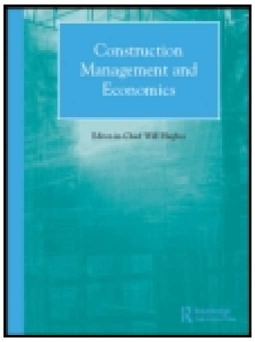

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Delays and cost increases in the construction of private residential projects in Kuwait

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Time-delays and cost-increases associated with the construction of private residential projects in the State of Kuwait are determined. A person-interview survey of 450 randomly selected private residential project owners and developers in 27 representative districts in metropolitan Kuwait formed the database for the study. The socio-economic traits of the owners/developers, and the pre-construction family planning, the design, and the construction phases of the sample projects are presented. Estimates of time-delays and cost-increases are made, and their causes identified. The three main causes of time-delays included changing orders, owners' financial constraints and owners' lack of experience in the construction business. Regarding cost overruns, the three main causes were identified as contractor-related problems, material-related problems and, again, owners' financial constraints. A number of recommendations end the paper. The minimization of time delays and cost overruns in private residential projects would require: the availability of adequate funds, allocation of sufficient time and money at the design phase, and selection of a competent consultant and a reliable contractor to carry out the work.

Keywords: Delay, cost increase, residential projects, Kuwait

Background

The construction of private residential projects in Kuwait, has grown at an accelerated pace since the Iraqi invasion of 1990–91. Fueled partly by the invasion-related destruction of infrastructures (including houses), and partly by the affluence and the availability of attractive government housing subsidy and loan programmes, the magnitude of private residential construction projects has overshadowed the development of other infrastructural facilities in the State in the last decade. In pre-invasion era, when the State's financial situation was flourishing, every Kuwaiti household head was eligible for a 400 sq m plot of land, and a long-term cash of KD 70 000 ($231 000), for the construction of his/her private residence. Today, an approximate waiting period of 12 years is needed to obtain such housing cash loan.

The growing boom in private residential construction activities has, in-turn, attracted the attention of a rapidly-growing number of small contractors – qualified and non-qualified alike. The lack and/or insufficiency in government rules, regulations and specifications on the qualifications of contractors (financial, technical, experience, etc.), has further paved the way and encouraged growth in the establishment of small contracting firms, most of which are unqualified and unfit for the job.

The combination of rapidly growing demand for the construction of private residences, owners' construction-inexperience, and the large pool of unqualified contracts, has resulted in numerous court cases dealing with conflicts between owners, material suppliers, and contractor in recent years (Hafez, 2001). However, in spite of the magnitude of the problem, a comprehensive analysis of factors associated with the construction of private residential problems in the State of Kuwait has not been performed. This research project was undertaken to narrow this informational gap.

The specific objectives of the study were to provide answers to the following questions:

(1) What problems are experienced during the construction of private residences in the State of Kuwait?
(2) What are the magnitudes of the time delays and cost increases associated with these problems?

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Review of literature

The construction of private housing projects, due mainly to their small size and scope, has not received sufficient attention from research professionals throughout the world. This research project, for example, represents the first such study in the State of Kuwait.

In general, time-delays and cost overruns (increases) are among the most common phenomena in the construction industry – from simple to complex projects. Morris and Hugh (1980) examined the records of more than 4000 construction projects and found that projects were rarely finished on time, or within the allocated budget. Tah *et al.* (1993), Assaf *et al.* (1995), Rad (1979) and Arditi *et al.* (1985), also observed that time and cost overruns were commonplace in the construction industry worldwide.

Several studies have also classified the main causes of delays as materials-related, labour-related, and equipment-related. A comprehensive grouping of the main causes of construction delays, however, was recommended by Hensey (1993). These included: materials, labour, equipment and financial factors. Also counted among the causes of postponements were improper planning, lack of control, subcontractor delays, poor co-ordination, inadequate supervision, improper construction methods, technical personnel shortages and poor communication.

The causes of construction delays in a developing economy have also been studied by Ogunlana *et al.* (1996). The study involved a survey of delays experienced in the construction of high-rise building projects in Bangkok, Thailand. It was found that resource supply problems were by far the most acute problems of the Thai construction industry. The results also supported the view that construction problems in developing economies could be classified into three major groups: inadequacy of resource supplies, client and consultant shortcomings, and contractor incompetence/inadequacy.

