Causes of delays in Saudi Arabian public sector construction projects

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ABSTRACT

Many public construction projects have been undertaken throughout the Kingdom of Saudi Arabia as part of the government's national development plans in the last three decades, with significant public expenditure involved. One of the critical problems concerning these projects is the frequent and lengthy delays that occur. In order to improve the situation, it is first necessary to identify the major causes involved. Several studies have already been reported which do this but all use different sets of variables. Also, none have attempted to identify the extent to which improvements are possible in practice. A new survey is reported that uses all the variables from the previous work and that are measured for both current degree of effect on delays and the extent to which each can be practically improved. These are contained in seven groupings: client, contractor, consultant, materials, labour, contract and relationship-related causes. The survey covers a sample of 86 clients, contractors and consultants working in the Saudi construction industry. The analysis reveals some considerable heterogeneity between the cause groupings and respondent groupings in terms of means and correlations, apparently partly due to lack of knowledge of respondents and a tendency for the consultants to blame the contractors for the delays and *vice versa*. The main results, therefore, are disaggregated to reflect the views of each respondent group concerning each group of causes. In general however, it is found

that the most influencing current cause of delay is the lack of qualified and experienced personnel – attributed to the considerable amount of large, innovative, construction projects and associated current undersupply of manpower in the industry.

KEYWORDS

Saudi Arabia, delays, heterogeneity.

INTRODUCTION

Many public construction projects have been undertaken throughout the Kingdom of Saudi Arabia in the last three decades as part of the government's national development plans, and with significant public expenditure involved. According to the Saudi Ministry of Planning, the construction industry contributed between 30% to 40% of the non-oil productive sectors at the end of each National Development Plan from 1980 to 2000 (Cordsman 2000).

One of the critical problems faced by the government sector is the frequent and lengthy delays in such projects. Zain Al-Abidien (1983) found that delayed projects accounted for 70% of projects undertaken by the Ministry of Housing and Public Works. Al-Sultan (1987) surveyed time performance of different types of projects in Saudi Arabia and concluded that 70% of public projects experienced time overrun. In a preliminary survey by the Water and Sewage Authority in the Eastern Province in Saudi Arabia, it was found that 45 (59%) out of a total of 76 projects completed

during the period 1985-1994 were delayed (Al-Khalil and Al-Ghafly 1999: 101). In a more recent survey, Kahlil (2004) reported a “rose coloured” 952 (40%) out of 2379 project in Saudi Arabia to have been delayed, suggesting that some improvements have been achieved over the last decade.

In terms of cost and follow-on consequences, project delay is considered to be one of the most serious and frequent problems in the Saudi Arabian construction industry (Faridi and Al-Sayegh 2006). The delay of any construction project affects the direct costs of the project. In the case where the project is a public building or facility, the complications increase as the client is a government department. The effects of delay in such cases may include:

- confusion regarding the public development plans
- disturbance of the budget execution plan for the government authority involved
- public inconvenience resulting from delay of the project.

From the contractor’s viewpoint, delay is simply an additional liability as:

- the construction period becomes longer
- the longer period results in higher overhead costs and expenses
- the entire contractor's working capital may become trapped in one project.

Delays also mean loss of output and revenues, since the contractor cannot become involved in other projects. The profit lost by the contractor, therefore, is equal to the opportunity cost of the projects the contractor misses (O'Brien 1998).

A common characteristic of construction projects is that they are dynamic and have a high level of uncertainty. This results in a cyclical argument, where delays are accepted as inevitable and is considered by some to be a global phenomenon affecting all the various construction project participants (Sambasivan and Soon 2007).

However, considering the above points and the costs resulting from delays, there is a need to take the previous studies one step further *to identify the causes of delays that produce the greatest effects and the extent to which these effects can be ameliorated in the Saudi Arabian construction industry*. In order to determine the root causes of delay, a thorough analysis is needed of the critical areas involved. The early identification of these critical areas should improve the performance of contractors and increase the chances of successful project completion.

Delay management research is a well established area in several industries. In transportation, for example, the *delay management problem* is to find wait-depart decisions such that the inconvenience over all customers is minimised (e.g., Schöbel 2001), with associated work analysing the occurrence of delays (e.g., Chen and Harker 1990; Higgins and Kozan 1998). In a similar way, delay management algorithms have been developed for Internet applications such as voice-over IP, videoconferencing and video streaming, which have strong delay requirements on their data streams – the goal being to optimise service differentiation and prioritisation of the information packets involved (e.g., Dumitrescu and Harju 2004). In sales and marketing on the other hand, capital investment policy models aimed at managing product growth involve market reaction to delivery delay in addition to salesmen and capital equipment expansion (Forrester 1967).

Many previous studies have been reported that have some relevance to this theme in the construction industry, with the causes of construction delays being identified in a wide range of countries, including Canada, Ghana, Hong Kong, Indonesia, Jordon, Nepal, Nigeria, Thailand, Turkey, and USA (these studies are too numerous to describe in any detail, but summaries are available in Chan (1998), Assaf and Al-Hejji (2006), Sambasivan and Soon (2007) and Lo et al. (2006)). Of these, 10 have identified the causes of delay of construction projects in Saudi Arabia (Al-Mudlej 1984; Al-Hazmi 1987; Al-Ojaimi 1989; Assaf and Mohammed 1996; Al-Ghafly 1995; Al-Khalil and Al-Ghafly 1999; Odeh and Battaineh 2002; Assaf and Al-Hejji 2006; Arain et al. 2006). Combined together, these 10 studies produced 112 causes of delay. Upon inspection, it was found that each of these causes could be allocated to one of Odeh and Battaineh's (2002) seven groupings, comprising:

1. *Client-related*
2. *Contractor-related*
3. *Consultant-related*
4. *Materials-related*
5. *Labour-related*
6. *Contract-related*
7. *Contractual relationship-related*

The 112 causes cited in the previous studies were then investigated further by means of a questionnaire survey. This was targeted at client, consultants and contractors to elicit their views quantitatively on the current extent of effect of each cause and the extent to which improved practices could ameliorate these effects in the future. This

required responses on a five point scale, comprising 0="No effect" to 4="Lot of effect", to 27 *client-related* causes, 34 *contractor-related* causes; 12 *consultant-related* causes, 9 *materials-related* causes, 17 *labour-related* causes, 10 *contract-related* causes and 3 *contractual-relationship* related causes (for the analysis, the last 2 groups were combined into a single group). Table 1 provides an extract from the question concerning *client-related* factors. An open-ended qualitative question was also added to allow respondents to provide further details.

Space limitations prohibit a detailed account at this point of the 112 causes involved. Instead, several of those found to be most significant as a result of the subsequent analysis are described in more detail in the Discussion section below.

RESULTS

Following a short pilot study, the final questionnaire was sent to potential respondents in Saudi Arabia (by email) in April 2007. A convenience sample of five major public construction projects in Saudi Arabia was adopted and a random sample was taken of the client/owners, consultants and contractors involved. Each person was given one month to complete and return the questionnaire. A total of 86 questionnaires were returned during this period, representing a 43% response rate.

The respondents comprise contractors (40%), consultants (36%) and clients' representatives (24%). The majority (40%) are 40–50 years of age, with 28% being 30-40 years of age and 19% over 50. Approximately 81% have at least 10 years experience and 82% have a bachelor's degree as their minimum level of education,

with 16% holding masters qualifications. 50% are executives of various companies, indicating a heavy involvement with the management practicalities as well as top-level decision-making in the construction industry. Most respondents are involved in projects costing over RS50million (USD$20million). This suggests that a reasonable cross section of respondents were involved in the survey and a concomitant reduction in the likelihood of the results being biased.

Homogeneity of responses

Previous research has found some significant differences in opinions between the various parties involved. For example, owners and consultants attribute the major causes of delay to be those for which the contractor is responsible and *vice versa* (Al-Khalil and Al-Ghafly 1999). This is also the case with these data and would be a source of bias if the data are to be aggregated. Figs 1-3 illustrate the differences in mean values recorded for the three groups of respondents and the six groups of causes for the Now, Future and Differences scores, where Now and Future denote the responses to the questions "**How much do the causes delay Saudi's construction projects** *at the moment?"*, and "**How much do you think they** *should* **be causing delays if practice is improved?"** respectively, with Differences being the simple arithmetic difference between the two. Two-way Analysis of Variance (ANOVA)[1] was conducted with the main independent variables being the 3-factor respondent groupings (1-client, 2-consultant, 3-contractor) and the 6-factor cause groupings (1-client-related, 2-contractor-related, 3-consultant-related, 4-labour-related, 5-materials-

related, 6-contract/relationship related) and the Now scores as the dependent variable. This showed both the respondent and cause effects and their interaction effects to be significantly different ($p<0.05$). Using the Future scores as the dependent variable produced the same results. However, using the Differences scores as the dependent variable showed only the respondent and respondent-cause interaction effects to be significant.

In terms of correlations, the result is less clear. Table 2a provides the Spearman correlation coefficients for all the pair-wise permutations of the three respondent groupings for each of the six cause groupings for the Now, Future and Difference scores. For example, column three provides the correlation coefficient for the clients versus the contractors, with 0.70 being recorded for the Now scores for the client-related causes. Results highlighted in **bold** and starred are significant ($p<0.05$). Further inspection of Table 2a indicates that:

1. the contractor-client and contractor-consultant results are the same
2. none agree on the *consultant-related* Future and to a lesser extent the *client-related* Future
3. client-consultant also do not agree on *consultant-related* Now and *contractor-related* Future.

