

EXPLORING THE INTERNAL DIMENSIONS OF WORK STRESS: EVIDENCE FROM CONSTRUCTION COST ESTIMATORS IN CHINA

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A recurring feature of modern practice is the stress placed on project professionals, with both debilitating effects on the people concerned and indirectly affecting project success. Cost estimation, for example, is an essential task for successful project management involving a high level of uncertainty. It is not surprising, therefore, that young cost estimators especially can become stressful at work due to a lack of experience and the heavy responsibilities involved. However, the concept of work stress and the associated underlying dimensions has not been clearly defined in extant studies in the construction management field. To redress this situation, an updated psychology perceived stress questionnaire (PSQ), first developed by Levenstein *et al* (1993) and revised by Fliege *et al* (2005), is used to explore the dimensions of work stress with empirical evidence from the construction industry in China. With 145 reliable responses from young (less than 5 years' experience) Chinese cost estimators, this study explores the internal dimensions of work stress, identifying four dimensions of *tension, demands, lack of joy* and *worries*. It is suggested that this four-dimensional structure may also be applicable in a more general context.

Keywords: work stress, perceived stress questionnaire, young cost estimators, exploratory factor analysis.

INTRODUCTION

Work stress has become an important concept in organizational management since the increased awareness of the prevalence of mental disorders such as depression in the 1980s (Tennant 2001). In the construction industry, because of the complexity and dynamic uncertainty of its projects, workers and professionals are frequently expected to confront and cope with stress (Ng, Skitmore and Leung 2005). In addition to concerns regarding the wellbeing of those affected, the study of work stress is especially important in organisational terms for the potential negative effects on production, such as safety incidents involving site workers, mistakes in professional services and reduced productivity.

Although identification and categorization studies of the causes of stress are not uncommon in the construction management field (e.g. (Leung *et al.* 2005, Ng, Skitmore and Leung 2005, Richmond and Skitmore 2006, Leung, Zhang and Skitmore 2008)), individual stress reactions, including stress assessment and emotional responses, have received little treatment to date. Additionally, stress reaction is widely regarded rather as a holistic concept with little investigation into the dimensions

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involved, raising consequential doubts over the veracity of the conclusions drawn in previous work.

Realizing a similar situation in psychosomatic research, Levenstein *et al* (1993) developed a 30 question perceived stress questionnaire (PSQ), validated with responses from 230 subjects comprising in-patients, out-patients, students and health workers. Pointing to some drawbacks existing in Levenstein *et al*'s PSQ, Fliege *et al* (2005) they used it in the German context with 650 subjects to conduct a principal component analysis (PCA), resulting in the identification of four dimensions of stress in terms of worries, tension, joy and demands, each represented by five questionnaire items (Fliege *et al*. 2005). However, this remarkable conclusion of exactly four dimensions with each containing exactly five items has yet to be replicated in any further empirical work.

Construction cost estimators, with huge responsibilities in construction projects, have been targeted as subjects in several previous studies (e.g. (Leung *et al*. 2005, Bowen, Edwards and Lingard 2012)). Since a further goal was to consolidate stress research in the construction industry by comparing the results with previous studies, cost estimators were used as subjects in this research. Our research, therefore, aimed to simultaneously explore the internal dimensions of stress in the construction industry context while testing the applicability of Fliege *et al*'s 4x5 structure to construction cost estimator stress. This was carried out with a sample of 145 predominately young (less than 5 years' experience) cost estimators working in the Chinese construction industry. As will be seen, four dimensions of tension, demands, lack of joy and worries are identified by Principal Components Analysis. A brief discussion is provided of the significance of the results in comparison with previous work and implications for future research, with the suggestion that the same four-dimensional structure may also be applicable in a more general context.

LITERATURE REVIEW

In stress related research, some studies have concentrated on external stressors or causes, some on subjective components such as anxiety and worries, and others on coping strategies (Levenstein *et al*. 1993). Although it is debatable that the measurement of stress should concentrate on those stressors or individual stress reactions including stress assessment and emotional responses in psychology research (Fliege *et al*. 2005), it is acknowledged that both approaches have their own advantages and drawbacks.

There are many studies relating to stressors. For example, job stress, in terms of job related tension, is evaluated by a 15 item inventory in Jamal (1984)'s exploration of the relationship between job stress and job performance. These stressors were categorized into four types, in terms of role ambiguity, role conflict, role overload and resource inadequacy. Most stress-related studies in the construction industry also concentrate on identifying and categorizing stressors. Leung *et al* (2005), for example, use causal structural modelling to examine the effects of stressors on stress, finding work overload, role conflict, job ambiguity, and working environment to be the most influential factors involved. Additionally, organizational support factors have been regarded as antecedents of stressors, with a few stressors (e.g. lack of autonomy) acting as mediators between organizational support and employee stress (Leung, Zhang and Skitmore 2008). Ng *et al*'s (2005) research on measuring the manageability of stress in relation to construction projects categorized 33 stressors into seven groups, in terms of works nature related stressors, work-time related

stressors, organisation policy related stressors, organisation position related stressors, situational/environmental stressors, relationship related stressors and personal stressors.