Aibinu and Jagboro (2002), in their study of the growing problem of construction delay in Nigeria, examined the effects of delays on the delivery of construction projects in the country. Utilizing a questionnaire survey of 61 construction projects, the authors identified, and assessed the impact of delays on the delivery of construction projects. Time and cost overruns were found to be frequent effects of delay. Acceleration of site activities coupled with improved clients' project management procedures and the inclusion of an appropriate contingency allowance in the precontract estimate were recommended as a means of minimizing the adverse effect of construction delays in Nigeria.

The construction duration for public housing projects in Hong Kong has been forecasted by Chan and Kumaraswamy (1999). The study database included 15 case studies of standard New Cruciform type housing blocks, collected from clients and contractors. Multiple Linear Regression statistics was utilized to analyse the data and formulate a construction duration model. The predictive ability of the developed model was also determined using an independent set of project information. The low level of the model's percentage error (less than $\pm 10\%$), in forecasting durations, confirmed that the model could be a reliable tool for predicting construction durations for public housing projects in Hong Kong.

Chan and Kumaraswamy (2002) also explored strategies used to compress construction durations of various types of building projects. The authors present the primary findings of three parallel investigations that sought out the critical contributors of faster construction procedures in Hong Kong. The paper finally recommends specific technological and managerial strategies for reducing construction durations.

A risk analysis procedure was developed by Stewart (2003), to predict economic risks due to changes in existing housing vulnerability to cyclone damage over time. The model was based on exposure of residential projects to cyclones in North Queensland, Australia. A cyclone damage risk-cost-benefit analysis was then used to assess the economic viability of strengthening existing houses. 'Zones of Economic Viability' were then established to determine the potential for cost-effective retrofitting of residential construction projects.

The application of an expert system for the estimating of costs of residential projects has also been investigated by Watson *et al.* (1992). The paper describes the implementation and objective-oriented architecture of the expert system. The main advantage of the artificial intelligence (AI) technology – reduction in the quantity of data requirements – is also discussed. The result of the model application provides strategic estimates of costs before plans have been drawn up. In addition, the model can use its knowledge to explain its conclusions, resulting in greater confidence in the AI system's results. Also presented in the paper are the model's implementation, specific features, its benefits, and the potential for further development.

In a study of the relationship between contractors and subcontractors in Saudi Arabia, (Al-Hammad, 1993), it was found that a number of factors significantly affected these relationships. Based on the result of a questionnaire survey of 16 general contractors and 17 subcontractors, the following conclusions were made. Delay in contract progress payment, lack of construction quality, errors and delays in shop drawings, and approval of sample materials were ranked highest as contractor-subcontractor interface problems. Ranking lowest among these factors were legal disputes, scheduling conflicts among subcontractors, geological problems and weather conditions.

As the review of literature above indicates, the construction of private dwellings has not received the attention it warrants from the international research community in general, and or from the rapidly developing housing market of the Persian Gulf nations, in particular. This research paper is attempting to address the issue in the State of Kuwait.

Method

Since this research represents the first study of owner-experienced problems during the construction of private residences in the State of Kuwait, no documented data on various aspects of the construction of private residences existed in the available literature. The study therefore had as its first task, the collection of data via a structured survey, the most common and effective method of obtaining non-available data (Krueckeberg and Silvers, 1974). In designing the survey questionnaire, a number of criteria were considered. These included the simplicity, clarity, and comprehensiveness of the questions, as well as the attractiveness of the format.

The questionnaire elicited information on the social traits of the owner, the pre-construction informal family planning, design, contracting, material selection and construction phases of the project. The developed questionnaire was pre-tested on a random sample of 30 individual owners of residential projects and was then modified to incorporate appropriate suggestions made by the pre-testing sample, prior to its distribution to sample population.

A total of 450 private housing projects were systematic-randomly selected from among projects located in 27 metropolitan districts. The sample districts were selected to represent the various geographical, land-use, population density and socio-economic distributions of households in Kuwait. A person-interview survey of owners of these sample residential projects by a trained Kuwaiti team consisting of one graduate and two senior civil engineering students provided the database for the analysis.

The selected sample dwellings however all shared a common characteristics: either had just been completed or were at the state of receiving the finishing touches (e.g. being painted). Only 7% of the selected residential projects had been occupied by owners for less than a month. Meeting this common characteristic in the selection of sampling dwellings had of course an adverse effect on the duration of data collection time period. Frequent unavailability of owners at the sample dwelling sites, required several site-trips in order to person-interview the sample owners. The main advantage of this common characteristic however was that, the selected sample dwellings were commenced and completed generally within the same timeframe, eliminating the need for updating various construction cost items to a common basis for comparison. Another important advantage was the fact that the owners of the sample residential projects had an accurate picture of cost overruns and time delays associated with the construction of their dwellings – adding to the reliability of the database.