Table 2b provides the results for the Now-Future correlations. For example, the correlation between contractors' Now and Future scores for the client-related causes is a low 0.06, while the correlation between the contractors' Now scores and clients'

[1] ANOVA is a parametric method of analysis for interval level data, while Likert scales are intrinsically ordinal. However, ANOVA is known to be robust in nonparametric settings and is regularly used for Likert scales (e.g., Zou and Lee, 2008; Chan and Lee, 2008; Lam et al, 2008)

Future scores for client-related causes is a significant 0.38. In general Table 2b indicates that for:

1. *Labour-related causes:* General agreement that Future is similar to Now
2. *Contract/relationship-related causes*: Ditto except the consultant's Now is different to client's Future
3. *Consultant-related causes*: All agree Future different to Now except the consultant's Now and client's Future
4. *Contractor-related causes:* Contractor's Future similar to all Nows; client's future similar to other's Nows (but not own Now); consultant's future different to all Nows
5. *Client-related causes:* Consultant's Future similar to his other's Nows (but not own Now); contractor's Future different to all Nows; client's Future a little similar to all Nows
6. *Materials-related causes:* Contractors' Future very different to all Nows; consultants' Future similar to contractors' Nows (but not own Now); client's Future a little similar to all Nows.

The reasons for this pattern of results need to be investigated by further research, but the extent of the heterogeneity involved makes it clear that a simple aggregation of data is likely to be misleading and a group by group analysis is needed.

Results for the cause groupings

Fig. 4 gives the results for the *client-related* causes, in terms of Now and Future mean scores for each cause for each respondent grouping, presented in terms of the ordered

overall mean Future scores. Here, we assume the Future values to be the baseline standard. In other words, the mean Future values are taken to represent the best realistically achievable result. On this basis, the aggregated results suggest the best of these to be “Owner’s interference”, “Owner’s personality”, “Negotiation by knowledgeable people”, etc., as these are seen to have the least effect with a mean value of around 2.0. The worst of the aggregated baseline results are “Key personnel replaced”, “Owner’s poor communication” and “Slow decision-making by owner” with a mean value of around 2.5. However, from the above analysis, we know the mean values differ significantly between each respondent group for the Future scores. Also, the scores are not significantly correlated (Table 2a), which indicates that aggregating results in this way may be misleading.

Table 3 gives the results of considering each group of respondents individually. This shows the five causes that have the greatest effect on delays for each respondent group. Therefore, the client response for the *client-related* causes, “Lack of finance to complete the work by the client” has the highest Future effect, with a mean score of 2.6. Equal with this is “Slow decision-making by the owner”, followed by “Suspension of work by the owner” (2.5), “Difficulties in obtaining work permits” (2.4) and “Non-payment of contractor claim” (2.3). The contractor response, on the other hand is “Replace key personnel” (2.8), “Slow decision making by the owner” (2.7), “Owner’s poor communication with the construction parties and government authorities” (2.7), “Interference by the owner in the construction operations” (2.7) and “Poor communication by owner and other parties” (2.7), with the consultant response as “Suspension of work by the owner” (2.7), “Owner’s poor communication with the construction parties and government authorities” (2.5), “Replace key personnel” (2.4),

“Lack of finance to complete the work by the client” (2.4) and “Delay in approving sample materials by owner” (2.4).

In contrast, the Now scores are clearly much higher than the Future scores, although they are more correlated than the Future scores. The five causes with the greatest Now effect on delays are again shown in Table 3. As expected due to the higher correlation, some of these occur more frequently across the respondent groups. “Lack of finance to complete the work by the client” and “Delay in progress payments by the owner” appear in the list of all three respondent groups.

Figs 5-9 contain the results for the remaining five cause groups, with Table 3 again containing the five causes with the greatest effect on delays in terms of both Now and what respondents think should happen in the future.

Other causes nominated by respondents

In addition to the 112 causes documented in the questionnaire, some respondents also nominated a range of other delay causes, comprising:

- Quality management system and assurance control
- The consultant attempting to hide their mistake when the quantity amount changes
- Insufficient allowance for employees' holidays in the schedule
- Inadequate original contract duration
- Lack of clarity of drawings and specifications

- Client need to analyse the causes of change
- The lack of experienced engineers engaged by consultants for high-tech work
- Insufficient numbers of contractors to build the increasing number of construction projects in Saudi Arabia
- Insufficient consideration of the behaviour of people
- Lack of regular meetings
- Unclear scope of work to be done by staff contractors
- High turn-over of personnel in Saudi Arabia
- Insufficient study of all the details and capacity of the contractor before selection by client
- Overdependence on the lowest tender amount in contractor selection
- Discrepancies between bill of quantities, specifications and drawings
- Level of salary of consultant staff
- Lack of ethics
- Delayed salary payments to staff
- Designer engineer selection of special building materials not available in the local market.

These will need to be included in any further studies of this kind.

DISCUSSION

The heterogeneous nature of the data presents special difficulties in analysis in what would otherwise be a relatively simple task of ranking aggregated mean responses. It

also brings into question the validity of the responses. Can all respondent groups be correct? If not, which one, if any, is correct, and how should the others be treated?

For example, Fig. 3 shows the contractor mean Now response to be higher for all cause groups except the *contractor-related* group. Is this because the contractors are actually more at fault than the other two respondent groups but are unable or unwilling to admit it? Or is that the contractors understand their own contribution better than the other respondents and therefore have provided the only correct result? Similarly, both client and consultant respondents rate their own effect on delays as less than the other respondents. Again, is this because they are hiding fault or just better (or less) informed? The general trend for the client respondents to be lower than other respondents suggests that perhaps the latter is the case, as clients are expected to have less contact with the realities of construction work than contractors and consultants. If this is the case, then it might also be expected that contractors would have more knowledge of the technical aspects of production management (such as materials and labour handling) than consultants. This would go some way to explaining the results in Fig. 3, where the *materials-related* and *labour-related* effects are ranked highest by contractors, followed by the consultants and then clients. This is also possibly the case for *contract-related* effects, where the client and contractor possibly have a bigger interest than the consultants. This would then leave the *contractor-effects* and *consultant-effects* to be explained as a recurrence of that found in Al-Khalil and Al-Ghafly's (1999) study, where the contractor blamed the client and *vice versa*. In this case, it would seem that the consultant blames the contractor, the contractor blames the consultant, while the consultant *and* contractor blame the client!

Again, the reason for the passivity of the client may be due to lack of detailed knowledge of site workings.

Interestingly, several of the Future results (Fig. 2) are quite similar to the Now results, except at a reduced level of effect. Again, the contractor-consultant-client ranking occurs for *materials-related* and *labour-related* effects, as is the above mentioned Al-Khalil-Al-Ghafly effect for the *consultant-related* effects. What is more generally apparent, however, is the relatively consistent disparity of the contractor and client responses. The client is clearly more optimistic than the contractor, with the consultant largely coming between. Whether or not this is cynicism on behalf of the contractor or naiveté on behalf of the client is hard to say. Perhaps, something of both applies.

Turning to the individual cause items themselves, the largest of the Now effects overall are the *contractor-related* "Poor qualification of the contractor's technical staff" (3.87), "Poor site management and supervision by contractor" (3.78), "Contractor experience" (3.7) and *labour-related* "Shortage of manpower (skilled, semi-skilled, unskilled labour)" all by the consultants. As mentioned above, this may be just another example of the Al-Khalil-Al-Ghafly effect, although these also attracted mean scores of 3.4, 3.5, 3.5 and 3.6 by the contractors. For the contractors, the highest are the *client-related* "Suspension of work by the owner" (3.61), the *consultant-related* "Delay in approving major changes in the scope of work by consultant" (3.6), *materials-related* "Shortage of construction materials in market" (3.6) and *labour-related* "Shortage of manpower (skilled, semi-skilled, unskilled labour)" (3.6), which seems to show a more balanced view (but hardly evidence for

correctness). For the clients, these are the *labour-related* "Shortage of manpower (skilled, semi-skilled, unskilled labour)" (3.6) and "Poor qualification of the contractor's technical staff assigned to the project" (3.5), and the *contractor-related* "Contractor experience" (3.57). Of these, "Shortage of manpower (skilled, semi-skilled, unskilled labour)" is common to all three respondent groups, with "Poor qualification of the contractor's technical staff assigned to the project" and "Contractor experience" common to both consults and clients – inviting the conclusion that experience is all important.

These and the other causes with the greatest current effect are discussed in more detail below in terms of the six causation groups involved.

1. Client-related causes

Finance issues are of much concern, as evidenced by the results in the study. These are related to the lack of finances, non-payments and delay in progress of payments by the clients. This may be due to a level of underfunding by the Saudi Ministry of Finance. Moreover, many departments need to review each contractor's payment. This is often a long process and has continually affected Saudi public construction projects for the last three decades. For instance, a number of researchers (Al-Mudlej 1984; Al-Hazmi 1987; Al-Subaie 1987; Al-Khalil and Al-Ghafly 1999; Al-Sedairy 2001) found the delay of payments or non-payment to contractors in Saudi Arabia to have become the major cause of delay of public projects. This issue is also illustrated

comprehensively by Arain et al. (2006) and Assaf et al. (1999), among others, who stress the importance of stabilising the contractors' financial situation.

