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# Subjective and objective stress in construction cost estimation

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Cost estimators play an important role in an organization, as they produce most predictions of probable final construction cost. Since both under- and overestimates can be costly, attention should be paid to the estimating tasks. People involved are therefore likely to experience a considerable amount of mental and emotional stress as a result of inaccurate estimation. The types of stress can be divided into objective stress (OS), subjective stress (SS) and emotional exhaustion (EE). The research described in this paper examined the relationships between OS, SS, EE and stressors based on a survey of construction cost estimation personnel. T-tests, factor analyses, correlation analyses and regression analyses were applied to identify differences between the professional estimators and other personnel, and the types of stress endured. The results indicate that the stress levels of both the professional estimators and other personnel are similar, with OS being significantly higher than SS, which is in turn significantly higher than EE. For professional estimators, increased levels of OS were found to be mainly associated with lack of autonomy and unfair reward and treatment. Increased SS and EE, on the other hand, appeared to be a function of relationship conflict, work underload, lack of feedback, lack of autonomy and unfair reward and treatment.

**Keywords:** Cost estimator, emotional exhaustion, objective stress, subjective stress, stress, stressors

## Introduction

Both client/owners and constructors need to be informed in advance of the likely costs of construction work. For constructors, successful bidding is critical for survival and this depends to a large extent on estimates of project cost to the constructor (e.g. Skitmore, 1989). Underestimates, for example, are more likely to win loss-making contracts, while overestimates are likely not to win any contracts at all. Estimates of client/owner costs are just as important, as underestimates imply cost overrun while overestimates often deny value for money.

The size and complexity of construction work is such that several personnel are often involved in producing estimates. These personnel include cost estimators, engineers, planners and other procurement staff. Both client/owners and constructors need to keep the time

spent in estimating to a minimum. For client/owners, an extended pre-tender period is an unwelcome interference in the procurement process, while for constructors, a lengthy and expensive estimating process simply adds to the overheads for unsuccessful bids. Typically, therefore, the estimating personnel need to work together tightly as a team for a short and fixed pre-tender period.

In such circumstances, it is not surprising that cost estimation is regarded by many as a highly stressful task for the personnel involved. This applies especially to the cost estimators themselves, whether employed by constructors for bidding or by client/owners for budgetary monitoring and control. However, stress may involve both eustress and distress dimensions in everyday life or a specific task (Stewart, 2006). *Eustress* represents the desirable outcome of stress for the improvement of working performance, while *distress* refers to the stress with a negative implication such as disease (Suedfeld, 1997). In order to optimize the stress of cost estimators, this paper aims to identify different types of stresses and

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examine their relationships with various stressors occurring during the estimation process.

Research to date has been concerned with the relationship between individual coping behaviour and relative working performance (Leung *et al.*, 2005a; Leung *et al.*, 2006), with stress being evaluated by the deviation between the expected and actual abilities to perform certain tasks (Leung, 2004; Leung *et al.*, 2005a, 2006). Clearly, this kind of stress focuses on event-related feelings, and therefore evaluates stress in an objective way. However, stress is not a product of events alone, but a function of both the events and the subjectively defined demands of the situation created by those events (Lazarus, 1966). These are termed *subjective stress* (SS) and *emotional exhaustion* (EE) to distinguish them from events-related *objective stress* (OS). The aspect of stress measured by earlier work, therefore, was limited to the frequency of stressor events within social systems (Linsky *et al.*, 1995). As a result, the underlying rationale for the research reported in this paper was that:

- (1) in addition to event-related OS, the level of stressful life events also influences the estimators' stress through a psychological process;
- (2) different stress levels exist between OS, SS and EE;
- (3) different stress levels exist between professional estimators and other estimating personnel;
- (4) different types of stress are induced by different stressors.

## OS, SS and EE

### OS and SS

Stress is regarded by many as contained neither in the person nor in the environment, but in the relationship between the two (Lazarus, 1990), and therefore includes job characteristics, organizational structure and social relationships. Hence, stress is likely to occur when there is conflict between the individual and the environment (Riley and Zaccaro, 1987). As a transaction, stress is also a dynamic and ongoing process (Lazarus, 1991; Dewe *et al.*, 1993). The individual interacts with the environment and continuously adjusts to better cope with the stress.

Stress is the general concept describing a 'load' on the system. This includes external and internal factors. External factors are considered to cause the OS while SS is seen as resulting from internal factors (Rodney, 2003; Laplante *et al.*, 2004). OS mainly focuses on the evaluation of events experienced by the person concerned. For estimation personnel, these include such

events as the number of deadlines, number of projects, etc. SS, on the other hand, is mainly evaluated by the degree of satisfaction with the environment, including feelings of happiness or depression, confidence in the organization, etc. Hence, SS is measured as the degree of subjective impact experienced as a result of a specific event (Horowitz *et al.*, 1979), while OS refers to a negative discrepancy between an individual's received state and desired state (Edwards, 1988).