Results

Mean traits

The mean traits of the sample residential projects are presented in Table 1. On average, a household head spent more than eight months planning prior to the start of the construction, and estimated a project time duration of nearly 9.5 months (standard deviation=3.6 months). However, the actual mean time duration for only the design phase of the sample projects was 3.4 (S=2.7) months, and that for the whole project was 18.2 months (S=7.4 months).

An average contractor had a manpower size of 30 persons, less than five of which were skilled, 17 were semi-skilled, and the remaining eight included the unskilled workers. The work experience of an average contractor was 14.1 years (Table 1).

An average private residence had a construction cost of KD 30 732 (US $101 415), and a land cost of KD 32 141 (US $106,065). The total project cost (which includes land cost, design cost, construction cost, material cost, financial cost – if any – and the cost of hiring and independent engineer to ensure construction quality, as was stated by the owner) for an average residence was KD 115 640 (US $381 612), and the total cost increase due to various factors was KD 1176 (US $3880), as also given in Table 1. The mean time increase was 1.1 month, ranging from zero to a maximum of two years.

The analysis of the mean traits of the sample residential projects, generally revealed a number of important points. First, the sample owners grossly underestimated the time required for the construction of their residential projects by nearly 100% (9.4 vs. 18.2 months). This estimate was made by owners at the pre-construction family-involved informal planning phase. Second, the average expenditure on the design of the project was only about 3% of the construction

Table 1 Mean traits of the study residential construction projects

Variable name	Descriptive statistics			
	Mean	Std dev.	Minimum	Maximum
Planning time (months)	8.3	8.0	1.0	48.0
Estimated project duration (months)	9.4	3.6	5.0	12.0
Design cost (KD)[a]	943.4	840.5	200.0	7500.0
Design duration (months)	3.4	2.7	1.0	14.0
Contractor size (persons)	30.1	29.0	3.0	120.0
Contractor experience (years)	14.1	6.4	4.0	30.0
Construction duration (months)	9.4	6.6	3.0	36.0
Construction cost (KD)	30733.0	25113.0	11000.0	355000.0
Material selection duration (months)	3.2	4.8	1.0	36.0
Material cost (KD)	50675.0	27342.0	7660.0	132700.0
Number of skilled labors	4.3	6.3	1.0	60.0
Number of semi-skilled labors	16.7	15.2	2.0	80.0
Design duration increase (months)	0.2	1.0	0.0	12.0
Design cost increase (KD)	14.8	237.5	100.0	5000.0
Construction duration increase (months)	0.84	2.8	1.0	24.0
Construction cost increase (KD)	1135.0	5597.0	200.0	80000.0
Material cost increase (KD)	26.2	361.7	0.0	7000.0
Land cost (KD)	32140.0	51809.0	2000.0	550000.0
Actual project duration (months)	18.2	7.4	6.0	36.0
Total project cost (KD)	115640.0	58440.1	12000.0	450000.0
Project time increase (months)	1.1	3.3	0.0	24.0
Project cost increase (KD)	1175.8	5665.6	30.0	80000.0

[a]KD 1=US $3.3

cost only, and not the total cost (including the cost of land if larger than the normal 400 sq m and/or in a choice location) of the residential project. Trying to save a little on the design cost may result in a significant loss at a later stage due to either incomplete drawings, design deficiencies and/or change orders, causing time-delays and cost increases. Third, the result of the analysis of the actual data (post-implementation) showed that the average time-delay and cost increase for the study projects were not excessively large – about 6% and 1% of project time duration and total cost, respectively. The owners' dissatisfaction with the construction of private residences in Kuwait may, therefore, be influenced by the psychological and irritation ('headache') factors associated with the implementation of various design, procurement and implementation phases of the project, and not solely a function of time-delay and/or cost increases.

Frequency analysis

The analysis of age and education of the sample residential project owners indicated that more than 88% of the owners were between 30 and 50 years in age – the working and productivity period of the life-cycle. Those less than 30 and more than 50 years in age, were less than 12% of the surveyed owners. More than 68% of the project owners had an institute or a higher education degree, and the remaining 32% had a high school or a secondary level diploma. In other word, more than 2/3 of the sample owners had higher than high school education.

