained (Macal, 2005).

Two cases were taken to evaluate the model verifications and to measure its accuracy and strength in forecasting and evaluating competitiveness strategies of the companies. The first three lowest contractors participated in Islamic Relief project and United Nations Development Program (UNDP) projects were studied.

Case1: Rehabilitation and Maintenance for Damaged Schools in Gaza City

The following case shows the results of Model verification of the first three lowest companies participated in the Islamic Relief project. The cost estimate was $ 588,514.91 with project duration of 135 days. The 1st, 2nd and 3rd lowest bidders were asked to verify the competitiveness strategies (CS) for each and to investigate if the lowest bidder has actually the highest CS. According to Equ. 2, the results introduced in below shows that the company that has strong factors obtained the highest level of competitiveness strategies with a percentage of 86%.

Competitiveness = (-12.704 +12.351 C4+5.221C1+2.654C2+8.331C6 +
+5.824C3) * (100/159.201)
= (-12.704+12.351*5+5.221*3.8+2.654*4.5+8.331*3.5+5.824*4.5)*(100/159.201)
= 86%

While the companies that have lower level of these factors obtained less level of CS. The level of competitiveness strategies for the 2nd lowest bidder was 73% while it was 63% for the 3rd lowest bidder.

It is concluded that results obtained from the first case study indicated that the lowest bidder has the highest competitiveness strategies as he won the bid. The results were consistent also for the second and the third lowest bidder. The model was able to measure successfully the degree of competitiveness for the participated companies in the first case.

Case2: Constructing 48 Re-Housing Units in Khan Younis

The second case study was used to verify the model of CS was to construct 48 Re-housing units in Khan Younis. This project was constructed under UNDP supervision and funding.

Model verification was done by targeting the first three lowest companies participated in this UNDP project. The cost estimate for this project was $ 1,200,000 with project duration of 11month. The 1st lowest, 2nd and 3rd lowest bidders were asked to verify the strength of competitiveness strategy (CS) for each of them and to investigate if the lowest bidder has the actually the highest CS. The results shows that the company that found all these factors existing strongly during their project implementation has the highest level of competitiveness strategies with a percentage of 84%. While the companies that have lower level of existence of these factors obtained less level of CS. The level of competitiveness strategies for the 2nd lowest bidder was 67% while it was 50% for the 3rd lowest bidders. Clearly, the model was

able to measure successfully the degree of competitiveness for the participated companies in the second case. Although the model was successfully able to measure local practices cases in Gaza Strip, the model is based on the most important factors in regional area. Therefore, the model could be used in any developing country have the same construction industry themes.

CONCLUSION

The objectives of this research was to identify the most important factors affecting contractor's competitiveness strategies in construction projects. Furthermore, to evaluate contractor's perspective regarding the most important factors affecting the competitiveness strategies, and finally to propose a model for measuring competitiveness strategies of contractors.

Nine groups of factor that affect contractor's competitiveness were developed and evaluated to study their affect at company's competitiveness strategies in the construction projects. The nine groups included 25 MIFs which were used later to develop a competitiveness model. The most important factors are illustrated in Table 12.

Factor analysis technique was used followed by measuring the correlations and multiple regression analysis to develop the model. Five models were obtained; each one has its unique R^2. The model that has the highest R^2 was selected as it represents the best model which was 0.749. This model includes five clusters with 18 factors. The highest weight was shown in company characteristics group that has seven factors participated in the model development. Such results illustrate strongly that most concentrations and focus of the company internal issues is a challenge that enable the company to compete. The model was tested successfully in two occasions in measuring their chance of competition which enable future use by contractors for the developed model. The model is applicable in developing countries that have the same themes of construction industry.

REFERENCES

Ahmad, I., and Minkarah, I. (1988). Questionnaire survey on bidding in construction. *Journal of Management in Engineering, ASCE, 4(3),* pp. 229-243.

Chan, E, and Au, M. C. Y. (2009). Factors influencing building contractors' pricing for time-related risks in tenders. *Journal of Construction Engineering and Management, 135(3),* pp. 135-145.

Drew, D., and Skitmore, M. (1997). The effect of contract type and size on competitiveness in bidding. *Journal of Construction Engineering Management and Economics, 15(5),* pp 469-489.

Drew, D. S., and Skitmore, R. M. (1993). Prequalification and c-competitiveness. OMEGA, *International Journal of Management Science, 21(3),* pp. 363-375.

Drew, S., Skitmore, M., and Lo, H. P. (2001). The effect of client and type and size of construction work on a contractor's bidding strategy. *Journal of Building and Environment, 36(3)* pp. 393- 406.