### EE

EE is closely related to *job burnout*. It is a gradual process due to prolonged exposure to stressful work conditions in which a formerly productive and committed worker loses all interest in his or her job or profession. The person experiences physical and emotional exhaustion, lack of interest in work and detachment from colleagues (Goliszek, 1992). Burnout is viewed as a process comprising a sequence of three components: (1) EE; (2) cynicism; and (3) efficacy. These have been investigated extensively. Three major approaches used to date are due to Maslach, Golembiewski and Byrne, Lee, Ashforth. EE could be considered as a result of cynicism and inefficacy (Golembiewski, 1989), or a stimulus of inefficacy (Byrne, 1994; Lee and Ashforth, 1996) or cynicism (Maslach and Jackson, 1996). In summary, an extensive literature accepts that burnout is caused by prolonged job stress (Brill, 1984) and therefore is considered to be a type of stress (Gaines and Jermier, 1983).

### Stressors

Stressors are the sources of stress. They can be events, people or thoughts which lead a person to perceive that some threatening demands are being made on him or her (Riley and Zaccaro, 1987). Generally, stressors can be divided into four different categories: (inter) personal, task, organizational and physical stressors (Leung, 2004; Leung *et al.*, 2005b; see Table 1). Personal stressors may be related to the person's genetic make-up, family background, personality traits, cultivated habits and environmental influences (Khanna, 1998). The person's working relationships and the social support available from colleagues, bosses and subordinates are related to interpersonal stressors. A poor working environment is a physical stressor (Driskell and Eduardo, 1991; Quick *et al.*, 1997). Task characteristics can be associated with stress and treated as stressors if the work demands exceed the resources available (Kahn and Byosiore, 1990) or involve tediously repetitive tasks (Cooper and Marshall, 1978). Organizational stress is concerned with the

**Table 1** Stressors of estimators

Stressors	Literature in stress management	For estimators in the industry, ...
<i>Personal stressors</i>		
Type A behaviour	An individual with Type A personality is extremely competitive, highly committed to work and has a strong sense of time urgency (Chesney and Rosenman, 1980).	Estimators with this type of personality generally contain higher emotional distress and suffer from more stress symptoms.
Relationship conflict	Poor relationships are induced as different beliefs between individual and organization, low interest in listening, lack of support in implementation and mistrust among participants, which subsequently produce low job satisfaction and psychological stress (Gmelch, 1982).	The construction industry emphasizes teamwork. Estimators need to interact with their colleagues, supervisors and meet the expectation of construction company/consultant firms. Either team conflict or value conflict (individual–organization) can induce stress in estimators during the estimation process.
<i>Task stressors</i>		
Workload	Excessive workload causes stress and anxiety due to the intensive working in a limited time period, while under workload can result in boredom and apathy due to insufficient work being required (Cooper and Marshall, 1978).	Estimators normally need to estimate construction cost within a specific period and update the budget frequently. This involves undertaking repetitive tasks (e.g. to check drawings and suppliers, to price rates and to sum up total amount). Thus they may suffer stress due to either too much workload (complicated) or too little workload (boring).
Role ambiguity	Unclear responsibilities and scope of work contribute stress to individuals resulting in depression, low self-esteem, dissatisfaction, futility and intention to leave (Buller, 2000). Therefore, role ambiguity creates a stressful environment.	Construction projects are dynamic, and cost estimators are often confronted with ambiguity caused by changes in client requirements, designs, laws or regulations. The problem is aggravated by job/task ambiguity, in the form of unclear scoping and task objectives.
<i>Organizational stressors</i>		
Lack of autonomy	Numerous researches have found that the degree of autonomy on the job has a direct relationship on stress level (e.g. Nevels, 1986; Beehr, 1995).	When cost estimators feel they are being treated as instruments by their supervisors, their 'SS' may rise due to depression, low self-esteem or weak morale. In fact, it is very difficult for estimators to carry out their job effectively without adequate autonomy. Therefore, 'OS' is induced.
Unfair reward and treatment	Reward refers to the basic norm of social exchange, i.e. reciprocity (Smith <i>et al.</i> , 2005). Individuals who have had greater upward career development may experience less stress because of fair and equitable policies and procedures (Paderon, 1991).	Estimators' perceptions of their abilities may decrease due to low rewards. Their emotions may be affected if they cannot see any fair or equitable reward system (e.g. OT pay or promotion) after hardworking.
Lack of feedback	Feedback is an essential step in the entire management process. Performance appraisal generates stress on the estimators, but it can assist supervisors adjust the workload and the job nature appropriately (increase/decrease) (Beehr and Jex, 2001).	A regular feedback process provides sufficient data to the supervisor to change the organizational structure, adjust the workload of estimators and clarify the job nature of employees. Hence, feedback provides a route to optimize the stress of estimators in construction/consultant firms.
<i>Physical stressors</i>		
Poor working environment	Working environment relates to job setting, temperature and the design of offices. Research findings indicate strong relationships among the environment, level of stress, and physical/psychological health (Gmelch, 1982; Furnham, 1997).	Estimators need to calculate contract sums accurately, therefore stress may occur by working in uncomfortable environments such as extreme temperatures (too cold or too hot) and overcrowded environments (Leung <i>et al.</i> , 2005b).

policy and climate in an organization. Policies made without concern for workers' feelings can cause great stress (Karasek *et al.*, 1981).