A number of pre-planning related – variables (prior to the start of the actual contracting and construction) variables were also addressed in the person-interview questionnaire survey of the sample residential owners. As presented in Table 2, 74% of the sample residential project owners performed a preconstruction planning of their projects, for which, nearly 86% spent six months or less. However, approximately, 5% allocated more than one year on the pre-construction planning phase of their residential projects (Table 2).

The majority of the sample owners consulted with their wives, relatives and friends during the pre-planning phase. However, some *only* consulted their wife (19%), relatives (7%) or friends (9%). With regard to the estimation of project time duration, and considering the fact that an average residential project actually took more than 18 months to complete, the majority of the sample owners underestimated the time duration of their residences during the pre-planning phase (Table 2).

More than a third of the sample owners selected their design office based on friends' recommendations.

Table 2 Frequency distribution of pre-planning phase variables

Variable name	Frequency	%
Have you done a pre-construction planning study?		
No	117	26.0
Yes	333	74.0
Planning time duration (months)		
<=6	386	86.0
7–12	43	9.0
>12	21	5.0
Who did you consult?		
Wife	83	19.0
Relatives	33	7.0
Friends	41	9.0
Combination	293	65.0
Estimate of time duration at pre-planning stage		
>=6	113	25.0
=>7	337	75.0

Table 3 Frequency distribution of design phase variables

Variable name	Frequency	%
Design Office Selection :		
Reputation/quality	111	25.0
Reasonable price	122	27.0
Friends' recommendation	162	36.0
Combination	55	12.0
Design Cost (K.D.) :		
<=750	378.0	84.0
751–1250	49.0	11.0
>1250	23.0	5.0
Design Time Duration (Months) :		
1	105	23.0
2	120	27.0
3	68	15.0
>3	157	35.0
'Variation Orders' during the Design Phase :		
0	195	43.0
⩾1	210	47.0
Design Drawings Completeness :		
No	87	19.0
Partially	136	30.0
Yes	227	51.0

Nearly 27% and 25% chose the design based on either the reasonableness of its price or its reputation, respectively (Table 2).

The result of the data analysis also showed that, in general, the surveyed individuals spent a small amount on the design aspect of their new residences. For example, 84% spent only KD 750 (US $2450) or less; for 5%, the cost of the design was in excess of KD 1250 (US $4100).

The distribution of the time of the design phase also points to the inadequacy of this important variable. In nearly a quarter of the sample projects, the design phase took only one month to complete. For another 27%, this time was two months; for nearly 35%, time was longer than three months (Table 2).

The inadequacy of the design cost and design time-duration of the sample residences is clearly reflected in the number of sample projects in which 'variation orders' were issued (47%). Naturally, when enough time and/or money is not spent for the design of any infrastructural project, many changes will have to be made to remedy design deficiencies during the construction phase. As the data in Table 3 shows, in nearly half of the sample projects, the design drawings were found to be incomplete at a later stage.

The frequency distribution of contract-related variables showed that the majority of the sample heads (75%) had selected the 'skeleton' type for contracting their residential projects, meaning the contractor would only build the skeleton of the structure. The owner himself would then supervise the completion of the remaining work. The 'turnkey' type of contracting was the choice for another 13% of the surveyed owners, while the remaining 12% had chosen 'other' types of contract procedures with the contractors. More than 67% of the owners hired an engineer to supervise the construction of their residential projects.

The frequency analysis of the data also indicated that 64% of the owners had established penalties for any contract delay, 64% had not checked to see whether the contractor was insured and more than 81% failed to ensure that the contracting firm's labourers were covered by an insurance agency in case of a construction accident. The analysis of the data also showed that most of the contracting firms were rather small (work force size of 15 or less), and only 6% had more than 10 years of contracting experience.

More than 65% of the sample owners did not check the size of the contracting firm, prior to the signing of the contract. The majority, by far (86%), did not visit any previously- completed residential project by their contractor, and 69%, did not inquire about the firm's general performance level, before signing the contract.

The majority (65%) of the sample owners themselves assumed the responsibility for the delivery of materials. For 26% the contractors were responsible, and for the remaining 9% of the sample projects materials were delivered by either the supplier (3%) or a combination of all parties.

Nearly half of the sample owners spent only one month on the selection of construction materials for their residential projects. The remaining half allocated a longer time period – 15% spent two months; 14%, three months; 15% took between four and eight months; and the remaining 7% allocated more than eight months – for choosing the necessary materials for the construction of their residential projects.

In most of the sample residences (85%), both local and imported building fitting and finishing materials were utilized in their construction. The remaining projects, however, made use of either local (11%) or imported fitting and finishing materials (4%).