Other client-related concerns include the suspension of work, which has been an acknowledged source of delays since the beginning of the Saudi Arabian construction renaissance 30 years ago (O'Brien 1976). This allows the project owner to suspend any part of the work at any point of time, within reason, to restudy and redesign any part of the project so that necessary modification and corrections can be made. More recently, the issue of change orders has also been noted as a critical factor in delay in public construction in Saudi Arabia (Assaf and Al-Hejji 2006).

The other major source of delay is the need for client approval. For example, the contractor has often to obtain the approval of the client to use a certain type of material in the project (Clough and Sears 1994). This cause emerged in previous studies by Al-Hazmi (1987) and Al-Khalil and Al-Ghafly (1999) who also found slow decision-making by the client to be a major cause of delay. The reason appears to be due to the client’s low level of technical submittals. This means the contractor is provided with insufficiently well informed studies and recommendations by the consultant, or the client's technical staff have little expertise in handling such technical matters.

2. Contractor-related causes

As mentioned above, contractor inexperience is a major cause of delay. This has emerged only once in previous studies (Al-Ojaimi 1989), which occurred during an economic spurt in Saudi Arabia - reflected in the initiation of several economic projects and a developmental economic boom. Right now, Saudi Arabia is once again experiencing a growth in its economy. The desire of different government sectors to build several mega-projects has been announced recently to the media. Many authors have noted lack of experience as one of the critical causes affecting the performance of the construction sector (e.g., Clough and Sears 1994; O'Brien 1998; Arain et al. 2006) .

A related issue is the poor qualification of the contractor's technical staff. This was first identified as a cause of delay in the 1980s (Al-Mudlej 1984; Al-Ojaimi 1989). The reason again appears to be the commissioning of huge projects due to the growth of the economy in these periods and the resultant shortage of personnel, as anticipated by Al-Barrak (1993), who advised contractors to engage highly proficient technical staff to ensure they will work effectively during the boom construction period.

Contractor difficulty in financing projects has been emerging since the 1990s as a critical cause of delay (Assaf et al. 1995; Al-Khalil and Al-Ghafly 1999; Odeh and Battaineh 2002) and is related to delayed progress payments to the contractor by the client. Since 1987, the government has stopped making advance payments to contractors (which was equal to 20% of the contract value).

Although Cori (1987) has linked successful construction projects with leadership ability and the right time on the site, no previous studies have shown poor site management and supervision by contractors to be critical causes of delay. It is again likely to be due to contractors in Saudi Arabia being increasingly required to perform large-scale projects in terms of size or in terms of the volume of construction works, and this may have led to contractors losing control of the management of the sites as they not familiar with projects of this scale.

The other contractor-related causes are conflict between contractors with other parties, and ineffective scheduling of the project by the contractor. These issues have also emerged previously to some extent. For instance, Al-Ojaimi (1989), Assaf et al. (1995), Al-Khalil and Al-Ghafly (1999) showed that scheduling had become a critical issue in the construction industry in Saudi Arabia. On the other hand, no mention is made in previous studies concerning work conflict between contractors and other parties as causes of delay. Of course, poor scheduling by the contractor may be related to lack of experience or it may relate directly or indirectly to the suspension of work by the client, as discussed earlier.

3. Consultant-related causes

As Al-Ghafly (1995) notes regarding Saudi consultants, it is important to recognise consultant performance as a crucial factor in construction projects. However, the majority of previous studies have been limited to just the client and contractor alone. The importance of consultants' experience and the delay in review of the design

documents found here might be interpreted as again reflecting the existence of numerous current projects of a vastly different nature from previous projects, demanding technical requirements with which consultants are unable to deal with successfully. In addition, delays in reviewing design documents may be related to the low level of standard technical service offered by contractors to the consultant, or to the fact that the number of consultancy staff is usually quite small, as clients often identify the lack of consultant staff as a problem.

4. Materials-related causes

The shortage of construction materials in the market and of other materials required has also been found by Assaf et al. (1995) to be a critical cause of delay. It is obvious that this phenomenon is a result of the booming construction industry in Saudi Arabia. That procurement delays are also important is new to Saudi Arabia, although it has been mentioned in the general literature (Arain et al. 2006; Fisk 1997). This may be because of changes in currency exchange rates for imported materials. There may also be connections between this factor and client/consultant delays in making the final decision for selection of materials.

5. Labour and equipment-related causes

Shortage of manpower and low skill levels have been shown to be important causes of delay in previous research (Al-Mudlej 1984; Al-Ojaimi 1989; Assaf et al. 1995; Odeh

and Battaineh 2002), with Faridi and El-Sayegh (2006) and Al-Mansouri (1988) noting that in particular, low skills of the labourers had led to delays. The shortage of local labour in Saudi Arabia has resulted in contractors using imported labour and therefore reducing their ability to judge the level of skill of their employees. Moreover, the quality of labour available is generally quite poor, which leads to low productivity and poor quality of work. There has also been an unstable workforce in the Saudi Arabian construction industry for a long time.

6. Contract-related and contractual relationship causes

Although the duration of the contract figures prominently in the results, it has not been raised in other recent studies. Al-Ghafly's 1995 study, however, showed the difficulties involved in completing projects based on an unrealistic timeframe. Once again, it is likely that the current complex environment in Saudi Arabia is a major determining factor. The novel projects currently being required by clients need experienced staff to determine a realistic construction duration period.

CONCLUSIONS

The stated objective of this paper is to identify the causes of delays that produce the greatest effects and the extent to which these effects can be ameliorated in the Saudi Arabian construction industry. These are summarised in Figs 4-9, where the perceived extent of the effects are shown both now and how they could be in the

future if appropriate corrective action is taken. However, as discussed at some length, these results need to be treated with care as they are confounded to some extent by significant differences of opinion, particularly between the contractors and consultants – each tending to blame the other to some extent. One thing that is clear though, is that the dominant view of the cause of construction delay concerns the shortage of qualified and experienced manpower, most likely brought about by the current boom in construction activity involving large, innovative, projects.

Several implications emerge that indirectly affect the duration of construction projects in the Saudi public construction industry. Three can be singled out as having major implications:

1. The failure to develop strategic plans for scheduling future construction projects has led to a current crisis in the construction sector. The issues relating to materials and labour are of significant concern. For example, the availability of construction labour, materials and equipment is greatly affected by demand in the currently booming Saudi Arabian construction industry. The development of future strategies and plans by the Saudi government sectors should help avoid confusion in the construction sector in the future. From these strategies, the government could then, for example, distribute projects more evenly over a number of years to help alleviate the situation.
2. The level of involvement and participation of each party to the construction process is widely different. For example, the client, in this case the government, is often unaware of technical issues and simply passes on its tasks to the consultant. This matter has led the client to be unaware of what is happening on the site itself. This aspect reduces the ability of the client to take

decisions that may facilitate the construction process. Poor daily communication between the client and consultant and lack of experience of the client's technical staff tend to exacerbate the situation. It may be beneficial for the Saudi government to offer greater encouragement for contractors and consultants to cooperate with external companies with more experience than local companies to improve the level of local experience.

3. The current disagreement between the three parties on the sources of delays, especially in relation to technical and management causes, may be due to the lack of a single system of measurement of each's progress or quality of work. It is possible that this may be overcome to some extent by the use of more modern management methods to measure the range of intangible issues involved.

REFERENCES

Al-Barrak, A. A. (1993), 'Causes of contractors' failures in Saudi Arabia', MS Thesis, King Fahd University of Petroleum and Minerals.

Al-Ghafly, M. A. A. (1995), 'Delay in the construction of public utility projects in Saudi Arabia', MS Thesis, King Fahd University of Petroleum and Minerals.

Al-Hazmi, M. H. (1987), 'Causes of delay in large building construction projects', MS Thesis, King Fahd University of Petroleum and Minerals.

Al-Khalil, M. and Al-Ghafly, M. A. (1998), 'Important causes of delay in public utility projects in Saudi Arabia'. *Construction Management and Economics,* **17**(5):647

Al-Khalil, M. I. and Al-Ghafly, M .A. (1999), 'Delay in public utility projects in Saudi Arabia'. *International Journal of Project Management,* **17**(2)101-106.

Al-Mansouri, O. H. (1998), 'The relationship between the designer and the contractor in the eastern province of Saudi Arabia ,'MS Thesis, University of Reading. England.

Al-Mudlej, K. (1984), 'Causes of delays and overruns of construction projects in Saudi Arabia', MS Thesis, King Fahd University of Petroleum and Minerals http://www.csis.org/burke/saudi21/S21_05.pdf (last accessed 30 August 2007).

Al-Ojaimi, S. (1989), 'Delay execution of projects on time in construction and building sector', MS Thesis, King Fahd University of Petroleum and Minerals,.

Al-Sedairy, S. T. (2001), 'A change management model for Saudi construction industry'. *International Journal of Project Management,* **19**(3):161-169.

Al-Sultan, S. (1987), 'Determination of construction contract duration for public projects in Saudi Arabia', MS Thesis, King Fahd University of Petroleum and Minerals.

Arain, F. M., Pheng, L. S. and Assaf, S. (2006), 'Constructors' views of potential causes of inconsistencies between design and construction in Saudi Arabia'. *Performance of Constructed Facilities,* **20**(1):74-83.

Al-Subaie (1987), 'Construction claims in residential houses in Saudi Arabia', MS Thesis, King Fahd University of Petroleum and Minerals**.**

Assaf, S. A. and Al-Hejji, S. (2006), 'Causes of delay in large construction projects'. *International Journal of Project Management,* **24**(4):349-357.