In fact, where chronic stress (OS or SS) is generated and unsolved, it is inevitable that individuals will suffer from 'EE', the major and initial dimension of burnout (Leiter and Harvie, 1996; Maslach and Leiter, 1997; Lloyd and King, 2001).

## Research method

A questionnaire was developed and administered to a variety of construction personnel with direct experience of construction estimation. Two hundred sets of questionnaires were distributed by fax, e-mail or in person to these personnel between October and December 2003. The respondents were working in a variety of organizations, including developers, consultant firms, public sector organizations, main contractors and subcontractors. There were 73 respondents in total—a return rate of 36.5%.

SS and EE were evaluated on a seven-point Likert scale ranging from 1 to 7, expressing stress from 'none', represented by (1), to 'a great deal', represented by (7) (Banks *et al.*, 1980; Maslach and Jackson, 1996). To measure the level of OS, Gmelch (1982) has proposed using the deviation between expected and actual abilities of people when they encounter stress. Stress, therefore, becomes apparent when actual abilities are lower than expected (Schuler, 1980; McGrath *et al.*, 1989). The respondents were therefore asked to rate their actual (a) and expected (b) abilities on the same scale. The overall level of the stress was taken to be represented by the sum of the differences between (a) and (b) ratings.

T-tests were first carried out to compare the means of the OS, SS and EE, and then to check the different stress levels of the various personnel involved. For the analysis, two respondent groups were defined: 'professional estimators' (PE) and 'other personnel' (OP). Fifty-four of the respondents were contractors' estimators and quantity surveyors, who formed the PE group (quantity surveyors were classified into this group as they acted as part-time estimators for pricing tenders), with the OP group being made up of the remaining nineteen estimating-related respondents, comprising planners, engineers, project managers, procurement staff, contract managers and directors. As a check on the sensitivity of the grouping arrangement, this was repeated again later but with only the contractors' estimators comprising the PE group and all the remaining respondents comprising the OP group. A third repetition was also done with the contractor and

developer estimators comprising the PE group and the remaining respondents again comprising the OP group. Only the results of the first grouping arrangement are reported in this paper. It should be noted, however, that all three grouping arrangements produced very similar results in terms of statistical significance.

Alpha was then used to ensure the reliability of eight stressors. Correlation analysis was employed to find the relationships between stresses and stressors, while linear regression analysis was used to identify the above relationships. In all cases, statistical significance was judged at the conventional 5% level.

## Data analysis and findings from quantitative data

### T-tests on OS, SS and EE

Paired-sample t-tests were conducted to ascertain if the mean stress levels were significantly different between the PE and OP groups of respondents. The OS and SS, SS and EE results, together with their Eta-squared values are summarized in Table 2. For the PE group, the difference in means between OS and SS is  $-4.981$ , the mean of the OS (51.967) being significantly greater than that of SS (46.986). This indicates that the PE respondents experience more OS than SS. The Eta squared is 0.191, indicating a large effect. As with the PE group, the OP group is more affected by OS than SS, with a significant difference in means of  $-6.730$ . The Eta squared in this case is 0.242, again indicating a large effect. In general, it was found that OS has the highest mean followed by SS and with EE being the lowest.

The independent t-test was used to test for differences between the PE and OP groups (Table 3). Although the means of the PE group are higher than OP group, these are not statistically significant. As a result of these, both the PE and OP groups were combined into one group for further analysis.

### Reliabilities of stressors

Based on the literature review, 25 questions were designed to measure the eight stressors in the questionnaire: Type A behaviour (F1) and relationship conflict (F2) under the *Personal stressors* category; work underload (F3) and role ambiguity (F4) under the *Task stressors* category; lack of autonomy (F5), unfair reward and treatment (F6) and lack of feedback (F7) under the *Organizational stressors* category; and poor working environment (F8) under the *Physical stressor* category. The questions for each stressor were tested successfully for stability, reliability and consistency (Rizzo *et al.*,

**Table 2** T-test among SS, OS and EE

Estimation personnel	Paired stress (X-Y)	Mean score		Mean differences	t	df	Sig. (2-tailed)	Eta-squared value
		X	Y					
PE	SS-OS	46.986	51.967	-4.981	-3.507	53	0.001	0.191
	SS-EE	46.986	32.106	14.881	7.395	53	0.000	0.513
	EE-OS	32.106	51.967	-19.861	-11.238	53	0.000	0.708
OP	SS-OS	43.770	50.500	-6.730	-2.332	18	0.032	0.242
	SS-EE	43.770	31.047	12.722	4.254	18	0.000	0.516
	EE-OS	31.047	50.500	-19.453	-6.333	18	0.000	0.702

Notes: 'Eta-squared value' represents the effect size statistics: 0.01=small effect; 0.06=moderate effect; 0.14=large effect (Cohen, 1988; Pallent, 2001).

1970; Sims *et al.*, 1976; Evers *et al.*, 2000). To ensure the reliability of each stressor for construction estimators, the alpha values of each stressor in this study are also shown in Table 4. The results show that all stressors, except role ambiguity (F4), are higher than 0.6, therefore seven stressors were analysed in the following correlation and regression analyses.