An analysis of the distribution of cost and time expenditures of the design phase of the sample residential projects indicated that in nearly 84% of the sample projects the design phase was successfully completed within the agreed monetary budget. The reasons for the incompletion of the remaining 16% included 'change orders' (25%), design deficiencies (8%), owner's inexperience (4%) and a combination of the above factors in the remaining 63% of the surveyed projects. The amount of cost increase due to design deficiencies was KD 250 (US $850) or less for 50% of the projects, and more than KD 250, for the remaining 50%.

Similarly, one fifth of the sample residential projects experienced time-delays due to design deficiencies. The amount of time-delay varied from three months or less for nearly three quarters of the projects, and more than three months for the remaining projects.

A significant percentage of the sample residential projects (33%) required additional (over the contracted amount) construction budgets to complete. The construction cost increase for 37% of the sample projects was KD 3000 (US $9900), while 28%, needed more than KD 15 000 (US $49 500) of additional capitals to be completed. Material delivery problems (37%), variation orders (9%) and combination of factors (42%) were the top three reasons for the increases in the construction cost of the surveyed residential projects.

The construction of more than 56% of the sample residences did not complete on the scheduled (contracted) time. Nearly 54% experienced a time-delay of four months or more, and approximately, a third required more than six months of additional time. Contractor problems (34%), weather (15%) and financial difficulties (14%) were the first, second and third reasons for these time delays. Other factors causing time-delays included labour problems (9%), variation orders (8%), material-related (6%) and 'other' problems (14%).

The delivery of construction materials also contributed to the causes of cost increase and time-delay of a small percentage of the sample projects. Only in 6% of the projects were additional costs – above those specified in the contracts – required for the complete delivery of materials. In 55% of these, the additional cost was in excess of KD 500 (US $1650). The remaining projects (94%), the delivery of materials was accomplished without any additional cost, but with some time-delays. The supplier (29%), the contractor (36%) or both, were responsible for the main causes of delays during the delivery of materials. Cement (57%) and reinforcement steels (14%), or both (29%), were the materials for which the delivery was often delayed.

The analysis of cost increases (for all phases) and their causes indicated that in approximately 30% of the projects, the total increase in cost was KD 2000 (US $6500) or less. In another 28%, the total cost increase was more than KD 10000 (US $33 000). The remaining 43% of the projects, the cost increase was in the range of KD 2000 to 10 000. Contractor-related problems (25%) were identified as the main reason for the sample projects' cost increases. This was followed by owners' inexperience in construction (22%), material-related problems (13%), weather-related (7%), labour-related (5%) and finally, variation orders (change orders) and a combination of these factors for the remaining 28% of the projects.

The distributional analysis of total time-delays (all phases) as well as their causes indicated that while none of the surveyed projects finished on time, approximately 30% experienced a delay of between one to three months during their entire implementation period. A total of 29% had a time-delay of between four and five months each. Nearly 22% were delayed between six and eight months beyond the scheduled time duration, while the remaining 19% each experienced at least nine months of delays. Again, contractor-related problems were the single most frequently observed factor that contributed to time delays during the construction of the sample residential projects (25%). Owners' financial difficulties were second (22%), and labour-related problems (13%) were the third most-frequent cause of time-delays of the sample projects. The weather factor caused delays to nearly 7%, variation orders to 5%, owners' lack of construction experience 1%, materials 0.7% and, finally, a combination of these factors caused delays for nearly 26% of the sample projects.

In order to obtain a better perspective on the relative magnitude of cost and time increases, a frequency distribution of total cost (excluding the cost of land) and total time duration (from start to finish) of the sample projects was performed the result of which is presented in Table 4. The total cost for 24% of the sample projects was KD 80 000 (US $265 000) or less. A total of 27% had a cost of between KD 80 000 and KD 100 000. The total cost for another 26% was between KD 100 000 and KD 130 000. A total of 16% had a total cost ranging from KD 130 000 to KD 200 000, and the remaining 7% had a total cost in excess of KD 200 000 (>US $650 000). A simple

Table 4 Frequency distribution of total project costs and total time-delays

Variable name	Frequency	%	Cum. %
Total residential project cost (K.D.):			
<=80 000	41	24.0	24.0
80 001–100 000	47	27.0	51.0
100001–130000	45	26.0	77.0
130 001–200 000	28	17.0	93.0
>200000	12	7.0	100.0
Total residential project duration (months):			
⩽12	304	73.0	73.0
13–18	52	12.0	85.0
19–24	43	10.0	96.0
>24	18	5.0	100.0

comparison of the amount of cost increases and the total cost of the sample residential projects (Table 4) indicates that the magnitude of cost increase for an average project is, rather small when compared to the total cost of the residential project. These relatively minor increases in the project cost, therefore, should not be a major factor for owners' dissatisfactions with the process of construction of residential projects in Kuwait. Other factors are most likely contributing to this dissatisfaction.