Assaf, S. A., Al-Khalil, M, and Al-Hazmi, M. (1995), "Causes of Delay in Large Building Projects", ASCE, Journal of Management in Engineering, **11**(2):45-50, March/April.

Assaf, S. A., Bubshait, A., Atiyah, S. and Al-Shahri, M. (1999), 'Project overhead costs in Saudi Arabia'. *Cost Engineering,* **41**(4):33

Assaf, S.A. and Mohammed, A. (1996), 'Causes of delay in large building construction projects'. *Journal of Management in Engineering,* **11**(2): 27-55;

Chan, D.W. (1998), Modelling construction durations for public housing in projects in Hong Kong, PhD thesis, The University of Hong Kong, Hong Kong.

Chan, E.H.W. and Lee, G.K.L. (2008), Applicability in Hong Kong of London's experiences on urban redevelopment practices. *Property Management.* **26**(2): 125-137.

Chen, B. and Harker, P. (1990), 'Two moments estimation of the delay on single-track rail lines with scheduled traffic'. *Transportation Science* **24**:261-275.

Clough, R. H. and Sears, G. A. (1994), *Construction contracting,* Wiley New York.

Cordsman, A. H. (2000), 'Saudi Arabia enters the 21st century V: economic, demographic and social challenges'. Center for Strategic and International Studies, 1800 K Street NW, Washington DC 20006.

Cori, K. A. (1987), 'The project team: Vehicle for reaching the project goals'. *Projects Management Institute*, pp. 167-172.

Dumitrescu, A. and Harju, J. (2004), Delay management in core-stateless networks. *Proceedings of NEW2AN*, pp. 156-160 http://www.cs.tut.fi/tlt/npg/icefin/documents/dumitrescu_harju_new2an.pdf. (accessed 3 September 2008).

Faridi, A. S. and El-Sayegh, S. M. (2006), 'Significant factors causing delay in the UAE construction industry'. *Construction Management and Economics,* **14**:1167-76.

Fisk, E. R. (1997), *Construction project administration,* Prentice-Hall, USA.

Forrester, J.W. (1967) Market growth as influenced by capital investment. *9th Annual Paul 0. Converse Awards Symposium*, 13 April, University of Illinois. http://sysdyn.clexchange.org/sdep/papers/marketgrowth.pdf. (accessed 3 September 2008)

Higgins, A. and Kozan, E. (1998), 'Modeling train delays in urban networks'. *Transportation Science* **32**: 346-357

Lam, P.T.I., Wong, F.W.H. and Chan, A.P.C. (2006), 'Contributions of designers to improving buildability and constructability'. *Design Studies* **27**(4) 457-479

Lo, T. Y., Fung, I. W. H., Tung, K. C. F. (2006), 'Construction delays in Hong Kong civil engineering projects'. *Journal of Construction Engineering and Management* **132**(6) 636-49.

O'Brien, J. (1998), *Construction change orders,* McGraw-Hill, New York.

O'Brien, J. (1976), *Construction delays: Responsibilities risk and litigation* Chaness Book International, Boston.

Odeh, A. M. and Battaineh, H. T. (2002), 'Causes of construction delay: traditional contracts'. *International Journal of Project Management*, **20**(1)**:**73-67.

Sambasivan, M. and Soon, Y.W. (2007), Causes and Effects of Delays in Malaysian Construction Industry. *International Journal of Project Management*, **25**:517-526.

Schöbel, A. (2001), A model for the delay management problem based on mixed integer programming. Electronic Notes in Theoretical Computer Science **50**(1). Proc ATMOS 2001. http://www.elsevier.nl/locate/entcs/volume50.html (accessed 3 September 2008)

Zain Al-Abidien, H.M. (1983), About the effect of delay penalty on the construction of projects and modification proposal, *Proceedings of the First Engineering Conference*, 14-19 May, King Abdulaziz University, Jeddah.

Zou, Yi and Lee, Sang-Hoon (2008), The impacts of change management practices on project change cost performance, *Construction Management and Economics*, **26**(4): 387-393.

CAPTIONS TO TABLES AND FIGURES

Tables

Figures

The list below contains causes of delays. For each of these causes you are kindly requested to express your opinion by answering the following three questions and placing (✓) in the appropriate box:
In a public construction project in Saudi Arabia
How much do the causes delay Saudi's construction projects *at the moment***?**
How much do you think they *should* **be causing delays if practice is improved?**
How much do you think it will cost to improve practice to bring this about?

	Client-related Factors	**Causes of Delay**												
		Answers What is happening now						**Answers What should be happening in future**						**How much money you think will cost to modify it**
		No effect	Very little	Little effect	Some effect	Lot of effect	I don't know	No effect	Very little	Little effect	Some effect	Lot of effect	I don't know	**RS**
		0	1	2	3	4		0	1	2	3	4		
1.	Lack of finance to complete the work by the client													
2.	Non-Payment of contractor claim													
3.	Owners interference													
4.	Replace key personal													
5.	Negotiation by knowledgeable people													
6.	Delay to furnish and deliver the site to the contractor by the owner													
7.	Delay in the settlement of contractor claims by the owner													
8.	Suspension of work by the owner													
9.	Delay in issuance of change orders by the owner													
10	Slow decision making by the owner													
11	Interference by the owner in the construction operations													
12	Uncooperative owner with the contractor complicating contract administration													
13	Delay in progress payments by the owner													
14	Owner's poor communication with the construction parties and government authorities													
15	Owner's failure to coordinate with Government													

	authorities during planning													

Table 1: Extract from questionnaire

	Cause	Client-Contractor	Client-Consultant	Contractor-Consultant
Now	*Client-related*	**0.70***	**0.53***	**0.62***
	Contractor-related	**0.52***	**0.41***	**0.56***
	Consultant-related	0.49	0.03	0.49
	Materials-related	**0.67***	**0.89***	**0.67***
	Labour-related	**0.76***	**0.92***	**0.70***
	Contract/relationship-related	**0.60***	0.45	**0.60***
Future	*Client-related*	0.33	0.33	0.34
	Contractor-related	**0.52***	0.12	**0.41***
	Consultant-related	0.28	0.17	-0.15
	Materials-related	0.60	0.43	0.50
	Labour-related	**0.87***	**0.76***	**0.67***
	Contract/relationship-related	**0.69***	**0.67***	**0.82***
Differences	*Client-related*	0.33	0.28	0.30
	Contractor-related	0.18	-0.06	0.28
	Consultant-related	0.52	-0.21	0.13
	Materials-related	**0.86***	0.47	0.40
	Labour-related	**0.70***	**0.75***	**0.54***
	Contract/relationship-related	0.09	0.25	**0.76***

*Significant at $p<0.05$

Table 2a: Spearman's correlation coefficients

	Cause		**Now** Client	Contractor	Consultant
Future	*Client-related*	Client	0.36	**0.38***	0.33
		Contractor	0.15	0.06	-0.02
		Consultant	**0.46***	**0.40***	0.21
	Contractor-related	Client	0.12	**0.41***	**0.52***
		Contractor	**0.38***	**0.44***	0.46
		Consultant	0.15	0.18	0.21
	Consultant-related	Client	-0.40	-0.11	**0.62***
		Contractor	**-0.60***	-0.57	-0.57
		Consultant	0.12	-0.12	0.05
	Materials-related	Client	0.44	0.36	0.38
		Contractor	-0.26	0.10	-0.41
		Consultant	0.38	**0.84***	0.08
	Labour-related	Client	0.44	**0.64***	0.30
		Contractor	**0.50***	**0.62***	0.33
		Consultant	**0.70***	**0.89***	**0.61***
	Contract/relationship-related	Client	0.50	0.51	0.15
		Contractor	**0.64***	**0.88***	**0.68***
		Consultant	0.54	**0.60***	0.40

*Significant at p<0.05

Table 2b: Spearman's future/now correlation coefficients

Cause	Client now	Avg	Client future	Avg	Contractor now	Avg	Contractor future	Avg	Consultant now	Avg	Consultant future	Avg
Client-related	Lack of finance to complete the work by the client	3.29	Lack of finance to complete the work by the client	2.6	Suspension of work by the owner	3.61	Replace key personal	2.8	Delay in progress payments by the owner	3.59	Suspension of work by the owner	2.7
	Non-Payment of contractor claim	3.16	Slow decision making by the owner	2.6	Non-Payment of contractor claim	3.58	Slow decision making by the owner	2.7	Lack of finance to complete the work by the client	3.45	Owner's poor communication with the construction parties and government authorities	2.5
	Slow decision making by the owner	3.14	Suspension of work by the owner	2.5	Lack of finance to complete the work by the client	3.55	Owner's poor communication with the construction parties and government authorities	2.7	Delay in approving sample materials by owner	3.43	Replace key personal	2.4
	Delay in progress payments by the owner	3.1	Difficulties in obtaining work permits	2.4	Late in revising and approving design documents by owner	3.47	Interference by the owner in the construction operations	2.7	Late in revising and approving design documents by owner	3.43	Lack of finance to complete the work by the client	2.4
	Uncooperative owner with the contractor complicating contract administration	3.1	Non-Payment of contractor claim	2.3	Delay in approving sample materials by owner	3.42	Poor communication by owner and other parties	2.7	Delay to furnish and deliver the site to the contractor by the owner	3.39	Delay in approving sample materials by owner	2.4
Contractor-related	Contractor experience	3.57	Difficulties in financing project by contractor	2.6	Contractor experience	3.5	Contractor experience	3	Poor qualification of the contractor's technical staff	3.87	Poor communication by contractor with other parties	2.9
	Ineffective scheduling of project by contractor	3.45	Poor qualification of the contractor's technical staff	2.6	Difficulties in financing project by contractor	3.5	Frequent change of sub-contractors because of their inefficient work	2.9	Poor site management and supervision by contractor	3.78	Ineffective scheduling of project by contractor	2.9
	Delay in the preparation of contractor submissions	3.41	Contractor experience	2.6	Poor site management and supervision by contractor	3.47	Poor qualification of the contractor's technical staff	2.8	Contractor experience	3.7	Contractor experience	2.8
	Improper technical study by the contractor during the bidding stage	3.38	Poor site management and supervision by contractor	2.4	Conflicts between contractor and other parties (consultant and owner)	3.44	Inefficient Work-break down structure	2.8	Difficulties in financing project by contractor	3.65	Poor qualification of the contractor's technical staff	2.8
	Poor qualification of the	3.33	Ineffective planning by contractor	2.4	Poor qualification of the contractor's technical staff	3.38	Difficulties in financing project by contractor	2.7	Ineffective control of the project progress by the contractor	3.57	Ineffective control of the project progress by the contractor	2.8