### Pearson correlation analysis and regression analysis

#### For all estimation participants

Bivariate correlation and regression analysis were used to identify the relationships between stresses and stressors. The Pearson correlation results (Table 5) indicate that OS is significantly correlated with only lack of autonomy (F5: 0.357). For the correlation between SS and stressors, relationship conflict (F2: 0.339) and lack of autonomy (F5: 0.412) are significant, while EE further significantly relates to four stressors including relationship conflict (F2: 0.339), work underload (F3: 0.310), lack of autonomy (F5: 0.518) and unfair reward and treatment (F6: 0.438).

For the regression results (Table 6), lack of autonomy is the first factor entering into the regression models for all three types of stress (OS, SS and EE) for the estimator group. Thereafter, lack of feedback enters into the OS model. These two stressors explain 21.5% of the OS variance. Lack of autonomy, lack of feedback and relationship conflict enters into the SS equation explaining 24.0% of the SS variance, while lack of

autonomy and unfair reward and treatment enter into the EE equation explaining 36.9% of EE variance.

#### For PE and OP groups

Separating the participants into PE and OP groups, however, provides a clearer picture (Tables 4 and 5). The results of the Pearson correlation (Table 5) indicate that OS, SS and EE are significantly correlated with more stressors in the PE group than in the OP group. Lack of autonomy is significantly correlated with all SS, OS and EE in the PE group; and only relates to the SS in the OP group. SS is significantly related to relationship conflict (F2: 0.349), lack of autonomy (F5: 0.303), and lack of feedback (F7: -0.441) for the PE group; and only work underload (F3: 0.480) and lack of autonomy (F5: 0.485) are significantly correlated for the OP group. For the OS, lack of autonomy (F5: 0.425) and unfair reward and treatment (F6: 0.271) were significantly related in the PE group, while no stressor was correlated with OS in the OP group. EE is significantly correlated with relationship conflict (F2: 0.384), work underload (F3: 0.269), lack of autonomy (F5: 0.566) and unfair reward and treatment (F6: 0.402) for the PE group; and unfair reward and treatment (F6: 0.530) and lack of feedback (F7: 0.490) for the OP group.

From the results of the regression analysis for the PE group (Table 6), lack of autonomy is a single predictor of OS for the PE group and a predictor of SS for the OP group, while no model is generated for the OS of OP group. This result further confirms the result of

**Table 3** T-test for two groups (PE-OP)

Stress	Mean			Levine's test for equality of variances		T-test for equality of means		
	PE	OP	Difference	F	Sig.	t	df	Sig. (2-tailed)
SS	46.986	43.770	3.216	0.085	0.772	0.994	71	0.324
OS	51.967	50.500	1.467	2.214	0.141	1.099	71	0.275
EE	32.106	31.047	1.058	0.022	0.882	0.294	71	0.770

**Table 4** Coefficient alpha reliabilities for the stressors

Factors		Nature	Items	Source	Alpha
<i>Personal stressors</i>					
F1	Type A behaviour	+	1. I am an achievement-oriented person who has the need to win.	Evers <i>et al.</i> (2000)	0.698
		+	2. I do not go home before I have finished what I have planned.	Evers <i>et al.</i> (2000)	
F2	Relationship conflict	+	3. I demand a lot of the quality of my work.	Evers <i>et al.</i> (2000)	0.703
		−	4. I seldom delegate tasks because others cannot complete the tasks as well as I can.	Gmelch (1982)	
		−	5. There often seems to be a lack of trust between myself and my subordinates.	Gmelch (1982)	
		−	6. I am often caught between conflicting demands from my supervisor and staff.	Gmelch (1982)	
		−	7. My beliefs often conflict with those of the organization.	Gmelch (1982)	
<i>Task stressors</i>					
F3	Work underload	−	8. I frequently find my work boring and repetitive.	Gmelch (1982)	0.701
		−	9. I feel my skills and abilities are not being used well.	Gmelch (1982)	
		−	10. I have a lot of responsibility in my job.	Gmelch (1982)	
F4	Role ambiguity	+	11. I understand exactly what is expected of me.	Rizzo <i>et al.</i> (1970)	0.474
		−	12. I am not sure I have divided my time properly among task.	Rizzo <i>et al.</i> (1970)	
		−	13. There is constant pressure to work every minute, with little opportunity to relax.	Rizzo <i>et al.</i> (1970)	
<i>Organizational stressors</i>					
F5	Lack of autonomy	−	14. I have to refer matters upwards when I can really deal with them adequately myself.	Dewe (1991)	0.766
		−	15. My boss often deals with me in an autocratic and over demanding manner.	Dewe (1991)	
F6	Unfair Reward and treatment	−	16. I was given insufficient authority to do my job properly.	Dewe (1991)	0.739
		−	17. I find the reward I get is relatively low when compared to the external market.	Calnan <i>et al.</i> (2004)	
		−	18. I often feel that the organization treats us unfairly.	Calnan <i>et al.</i> (2004)	
		−	19. I find the reward I get does not balance with the effort I pay.	Calnan <i>et al.</i> (2004)	
F7	Lack of feedback	−	20. It is hard to receive information from my supervisor on my job performance.	Sims <i>et al.</i> (1976)	0.735
		+	21. I can get feedback from my supervisor on how well I'm doing.	Sims <i>et al.</i> (1976)	
		−	22. I have no opportunity to find our how well I am doing on my job.	Sims <i>et al.</i> (1976)	
<i>Physical stressor</i>					
F8	Poor working environment	−	23. The lighting in the office is too dim.	Gmelch (1982)	0.856
		−	24. My office is too noisy.	Gmelch (1982)	
		−	25. My office is too crowded.	Gmelch (1982)	