The amount of time-delays experienced by the sample residential projects on the other hand, are rather large when compared to the total time duration of these projects (Table 4). Nearly, 73% of all sample residences were constructed in one year or less, and only 4% required more than two years to complete. As indicated before, the amount of time-delays in nearly 19% of the surveyed projects was at least nine months – which constitutes a significant amount of delay when compared, for example, to the total time for the completion of 96% of the sample projects, which was 2 years or less.

The total project cost figures in Table 4 does not include the price of the residential land, if more than 400 sq m and/or a choice of location. Although a desert landscape, the price of land in the State of Kuwait is unreasonably high. The analysis of the data showed that the cost of land for nearly a third of the sample residences was KD 2000 (US $6500). At the other end of the scale, nearly 4% of the sample owners spent more than KD 120 000 (US $400 000) alone on the purchase of land for their residential projects. Most likely, these projects include those which had a construction cost of more than KD 200 000 (US $650 000), which accounted for nearly 7% of the sample residences. The cost of the additional land for the remaining (nearly) two-thirds of the sample projects varied from KD 2000 to KD 120 000.

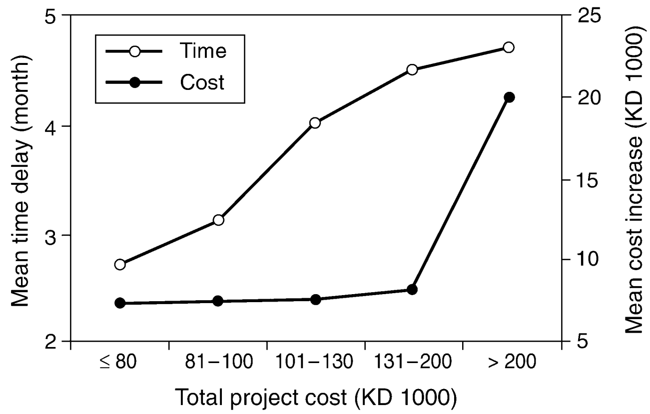

Figure 1 Total project cost and project time increase

Analysis of interrelationships

The relationship between the sample projects' total cost and time/cost increases indicated that, both variables (time-delays and cost increases), increased with an increase in the total cost of the residential project (Figure 1). However, the rate of increase in time-delay was higher than that of the cost, except for the most expensive residential projects where the opposite was true. This finding is in accordance with the expectations, since costlier projects are normally larger in size and more complex in construction activities. Any delay in such projects would result in a significant increase in costs.

Analysis of the data also showed that the sample owners who undertook the pre-planning phase prior to the commencement of design phase (planning for financial, size, type of materials, design office, likely contractors, etc.), experienced shorter project time-delays than their counterparts who did not. The amount of time-delay also decreased with an increase in the pre-planning time period. For example, owners of the residential projects with a total cost of between KD 131 000 and KD 200 000, who spent more than one year pre-planning the project, experienced 1.3 months less time-delay during the implementation of their residential projects, compared to those who spent less than six months on this phase.

A similar trend was also found to exist between the expenditures of money and time during the design phase of the sample residential projects and time/cost increases (particularly cost increases) during their implementation. The analysis result showed that a significant reduction in both, cost increase and time-delay, was experienced by owners who spent more money and time on the design phase of their residential projects. Quite clearly, any investment of time (attention) and money during the design phase of a construction project would, in general, ensure a better