	contractor's technical staff											
Consultant-related	Late in reviewing and approving design documents by consultant	3.1	Inadequate experience of consultant	2.3	Delay in approving major changes in the scope of work by consultant	3.6	Conflicts between consultant and design engineer	3.1	Inadequate experience of consultant	3.5	Internal company problems	2.6
	Delay in performing inspection and testing by consultant	3.1	Delay in approving major changes in the scope of work by consultant	2.2	Late in reviewing and approving design documents by consultant	3.4	Replacement of key personnel	3	Late in reviewing and approving design documents by consultant	3.2	Late in reviewing and approving design documents by consultant	2.3
	Delay in approving major changes in the scope of work by consultant	3	Frauds	2.2	Inflexibility (rigidity) of consultant	3.4	Frauds	2.8	Delay in approving major changes in the scope of work by consultant	3	Frauds	2.2
	Inflexibility (rigidity) of consultant	3	Company organisation	2.2	Inadequate experience of consultant	3.4	Inadequate experience of consultant	2.7	Replace key personnel	3	Inflexibility (rigidity) of consultant	2.2
	Replace key personnel	3	Replacement of key personnel	2.1	Delay in performing inspection and testing by consultant	3.3	Internal company problems	2.7	Frauds	3	Company organisation	2
Materials-related	Shortage of construction materials in market	3.4	Shortage of materials required	2.3	Shortage of construction materials in market	3.6	Delay in manufacturing special building materials	2.9	Shortage of materials required	3.6	Delay in manufacturing special building materials	2.6
	Shortage of materials required	3.4	Shortage of construction materials in market	2.3	Shortage of materials required	3.4	Shortage of construction materials in market	2.8	Shortage of construction materials in market	3.4	Shortage of construction materials in market	2.5
	Late procurement of materials	3.3	Delay in manufacturing special building materials	2.3	Late procurement of materials	3.4	Changes in materials prices	2.8	Delay in materials delivery	3.4	Shortage of materials required	2.4
	Delay in materials delivery	3.2	Changes in materials prices	2.2	Delay in manufacturing special building materials	3.4	Late in selection of finishing materials due to availability of many types in market	2.8	Late procurement of materials	3.3	Late procurement of materials	2.4
	Damage of sorted material while they are needed urgently	3.2	Delay in materials delivery	2.1	Delay in materials delivery	3.3	Shortage of materials required	2.7	Damage of sorted material while they are needed urgently	3.2	Late in selection of finishing materials due to availability of many types in market	2.3
Labour-related	Shortage of manpower (skilled, semi-	3.6	Low skill of manpower	2.4	Shortage of manpower (skilled, semi-skilled,	3.6	Low skill of manpower	2.8	Shortage of manpower (skilled, semi-skilled, unskilled	3.7	The required labour skills are not available	2.6

	skilled, unskilled labour)				unskilled labour)				labour)			
	Poor qualification of the contractor's technical staff assigned to the project	3.5	The required equipment and tools are not available	2.4	Low skill of manpower	3.4	Shortage of manpower (skilled, semi-skilled, unskilled labour)	2.7	Shortage of technical professionals in the contractor' s organization	3.6	Shortage of manpower (skilled, semi-skilled, unskilled labour)	2.5
	Low skill of manpower	3.2	Shortage of manpower (skilled, semi-skilled, unskilled labour)	2.3	Shortage of technical professionals in the contractor' s organization	3.3	Poor qualification of the contractor's technical staff assigned to the project	2.7	Poor qualification of the contractor's technical staff assigned to the project	3.6	The required equipment and tools are not available	2.5
	Shortage of technical professionals in the contractor' s organization	3.2	Poor qualification of the contractor's technical staff assigned to the project	2.3	The required labour skills are not available	3.3	The required labour skills are not available	2.6	Low skill of manpower	3.4	Low skill of manpower	2.4
	The required labour skills are not available	3.1	The required labour skills are not available	2.3	The required equipment and tools are not available	3.3	The required equipment and tools are not available	2.5	The required labour skills are not available	3.3	Poor qualification of the contractor's technical staff assigned to the project	2.4
Contract/relationship-related	Original contract duration is too short	3.2	Major disputes and negotiations	2.1	Original contract duration is too short	3.4	Major disputes and negotiations	2.6	Original contract duration is too short	2.9	Inappropriate overall organization structure linking all parties to the project	2.2
	Major disputes and negotiations	3.1	Lack of communications between the parties	1.9	Major disputes and negotiations	3.2	Original contract duration is too short	2.6	Lack of communications between the parties	2.9	Original contract duration is too short	2
	Ineffective delay penalties	3	Original contract duration is too short	1.8	Lack of communications between the parties	3.2	Inappropriate overall organization structure linking all parties to the project	2.5	The scope of work the contractor is not well defined	2.9	Lack of communications between the parties	2
	Inappropriate overall organization structure linking all parties to the project	3	Type of construction contract	1.8	Legal disputes between various parts	3.1	Lack of communications between the parties	2.4	Conflict between contract documents	2.9	Inadequate definition of substantial completion	2
	Type of project bidding and award (negotiation, lowest bidder)	2.8	Type of project bidding and award (negotiation, lowest bidder)	1.7	The scope of work the contractor is not well defined	3.1	Conflict between contract documents	2.4	Major disputes and negotiations	2.8	Major disputes and negotiations	1.9