correlation analysis in the previous part (i.e., no significant relationship between OS and stressors in the OP group; refer to Table 5). On the other hand, lack of feedback is the first factor entering into the regression model for SS for the PE group. Thereafter, relationship conflict enters into the model. These two stressors explain 29.4% of the SS variance. Lack of autonomy and unfair reward and treatment enter into the EE equation for the PE group, explaining 43% of EE variance, while unfair reward and treatment is the

only predictor of EE for the OP group with the explanation of 28.1% of variance.

## Discussion

The results of the t-test indicate that OS can be considered as the first step in detecting the stress of estimation personnel; while estimators with high levels of SS and EE may represent that they are facing/feeling

**Table 5** Correlation between stressors and stresses

Estimation personnel	Dependent	F1	F2	F3	F5	F6	F7	F8
ALL	OS	-0.062	0.044	0.018	<b>0.412**</b>	0.197	-0.180	-0.012
	SS	-0.111	<b>0.339**</b>	0.123	<b>0.357**</b>	0.145	-0.211	-0.144
	EE	0.110	<b>0.339**</b>	<b>0.310**</b>	<b>0.518**</b>	<b>0.438*</b>	0.031	0.021
PE	OS	-0.048	-0.011	-0.061	<b>0.425**</b>	<b>0.271*</b>	-0.263	-0.103
	SS	-0.010	<b>0.349**</b>	-0.029	<b>0.303*</b>	0.143	<b>-0.441**</b>	-0.160
	EE	0.121	<b>0.384**</b>	<b>0.269*</b>	<b>0.566**</b>	<b>0.402**</b>	0.134	-0.046
OP	OS	-0.126	0.159	0.189	0.312	-0.068	0.053	0.265
	SS	-0.406	0.297	<b>0.480*</b>	<b>0.485*</b>	0.094	0.322	-0.124
	EE	0.074	0.235	0.454	0.364	<b>0.530*</b>	<b>0.490*</b>	0.190

Notes: \* Correlation is significant at the 0.05 level (2-tailed); \*\* correlation is significant at the 0.01 level (2-tailed).  
F1–F8 refer to Table 4.

serious stress in the estimation process compared with the OS. Organizational stressors (lack of autonomy and unfair reward and treatment) are significantly related to the OS, while personal stressors (relationship conflict), task stressors (work underload) and organizational stressors (lack of autonomy, unfair reward and treatment and lack of feedback) are correlated with the SS and EE of construction estimators. The identified

relationships among SS, OS, EE and stressors are summarized in Figure 1.