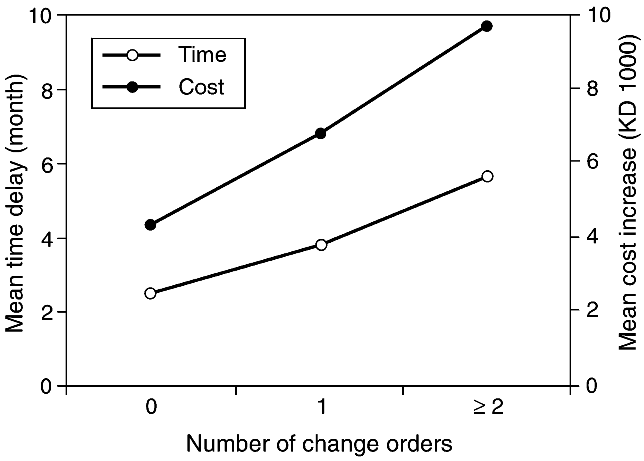

Figure 2 No. of change orders and project time/cost increases

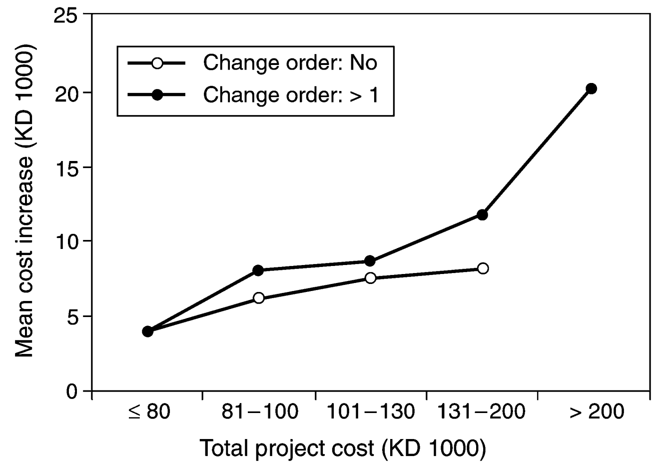

Figure 4 Change orders and project cost increase by total project cost

design quality and a more complete set of design drawings, which would consequently reduce the likelihood of change orders and, thus, alleviate costly delays during the implementation phase of a project.

As was expected, the number of change orders (variation orders) issued during the various phases of a construction projects negatively affected both, projects' time-delays and cost increases. This was particularly true if change orders were issued during the construction phase where the progress of many work crews and tasks will be adversely affected.

Figures 2, 3 and 4, show the result of the analysis of the sample data with regards to the impact of change orders on time cost increases. It is clear that projects with no change orders generally enjoyed shorter time-delays and cost increases compared to those characterized by the issuance of one change order or more. As shown in Figure 1, projects with one change order experienced more than 58% time delay and 58% cost increase when compared to those with no change orders. The rate of increase in time delay and cost increase was even higher for projects where more than one change order was issued. The differences in time-delay (Figure 3) and cost increase (Figure 4) for projects with, and without, any change orders generally increased with an increase in the total cost of the residential project.

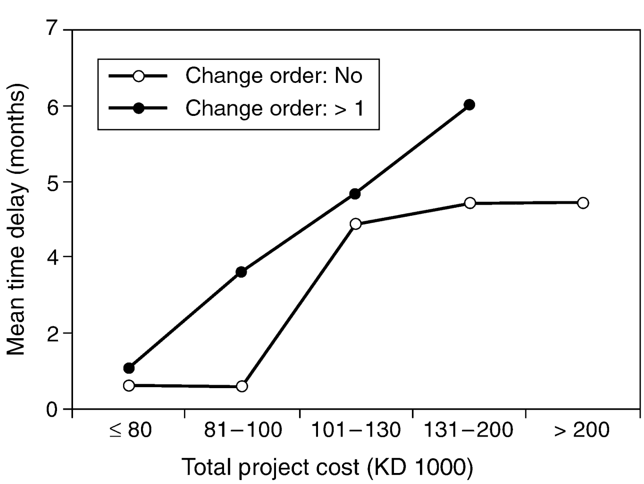

Figure 3 Change orders and project time delay by total project cost

The impact of change orders on timely execution of the sample residential projects also proved significant. As presented in Table 5, while nearly 71% of the sample projects with no change orders finished on schedule, only 45% of those with a change order finished on time. The result of the chi-square test also confirmed the existence of statistically significant differences (at the 95% significance level) in on-time finish of projects with, and those without any change orders ($\chi^2=11.0$, df=1, $p<0.001$).

In many of the sample residential projects, a supervising engineer was hired (by owners) to independently monitor the progress of work and ensure the timely delivery of materials. One would expect that projects with such a control mechanism in place would most likely experience shorter time-delays and smaller cost increases during the course of their implementation. To

Table 5 The impact of change orders on timely completion of the sample projects

Change Order	Projects completed on schedule time (%)	
	Yes	No
⩾1	45.0	55.0
0	71.0	29.0
($\chi^2=11.0$, df=1, $p<0.001$[a])		

[a]At the 95% significance level.