Dulaimi, M. F. and Shan, H. G. (2002). The factors influencing bid mark-up decisions of large- and medium-size contractors in Singapore. *Journal of Construction Engineering Management and Economics, 20(7),* pp. 601 - 610.

Drew, D .S., Skitmore R. M., and Lo, H. P. (2001). The effect of client and type and size of construction work on a contractor's bidding strategy. *Journal of Building and Environment, (36) 3*, pp. 393- 406.

El-Karriri, A. (2008). Factors affecting bidder participate in the construction tenders. M.Sc. Thesis, Islamic University, Gaza.

Egemen, M. and Mohamed, A. (2007). A framework for contractors to reach strategically correct bid/no bid and mark-up size decisions. *Building and Environment, 42(3),* pp. 1373-1385.

Flanagan, R., Lu, W., Shen, L., and Jewell, C. (2007). Competitiveness in construction: a critical review of research. *Construction Management and Economics, 25 (9),* pp. 989 - 1000.

Lowe, D. J., and Parvar, J. (2004). A logistic regression approach to modelling the contractor's decision to bid. *Journal of Construction Management and Economics, 22(6),* pp. 643-653.

Lu, W.S., Shen, L.Y., and Yam, M.C. H. (2008). Critical success factors for competitiveness of contractors: China study. *Journal of Construction Engineering and Management, 134(12),* pp. 972-982.

Fu, W. K., Drew, D. S., and Lo, H. P. (2003). Competitiveness of experienced and inexperienced contractors in bidding. *ASCE, Journal of Construction Engineering and Management, 129(4),* pp. 388–395.

Kumaraswamy, M. M., and Walker, D. H. T. (2000). *Multiple performance criteria for evaluating construction contractors*. Procurement Systems – A Guide to Best Practice in Construction, London: E and F N Spon, pp.228–251.

Lu, W. S. (2006). A system for assessing and communicating contractors' competitiveness. Thesis submitted to the Degree of Doctor of Philosophy in the Department of Building and Real Estate, the Hong Kong Polytechnic University, Hong Kong.

Macal, C. M. (2005). Model verification and validation. Workshop on threat anticipation: Social science methods and models, The University of Chicago and Argonne National Laboratory April 7-9, Chicago.

Oo, B.L., Drew, D.S., and Lo, H.P. (2007). Applying a random coefficients logistic model to contractors' decision to bid. *Journal of Construction Engineering Management and Economics, 25(4),* pp. 387-398.

PASSIA (2008). The Palestinian Academic Society for the Study of International Affairs. Diary 2008 Calendar.

Shen, L.Y., Lu, W. S., and Yam, C.H.M. (2006). Contractor Key Competitiveness Indicators (KCIs): a China study. *Journal of Construction Engineering and Management (ASCE), 132(4),* pp. 416–424.

Shen, L.Y., Drew, D., and Zhang, Z.H.,(1999). Optimal bid model for price-time biparameter construction contracts. *Journal of Construction Engineering and Management, 125(3),* pp. 204-209.

Shen, Q and Liu, G. (2003). Critical Success Factors for Value Management Studies in Construction. *Journal of Construction Engineering and Management, 129(5),* pp. 485–491.

Shen, L.Y., Lu W. S., Shen Q. P., and Li H. (2003). A computer-aided decision support system for assessing a contractor's competitiveness. *Automation in Construction, 12*, pp. 577-587.

Shen, L.Y., and Tan, Y. T. (2004). Applying the fuzzy resources allocation (Fra) model by different contractors for different types of projects, in Wu et al. (eds) Proceedings of the CRIOCM 2004 International Symposium on Advancement of Construction Management and Real Estate, 30 (2) Nov, Hang Zhou, China, The Chinese Research Institute of Construction Management, pp. 212–223.

Tan, Y., Shen, L., Khalid, A. G., and Song, S. C., (2008). An examination of the factors affecting contractors' competition strategy: a Hong Kong study. *International Journal of Project Organization and Management, 1*, pp. 4-23.

Tan, Y., Shen, L., Yam, H. C. M., and Lo, A. (2007). Contractor Key Competitiveness Indicators (KCIs): a Hong Kong Study. *Surveying and Built Environment, 18(2),* pp. 33-46.

Wanous, M., Boussabaine, H. A., and Lewis, J. (2000). To bid or not to bid: a parametric solution. *Journal of Construction Management and Economics, (4),* pp. 457–66.

Wanous, M., Boussabaine, H. A., and Lewis, J. (2003). A neural network bid/no bid model: the case for contractors in Syria. *Journal of Construction Management and Economics, 21(7),* pp. 737-744.