### Different types of stress

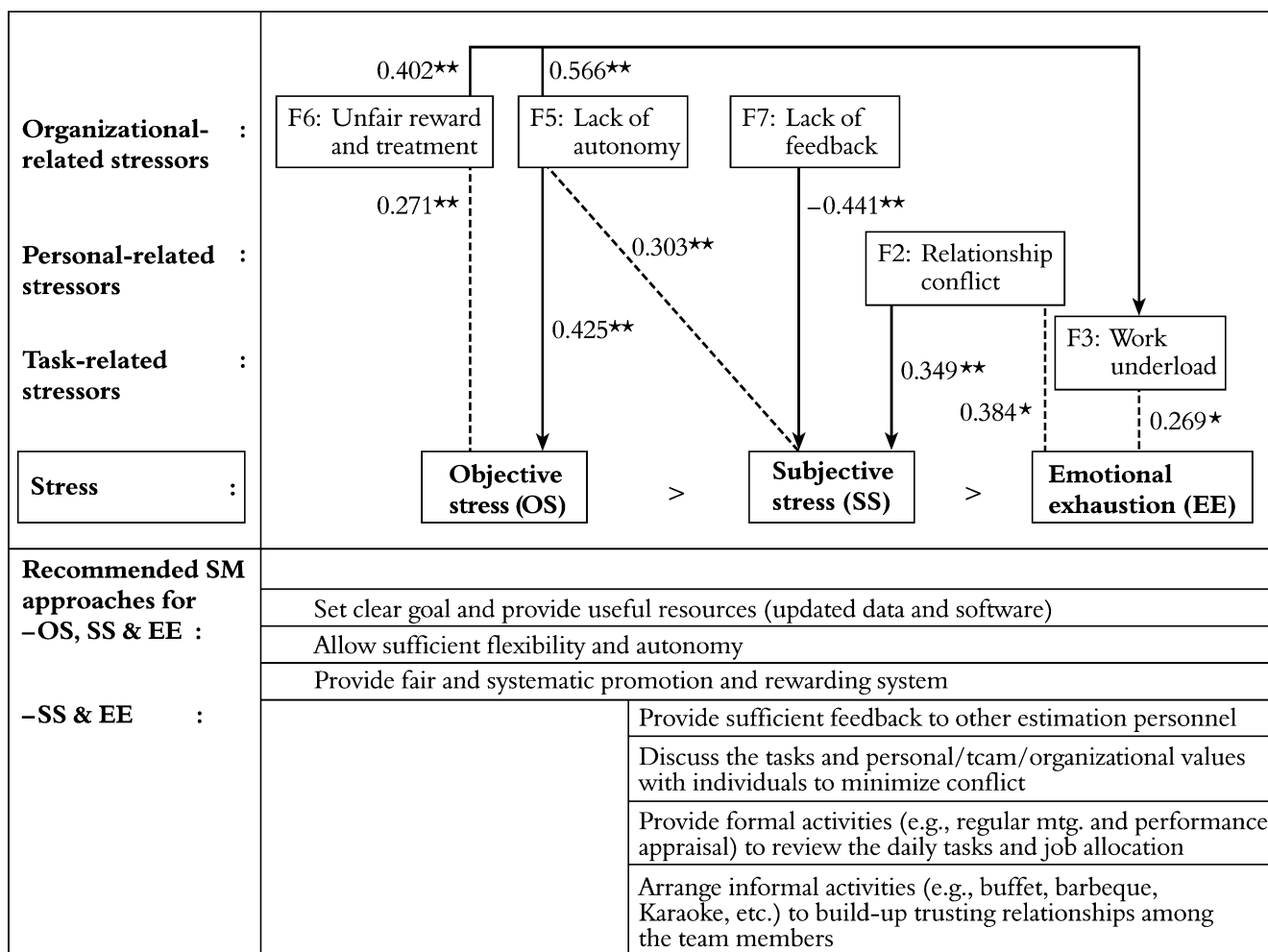
The study revealed that stress should not simply be used as a one-dimensional measure among estimation personnel. Instead, stress is a multidimensional ele-

**Table 6** Regression analysis between stress and stressors

Estimation personnel	Dependent	Model	Unstandardized Coefficients		t	Sig	R	R <sup>2</sup>
			B	Std. error				
ALL	OS	(Constant)	-4.352	3.273	0.188	0.000	0.464	0.215
		<i>F5 Lack of autonomy</i>	0.834	0.207	0.000			
		<i>F7 Lack of feedback</i>	-0.424	0.211	0.049			
	SS	(Constant)	33.122	5.439	0.000	0.000	0.490	0.240
		<i>F5 Lack of autonomy</i>	0.807	0.318	0.013			
		<i>F7 Lack of feedback</i>	-0.721	0.305	0.021			
	EE	<i>F2 Relationship conflict</i>	0.636	0.283	0.028		0.607	0.369
		(Constant)	1.727	2.039	0.400	0.000		
		<i>F5 Lack of autonomy</i>	0.568	0.128	0.000			
PE	OS	<i>F6 Unfair reward and treatment</i>	0.499	0.149	0.001		0.425	0.181
		(Constant)	-8.667	3.181	0.009	0.001		
		<i>F5 Lack of autonomy</i>	0.847	0.250	0.001			
	SS	(Constant)	45.376	6.080	0.000	0.000	0.542	0.294
		<i>F7 Lack of feedback</i>	-1.157	0.328	0.001			
		<i>F2 Relationship conflict</i>	0.818	0.306	0.010			
	EE	(Constant)	-0.389	2.550	0.879	0.000	0.656	0.430
		<i>F5 Lack of autonomy</i>	0.667	0.136	0.000			
		<i>F6 Unfair reward and treatment</i>	0.559	0.178	0.003			
OP	SS	(Constant)	24.202	8.501	0.011	0.035	0.485	0.236
		<i>F5 Lack of autonomy</i>	1.648	0.720	0.035			
		(Constant)	6.756	2.968	0.036	0.020	0.530	0.281
	EE	<i>F6 Unfair reward and treatment</i>	0.688	0.267	0.020			

Note: Variables in italic appear in 'ALL and PE models' or 'ALL and OP model'.





**Figure 1** Causal models of stressors–stress (SS/OS/EE) for professional estimators

Notes: —————> = causal relationship reveals in both correlation analysis and regression model.

-----> = causal relationship reveals in regression model.

----- = relationship reveals in correlation analysis.

Figure on the lines represent the correlation coefficient (refer to Table 5).

\* Correlation is significant at the 0.05 level (2-tailed); \*\* correlation is significant at the 0.01 level (2-tailed) (refer to Table 4).

> = mean of OS is significantly higher than SS; mean of SS is significantly higher than EE (refer to Table 1).

ment (SS, OS and EE) in cost estimation. Although some researchers (Gaines and Jermier, 1983; Stordeur *et al.*, 2001) applied EE to measure the stress of nurses and police, the results indicate that the means of OS are significantly higher than that of SS, and the means of EE are the lowest of the three. This may be due to the nature of tasks undertaken by the estimators—such as calculation, planning and organizing—which all reflect the objective nature of construction projects. Therefore, compared with SS and EE, which arise out of the physical and psychological environment, OS from the task is more likely to appear and have a significant impact on cost estimators. On the other hand, EE, which is a chronic state of emotional and physical depletion, is least likely to affect estimators.