Table 3: Top 5 results

Fig 1: Difference results
Vertical bars denote 0.95 confidence intervals

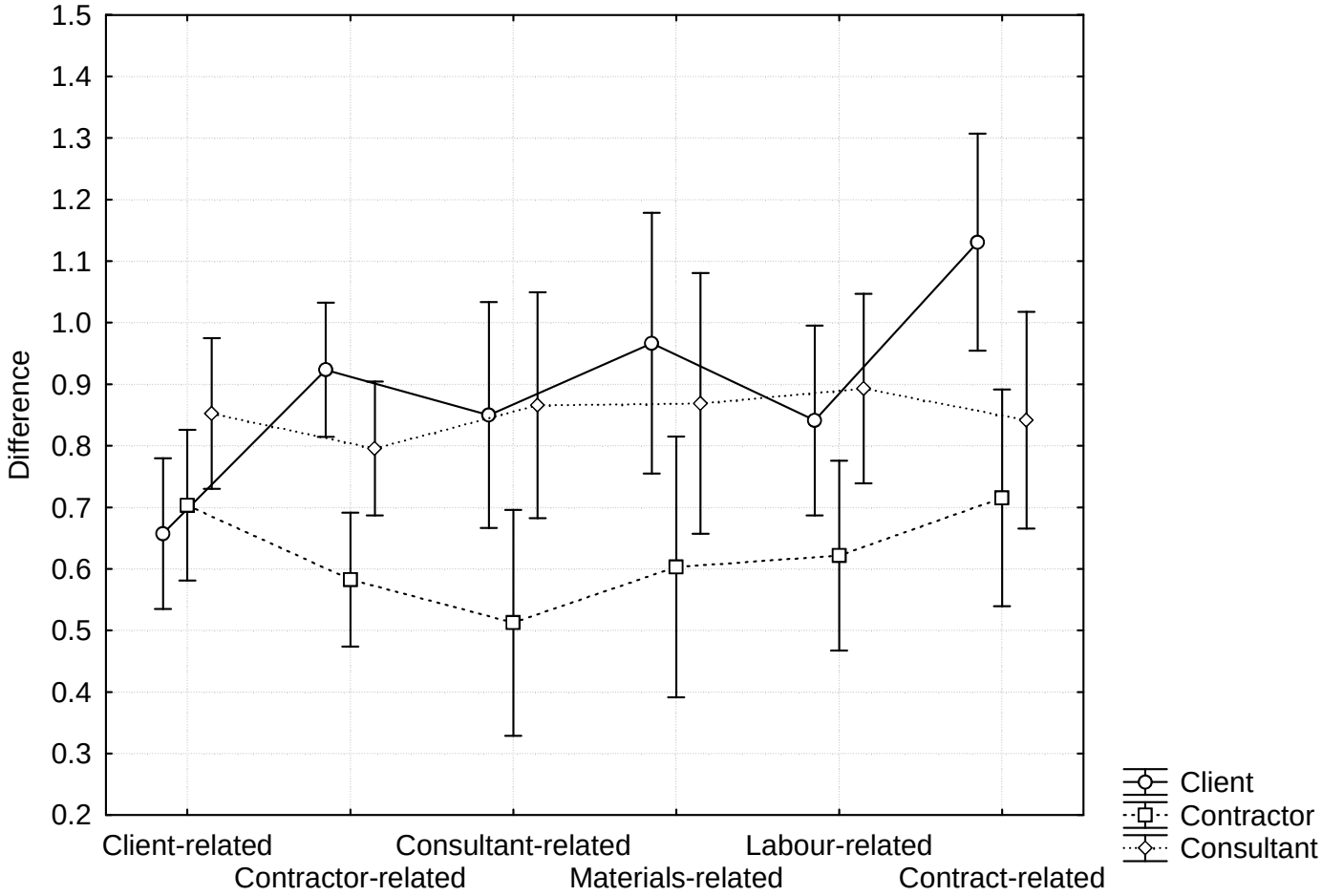

Fig 2: Future results
Vertical bars denote 0.95 confidence intervals

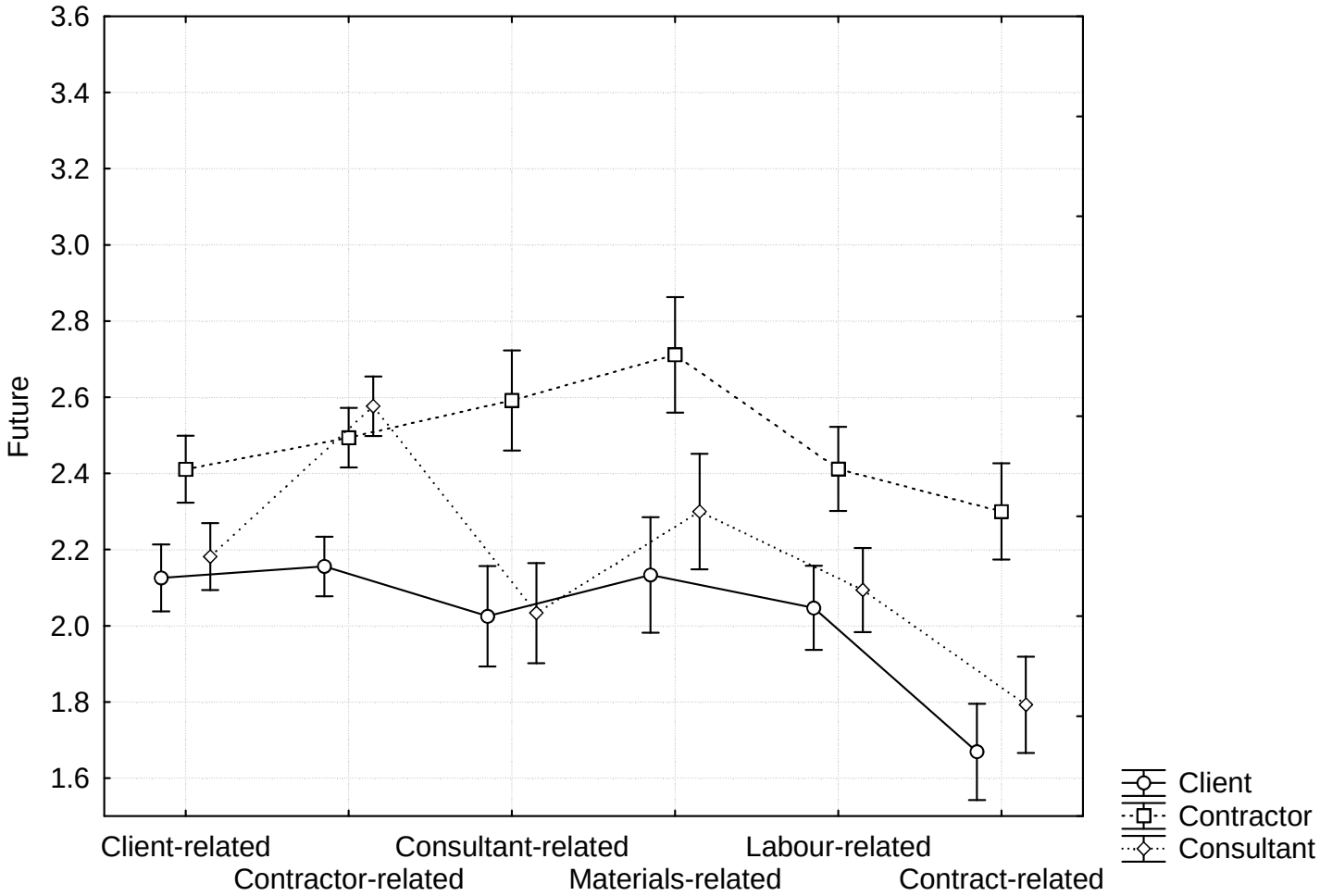

Fig 3: Now results