Table 6 The impact of supervising engineers on timely completion of sample projects

Did you hire a supervising engineer?	Projects completed on schedule time (%)		
	Yes	No	
Yes	51.0	49.0	
No	30.0	70.0	
(χ^2=17.8, df=1, p<0.001)			
	Material delivery on schedule time (%)		
	Yes	Partly	No
Yes	48.0	24.0	28.0
No	33.0	37.0	30.0
(χ^2=11.6, df=2, p<0.003)			

examine this hypothesis, a category analysis along with a test of chi-square were performed on the data, and time-delays and cost increases were computed for projects, categorized by their total cost.

As expected, a significant reduction in time-delay was observed at projects that employed an engineer to independently supervise the progress of the work. The data in Table 6 shows the result of a category analysis, which confirms the existence of statistically significant differences in time-delays and in material deliveries for projects with a supervising engineer and those without (χ^2=17.8, df=1, p<0.001; χ^2=11.6, df=2, p<0.003).

A similar trend was also found to exist between the amount of cost increase and the option of hiring a supervising engineer. The amount of cost increase generally increased with an increase in the total cost of the residential projects, for both options. However, the difference in cost increase for projects with a supervising engineer, and those without, was not statistically significant at the 95% significance level.

Owner-reported causes of time/cost increase

The owners of the sample residential projects were also requested to provide information on the sample projects' main causes of delays and the respective cost increase during their implementation phase. The analysis of responses indicated that the number of issued change orders during the design and the implementation phases was the highest ranked factor contributing to time-delay of the sample projects (5.3 months). Change orders also added KD 9000 to the total cost of an average residential project (the fourth rank in the cost-increase). Owners' financial constraints added a time-delay of 4.9 months (second rank) and an additional KD 10 000 (ranked third) to the cost of the project. As shown in Table 7, the sample owners' 'lack of experience' in the construction field, was ranked third in terms of time delays (but the least contributor to cost increases), followed by materials (ranked fourth), weather, labour, contractor and, finally, a combination of the above (which contributed to an average of five months of delays and an increase of KD 8900 to a project's total cost). Contractor-related problems contributed the most (KD 20 000) to cost increase and the least to the time delay (an average of two months) of the sample residential projects.

Conclusions and recommendations

In general, the amount of time-delay and cost-increase (overrun), increased with an increase in the total cost of a residential project. However, private residence owners who spent more time on the pre-planning phase – spent more money on the design phase; issued less change orders; selected more experienced contracting companies; and hired a supervising engineer to independently supervise the progress of work and ensure the delivery of materials – experienced less time-delays and cost-increases during the implementation phase of their residential projects. A major factor contributing to the sample projects' time-delay and cost-increase was the insufficiency of money and time allocated to its design phase.

The accumulated conflict experiences between the owners of private residential projects and their

Table 7 Owner-reported causes of time/cost increase

Delay cause	Time-delay		Cost increases	
	Months	Rank	KD	Rank
Change orders	5.3	1	9000	4
Financial constraints	4.9	2	10000	3
Owner's lack of experience	4.4	3	1000	7
Materials	4.3	4	10200	2
Weather	3.9	5	8800	5
Labour	2.9	6	2800	6
Contractor	2.0	7	20000	1
'Combination'	5.0	0	8900	–

contractors in the last decade have clearly pointed to contractor disqualification as a main contributing factor to causes of construction delays and cost overruns. The boom in the post-invasion construction of private residential projects in Kuwait and the lack of effective government regulations, specifications and control mechanisms on the qualifications of contracting firms have led to the establishment of many small contractors, most of which are unqualified and unfit for the job. The owners of new dwelling projects should avoid involvement with these firms. The responsible municipal authorities in Kuwait should also play a crucial role by ensuring that unqualified contractors are identified and prevented from malpractice. Naturally, the establishment of an appropriate set of rules, regulations and specifications concerning the qualifications of contracting firms is a pre-requisite to the elimination of unfit contractors from the construction industry in Kuwait.

The three main causes of time-delays were, in order, the number of change orders, financial constraints and owners' lack of experience in construction. The three main causes of cost overruns on the other hand were, in order, contractor-related problems, material-related problems and, again, owners' financial constraints.

What should the owner of a new residential project in Kuwait do to minimize headaches, time-delays and cost-overruns? They should: (a) ensure adequate and available source of finance; (b) perform a pre-construction planning of project tasks and resource needs; (c) allocate sufficient time and money on the design phase; (d) if cost-effective (depending on the size of the residential project), hire an independent supervising engineer to monitor the progress of the work and ensure timely delivery of materials; and finally, the most important factor of all, (e) select a competent consultant and a reliable contractor to carry our the work.

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