### Stress levels of the PE and OP groups

From the independent t-test analysis, the hypothesis of different stress levels in PE and OP groups was rejected. That is to say, the professional estimators and other personnel (by a variety of definitions) can be regarded as having the same stress levels, including SS, OS and EE. In the estimation stage, both groups are involved in the process and therefore are presumably subject to similar amounts of stress via both the overall task in hand and the environmental influences that occur.

### Significant effects of stressors on OS, SS and EE

As the analysis shows, the PE group is much clearer about the stressors involved than the OP group, with

the correlation coefficient results increased for the PE grouping alone—perhaps because the PE respondents, being professionals, have learned to recognize and anticipate potentially stressful situations in order to better manage them. Their responses, therefore, are likely to be closer to the truth than those of the OP group.

For the PE group, SS is mainly caused by relationship conflict and lack of autonomy and reduced by lack of feedback, while OS is related to lack of autonomy and unfair reward and treatment. EE is correlated with relationship conflict, work underload, lack of autonomy and unfair reward and treatment.

Lack of autonomy is positively related to the stress perceived by various kinds of estimation personnel, especially the professional estimators, and is the only stressor correlated with all three types of stress. Without adequate autonomy, estimators find it difficult to carry out their job effectively. Therefore, 'OS' is induced. People chronically stressed, or being unable to deal with chronic stress, are likely to become EE, the major and initial dimension of burnout (Leiter and Harvie, 1996; Maslach and Leiter, 1997; Lloyd and King, 2001).

Unfair reward and treatment is positively related to both of the OS and EE of the professional estimators. It represents an imbalance between a person's effort contributed and his/her reward received. Siegrist (1996) and Calnan *et al.* (2000) found that the imbalance of effort and reward in employment, especially for high effort associated with low reward, is directly related to emotional distress of the individuals. The construction industry's contribution to GDP in Hong Kong decreased to 4.4% in 2004 from 5.7% in 1997 due to the recession. This fact forced many construction companies to streamline their organizational structure in order to maintain profitable and effective construction process. Therefore, it has been difficult to raise the salary or allow the promotion of Hong Kong construction estimators in recent years. It is therefore unavoidable that unfair reward and treatment may make the estimating personnel dissatisfied with their jobs and feel the reward they receive is not sufficient compensation for the effort and time they put into their work.

Feedback plays an important role in the management process, as it can guide and improve individual behaviour in future (Leung *et al.*, 2004). This study revealed interesting results: lack of feedback is positively related to the EE of other estimation personnel and, simultaneously, has a negative effect on the SS of professional estimators. It implies that too much feedback induces a negative impact on a professional estimator's SS level. It is suggested, therefore, that senior estimation managers in construction companies

and consultant firms provide only enough feedback to other estimation personnel (e.g., engineers, procurement staff, etc.) to enable them to understand the overall bidding strategies and tendering procedure for specific projects.

Conflict makes both a functional and dysfunctional impact on construction projects and therefore cannot be simply eliminated (Leung *et al.*, 2005b). However, the study revealed that conflict between supervisors, colleagues and estimators (team conflict), and different beliefs between individuals and organization (value conflict) lead estimators to SS and EE. Hence, relationship conflicts are considered excessive for professional estimators. Relationship conflicts affect communications between team members and colleagues, and the result of this study thus revealed that this is highly associated with subjective job distress (SS) (Kahn *et al.*, 1964; Fisher and Gitelson, 1983; Jackson and Schuler, 1985) and may eventually lead to job burnout (EE).

Work underload refers to repetitive and tedious work carried out with vague responsibility. As discussed, many construction companies in Hong Kong have been streamlined in recent years because of the economic recession. The skills and knowledge of estimators are underutilized. Professional estimators are often bored or apathetic owing to insufficient (quantitative underload) or tedious and repetitive tasks (qualitative underload). It is understandable that an individual with a continuous work underload may lose interest in his/her job and result in EE. A series of practical recommendations follow aimed at avoiding estimator stress.

## Recommendations

### Practical implications

Since professional estimators experience more OS than SS and EE, senior estimation managers are recommended to first detect the stress of estimators using the OS scale (Gmelch, 1982). SS (Banks *et al.*, 1980) and EE (Maslach and Jackson, 1996) can then be used to measure the residual subjective stress of estimators. Various stress management approaches are suggested to estimators and their employers for optimizing their OS, SS and EE (refer to Figure 1).

Sufficient autonomy and fair reward systems are fundamental anti-stressors needed to maintain an optimized OS (as well as SS and EE), while appropriate feedback, conflict and workload are necessary for reducing the SS and the EE of estimators. Cost estimators need to provide accurate estimates of building prices and legal advice for bidding construction projects, and therefore their personal decision

making plays an important role in the tendering process. Senior managers are advised to set clear goals, provide useful resources (e.g. updated data and software) and allow sufficient flexibility and autonomy for estimators to make decisions based on their own information.