Vertical bars denote 0.95 confidence intervals

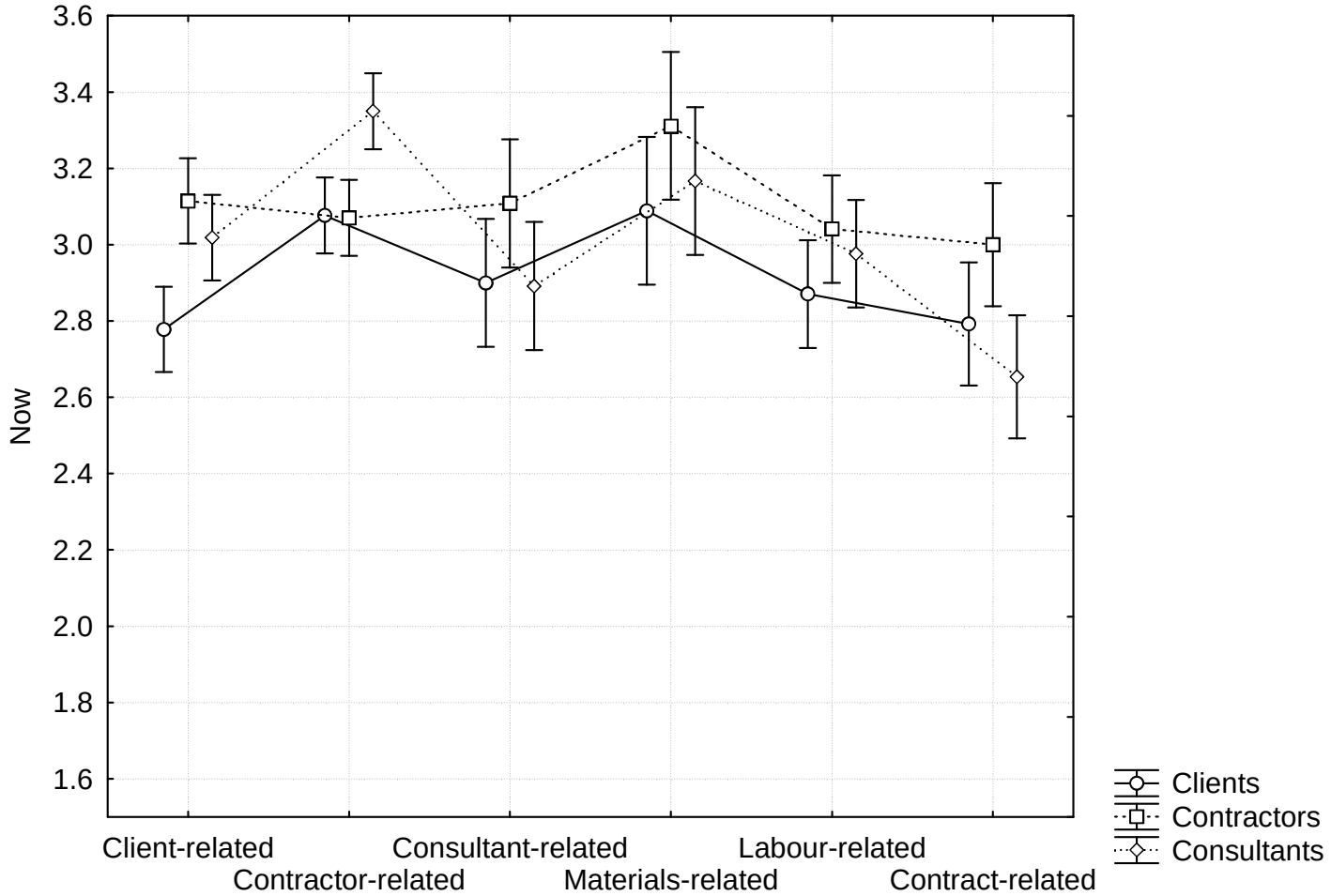

Fig 4: Client-related causes of delay

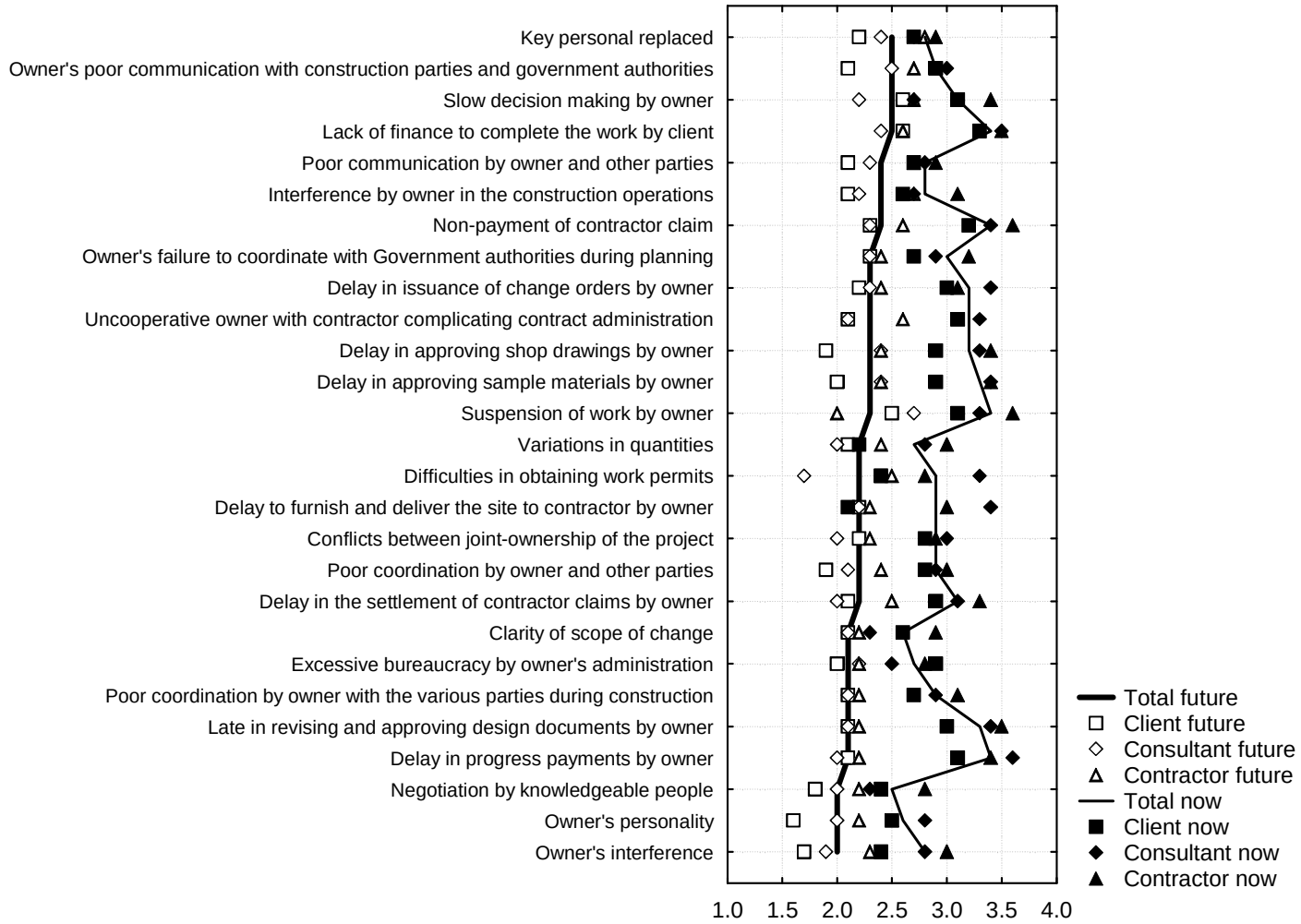

Fig 5: Contractor-related causes of delay

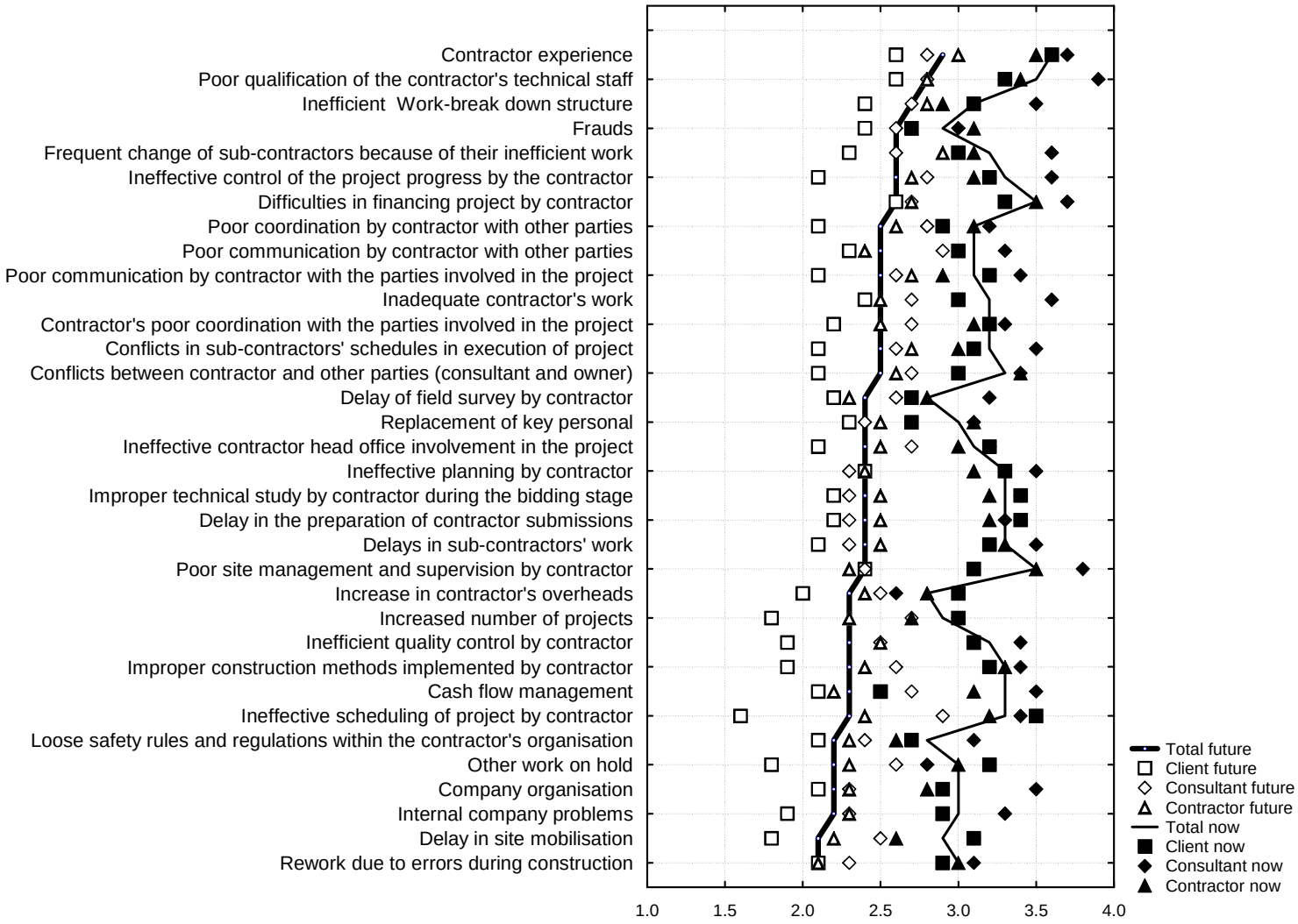

Fig 6: Consultant-related causes of delay