Negative effects of stressors occur when insufficient resources are available to cope with them (Cohen, Kamarck and Mermelstein 1983). The study of coping strategies is therefore another common topic. Aiming to help project participants better cope with stresses, Ng *et al* (2005), for example, conducted a questionnaire survey to measure the manageability of the stressors most confronted by construction project participants. Richmond and Skitmore (2006) also provide 14 stress coping strategies for 50 identified potential stressors by conducting interviews with IT project managers.

The influencing mechanism of work stress is not as easy to understand. Hon (2013), for example, examines the link between working-creativity-caused stress and service performance with evidence from 305 employees in 48 service organizations, finding co-worker support to be a significant moderator. When there is high co-worker support, higher stress leads to slightly better performance; but when co-worker support is low, higher stress leads to a much worse performance. Similarly, evidence from a survey of 306 nurses indicates that perceived social support from co-workers improves reported job performance and reduces reported job stress (Abualrub 2004). Interestingly, AbuAlrub (2004) also found a U shape relationship to exist in the job stress and job performance relationship, with respondents reporting moderate job stress believing their performance is worse than those reporting low/high job stresses. Jamal (1984), on the other hand, in analysing a sample data from 440 nurses working in Canada, proposes employee professional and organizational commitment as moderators in the stress-performance link, although this is only partially supported by the data. Because of the complexity in defining the role of stress and the little coverage of emotional stress reactions in construction research, therefore, it is of value to investigate its dimensions further to deepen our understanding of their interactions with external stressors.

RESEARCH METHOD

Perceived stress questionnaire

Fliege *et al*'s (2005) 4x5 PSQ was used as the main instrument in the study. After revisiting the results of Fliege *et al*'s factor analysis and considering the likely drawbacks and suitability of these items in the Chinese context, a modified 4x4 (four dimensions of stress, with each containing four items) version was conjectured for the Chinese cost estimator context. Also, while Fliege *et al*'s PSQ refers to the respondent as "you", we decided to address the respondent as "I" to make it easier for Chinese respondents to report more personal emotional reactions. Additionally, the four-scale questionnaire response format used in Levenstein *et al* (1993) was changed to a seven-point Likert scale format to elicit more finely grained information. Also, a "don't know" option, omitted from Levenstein *et al*'s and Fliege *et al*'s versions, was offered in the questionnaire as standard procedure for those unable to answer corresponding questions.

The main part of the questionnaire is presented in Table 1. According to Fliege *et al* (2005)'s categorization, Q1-Q4 belongs to "demands", Q5-Q8 belongs to "worries", Q9-Q12 belongs to "tension" and Q13-Q16 belongs to "joy". Q13-Q16 was reversed

in the analysis and named as AQ13-AQ16 indicating the “*lack of joy*” dimension consistent with Levenstein *et al*’s categorization.

Table 1: Perceived stress questionnaire

No.	Work stress	1-not at all to 7 very intensive	Don't know
Q1	I have too many things to do	1 2 3 4 5 6 7	<input type="checkbox"/>
Q2	I do not have enough time for myself	1 2 3 4 5 6 7	<input type="checkbox"/>
Q3	I feel under pressure from deadlines	1 2 3 4 5 6 7	<input type="checkbox"/>
Q4	I feel I am in a hurry	1 2 3 4 5 6 7	<input type="checkbox"/>
Q5	I have many worries	1 2 3 4 5 6 7	<input type="checkbox"/>
Q6	My problems seem to be piling up	1 2 3 4 5 6 7	<input type="checkbox"/>
Q7	I fear I may not manage to attain my goals	1 2 3 4 5 6 7	<input type="checkbox"/>
Q8	I feel frustrated	1 2 3 4 5 6 7	<input type="checkbox"/>
Q9	I feel tense	1 2 3 4 5 6 7	<input type="checkbox"/>
Q10	I feel mentally exhausted	1 2 3 4 5 6 7	<input type="checkbox"/>
Q11	I have trouble relaxing	1 2 3 4 5 6 7	<input type="checkbox"/>
Q12	I are hard to feel calm	1 2 3 4 5 6 7	<input type="checkbox"/>
Q13	I feel I am doing things you really like (R)	1 2 3 4 5 6 7	<input type="checkbox"/>
Q14	I am light hearted (R)	1 2 3 4 5 6 7	<input type="checkbox"/>
Q15	I feel safe and protected (R)	1 2 3 4 5 6 7	<input type="checkbox"/>
Q16	I am full of energy (R)	1 2 3 4 5 6 7	<input type="checkbox"/>

Translation and back translation

Because of differences in cultural backgrounds and languages, the translation of questionnaires from English to Chinese needs be carried out with care. To do this, the two-stage translation and back translation technique was adopted as used by Ding and Ng (2007) in their translated Chinese version of McAllister’s trust scale. The first stage involved the Chinese version of the questionnaire was translated by a bilingual PhD candidate with knowledge of PSQ, with the preliminary Chinese draft emerging after several subsequent rounds of discussions with a bilingual member of university academic staff. For the second stage, another pair of bilingual assistants (i.e. PhD student and academic staff) *without* prior knowledge of the PSQ English version of the questionnaire translated the Chinese questions back to English. The two English versions were then compared for significant inaccuracies (Table 2). The discrepancies found were then corrected to produce the final version of the questionnaire.