On the other hand, a fair and systematic promotion and awarding system (Tsutsumi and Kawakami, 2004) helps to reduce stress levels of estimators, especially QS and EE. Estimation personnel have a key role in ensuring profitable construction projects for the company and their professional input is likely to have significant influence on company profitability. Construction senior managers, therefore, should benefit from regular reviews of the external professional market and individual contributions, with promotion and rewarding systems reflecting individual efforts and contributions.

In order to avoid unnecessary stress, too much feedback from supervisors should be avoided. Senior estimation managers should discuss the tasks and personal/team/organizational values with individuals as a means of reducing relationship conflict, minimizing emotional exhaustion and avoiding estimator burnout. Formal activities (e.g. regular meetings and performance appraisals) can help in reviewing daily tasks and the allocated workload, while informal activities (e.g. buffets, barbeques, Karaoke sessions, etc.) provide a means of building up trusting relationships among team members (Leung *et al.*, 2005b).

### Research implications

The relatively small sample used for this study may limit the generalizability of the results. Absolute sample size is no longer an effective way for verifying the validity of research results, as absolute sample size varies according to the types of scales researchers examine (Osborne and Costello, 2004). The ratio of subjects (sample size) to items would be more representative and is widely adopted (Ferketich, 1990; Knapp and Brown, 1995). In this study, the subject-to-item ratios in the factor analysis ranged from 8:1 to 24:1, representing 50–70% samples with correct factor structure (Costello and Osborne, 2005). These are better than the range of various stress management studies (Cole *et al.*, 2001—6:1; Jepson and Forrest, 2006—7:1; Stuber and Kazak, 1997—7:1; Ernst, 2004—5:1; Marshall, 2004—7:1).

Moreover, all the respondents in this survey were identified through membership records of the Hong Kong Institute of Surveyors and the Royal Institute of Chartered Surveyors and have direct experience of construction estimation. Therefore, it is unlikely that the results are biased by differential response to the

measured variables. Indeed, they reflect the experience of normal practice in the industry and could provide useful baseline information for large-scale studies in the future.

The causal relationships postulated are partially supported by the analytical techniques used, but there is need of further research. For example, the quantitative data analysis undertaken provides the context and support for subsequent qualitative studies (e.g. case studies). These can be used to cross-validate the relationships between stressors and different types of stress in real projects, since lateral studies can only be effective when confounding variables are constrained and controlled. Triangulation may, therefore, be employed to provide the necessary 'leverage' to assist in obtaining a better understanding and generalization through exploratory case studies, lateral research and their interaction.

In summary, the results confirm the findings of previous studies (Leung *et al.*, 2005b), that conflict and workload are stressors influencing the stress levels of estimation personnel. However, physical setting has no correlation to SS, OS or EE in the present study while it was one of the major stressors influencing stress in previous studies. According to Gmelch (1982) 'stressors of environment are not so much a matter of the stressors themselves, but of a person's ability to control them' (p. 23). Therefore, an individuals' personality is important in determining his or her responses to environmental stressors. Further study of the interaction of stressors, especially physical and personal, on the stress of estimators is also recommended.

### Conclusions

In general, stress is regarded as a subjective feeling that demands of work exceed the individual's belief in his/her capacity to cope; it also represents emotional exhaustion, depersonalization and reduced personal accomplishment. The literature review revealed that stress should not simply be classified into either subjective or objective dimensions. From the organizational behaviour and psychological science literature, three types of stress were identified in this paper: subjective stress, objective stress and emotional exhaustion.

Professional estimators and other estimating personnel can be considered involving the same stress levels of SS, OS and EE. The results of the research showed that professional estimators experience the highest OS levels, followed by SS and then EE. This may be due to the tasks involved such as calculating, planning and organizing, being mainly of an objective nature. Hence,

the determination of OS and management of the relevant stressors would be the first step to take in managing the stress of estimation personnel. Therefore, a senior estimation manager should not wait for the occurrence of SS or EE before taking appropriate action. The study revealed that the OS of professional estimators mainly derives from lack of autonomy, and unfair reward and treatment. Therefore, senior estimating managers are strongly recommended to allow professional estimators to participate into the decision-making process and establish fair promotion and rewards for each person (i.e. organizational stressor) and, simultaneously, provide sufficient feedback to other estimation personnel for their improved cooperation in the estimation team.

However, cost estimation not only requires precise technical and analytical input from estimators, but also involves the use of subjective judgment. Hence, both SS and EE also need to be considered in the estimation process in addition to OS in order to fully understand the stress of estimation personnel. The study revealed that relationship conflict, lack of feedback, lack of autonomy, unfair reward and treatment and work underload lead to SS and EE. Once the senior estimation managers find that professional estimators have SS or EE symptoms, it is suggested that they take steps to further understand the relationship among colleagues (i.e. personal stressors), investigate the autonomy and feedback empowered to the estimators in their work, reconsider the existing reward system in the organization (i.e. organizational stressor) and further review the workload allocation of the professional estimators in the company (i.e. task stressors).

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