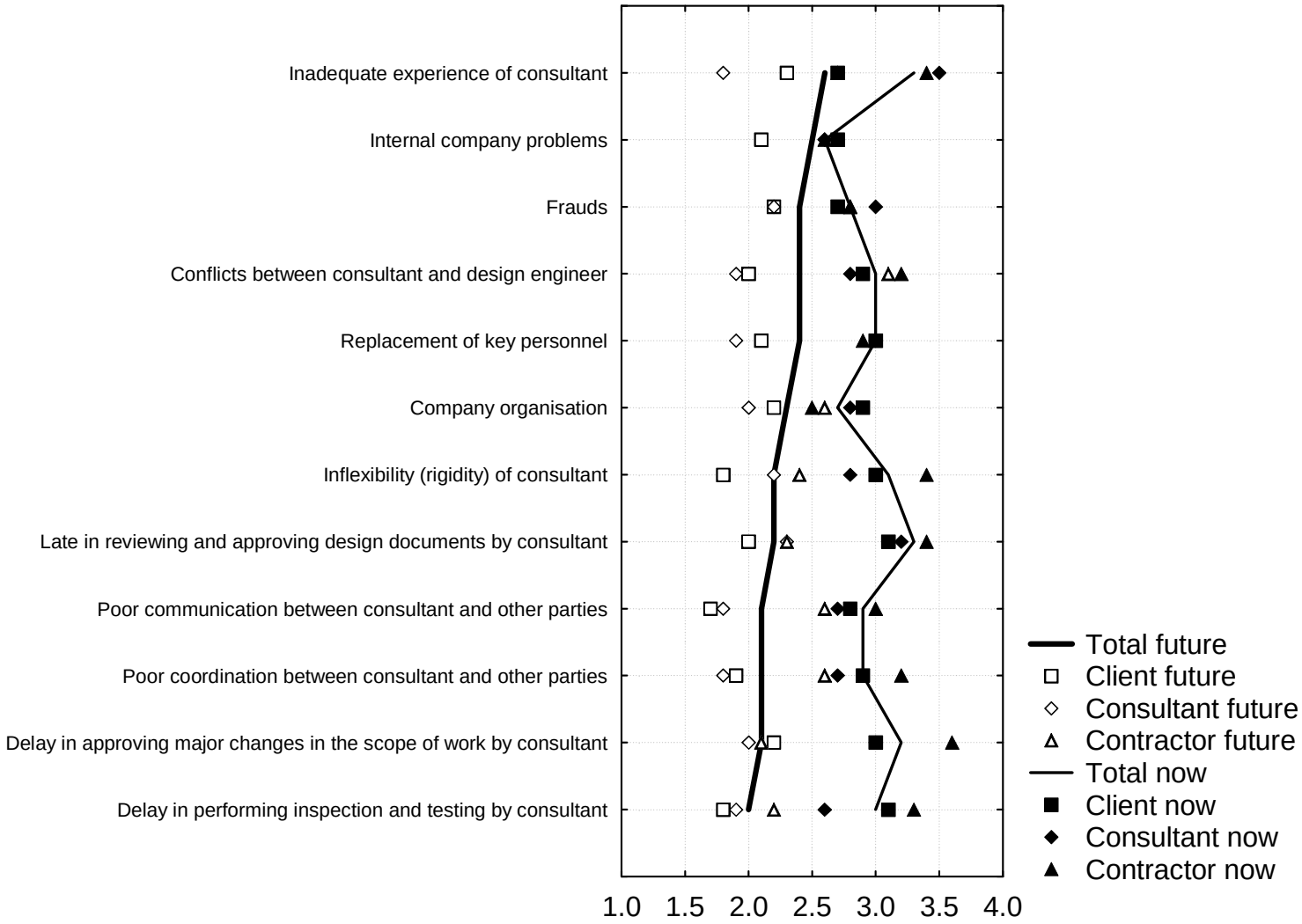

Fig 7: Materials-related causes of delay

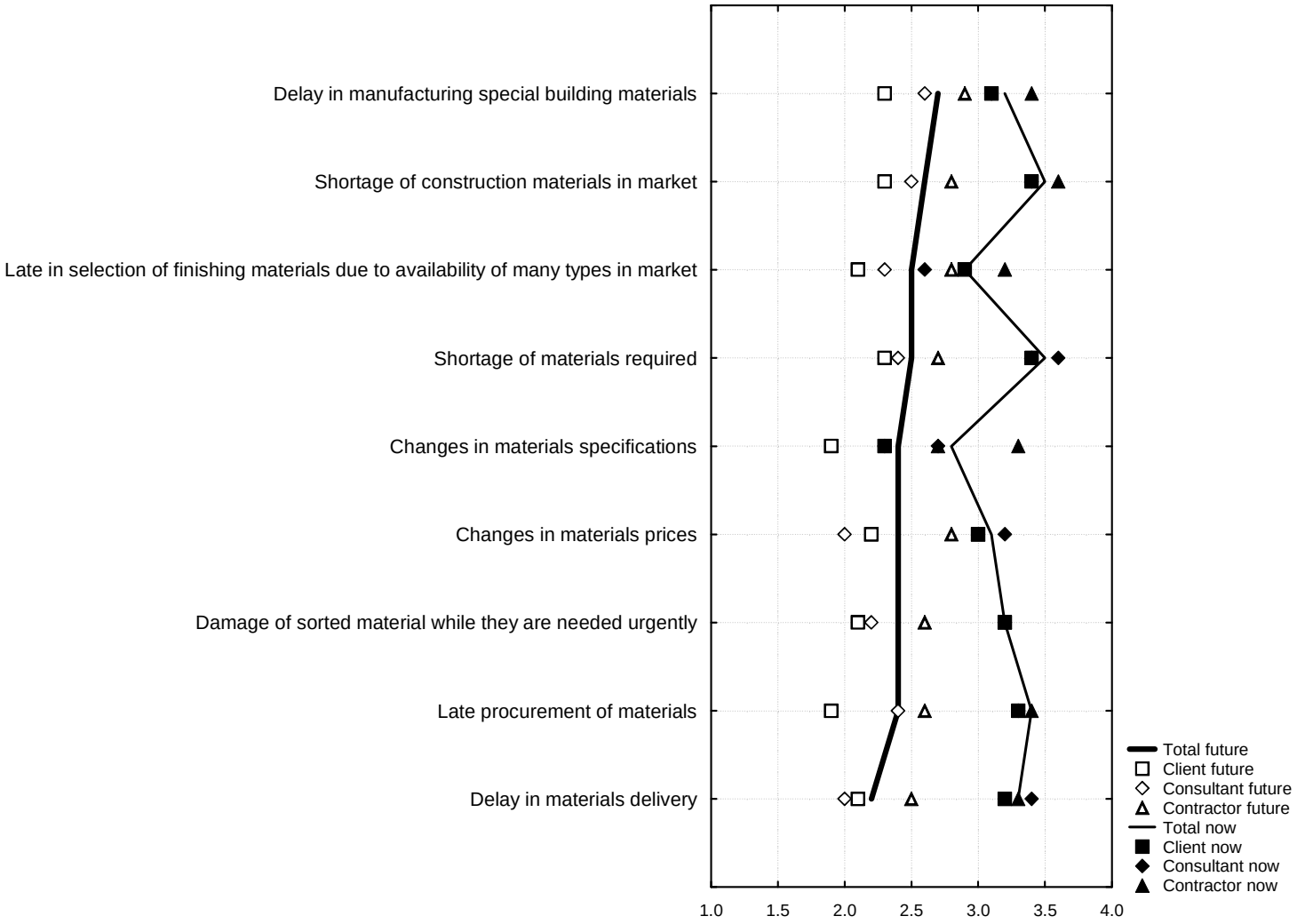

Fig 8: Labour-related causes of delay

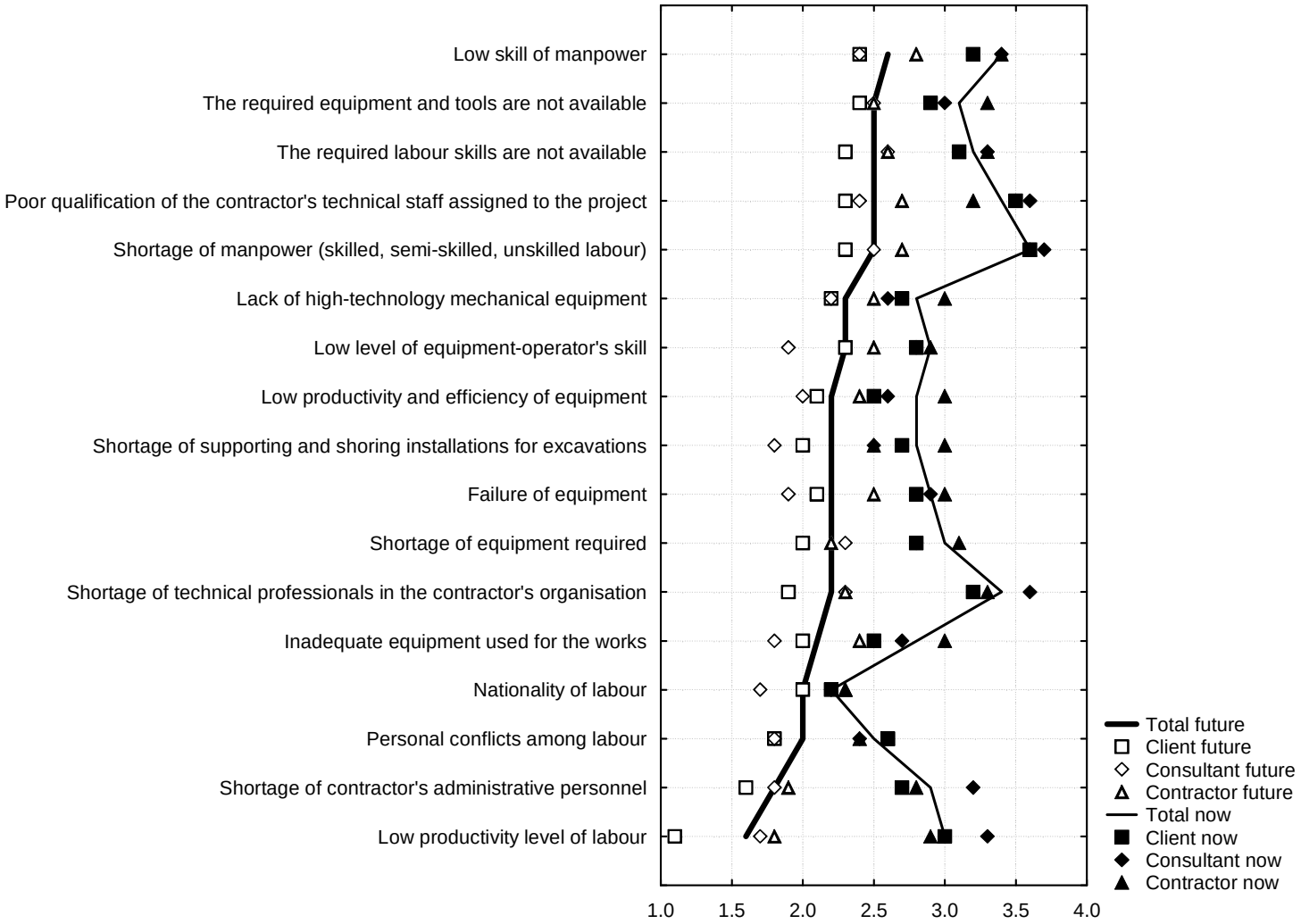

Fig 9: Contract/relationships-related causes of delay