Table 2: Translation and back translations

No.	Final Chinese version	Back translation-1	Back translation-2
Q1	我有太多事情要做	I have a lot of things to do.	I have too many works to do
Q2	我感到留给自己的时间不够	I feel that I have limited time to myself.	I feel not enough time for myself
Q3	我感到来自截止日期的压力	I feel the pressure from deadlines.	I feel deadline pressure
Q4	我感觉自己很着急	I feel that I am in a hurry.	I feel I am in a hurry
Q5	我有很多担心	I have many worries.	I have a lot of concerns
Q6	我的问题似乎越堆越多	It seems that my problems are increasing.	My problems seem to be accumulating
Q7	我担心我不能实现我的目标（们）	I am afraid that I cannot achieve my goals.	I am concerned about not realising my objective(s)
Q8	我感到受挫与沮丧	I feel frustrated and depressed.	I feel frustrated and depressed
Q9	我感到紧张	I feel nervous.	I feel nervous
Q10	我感觉到精神上的疲惫	I feel mentally exhausted.	I feel mentally exhausted
Q11	我在放松身心上存在问题	I have some problems on relaxing my body and mind.	I have problem in physical and psychological relaxation I have difficulty in calming down
Q12	我很难冷静	It is hard for me to keep calm.	
Q13	我感觉我在做自己真正喜欢的事情	I feel I am doing the things that I like.	I think I am doing the work that I truly like
Q14	我很轻松	I feel relaxed.	I am very relaxed
Q15	我有安全感	I feel a sense of security.	I feel secure
Q16	我感觉充满能量	I feel that I am full of energy.	I feel energetic

Data collection and demographics

Due to the impossibility of covering all populations and the sensitive questions asked in the PSQ (Shi *et al.* 2014), a snowball sampling technique was used rather than delivery direct to companies. Since young cost estimators can become stressful at work due to a lack of experience, and five years' experience is generally acknowledged as the necessary time for practitioners to master skills in construction cost estimation (Skitmore *et al.* 1990), potential respondents were restricted to having less than five years' working experience. 145 valid responses were received. Of these, 75 (51.7%) respondents are male and 69 (47.6%) are female (1 missing data); 42 (29%) are younger than 25, 101 (69.7%) range from 25 to 34 and 1 (0.7%) from 35 to 44 (1 missing data); and for their highest educational level, 13 (9%) possessed diplomas, 110 (75.9%) a bachelor's degree and 22 (15.2%) a master's degree.

Data analysis

Data reliability

Cronbach's alpha is used to evaluate the internal consistency of the questionnaire items. The overall value is 0.884, with 0.847, 0.838, 0.790 and 0.749 for the "demands" (Q1-Q4), "worries" (Q5-Q8), "tension" (Q9-Q12) and "lack of joy" (AQ13-AQ16) dimensions respectively. Since all these values are larger than the 0.7 cut-off value, the whole and the parts of the questionnaire are considered to be acceptably consistent (Xiong *et al.* 2014). Since Cronbach's alpha value is affected by the length of the scale, the matrix of correlations of individual items is also examined for confirming scale reliability. With a mean of the absolute values of item-item

correlations of 0.326 (SD=0.185), the results indicate an acceptable level of reliability (Ding and Ng 2007).

Although the principal component analysis (PCA) deals well with non-normal distribution situations (Wang and Du 2000), tests on sample distributions are still useful to reflect information on the population distribution. The sample skewness and kurtosis statistics can be used to test the normality of distribution of variables and both should lie within the [-1, +1] interval (Hair 2006). Here, the skewness and kurtosis values of all 16 variables are within the range of -0.86 to 0.45 and -0.55 to 0.46 respectively, which indicates the normal distribution assumption implicit in PCA to be satisfied.

Validation

The PCA confirms the hypothesized four-dimensional structure of stress, with a 0.840 Kaiser-Mayer-Olkin measure of sampling adequacy higher than the the cut-off value of 0.5 (Hair 2006) and a highly significant $p < 0.0001$ for Bartlett's test for sphericity indicating that the items are suitable for factor analyses. The forced 4-factor solution applying varimax rotation, an widely applied orthogonal rotation method maximizing the sum of the variances of the squared loadings (Abdi 2003) and used in Leventin *et al* (1993) and Fliege *et al* (2005), explains 70.1% of the overall variance with component 1, component 2, component 3 and component 4 accounting for 37.9%, 16.6%, 10.2% and 5.4% respectively. The allocated components, means, standard deviations and communalities (h^2) of the items are summarised in Table 3. For clarity, only the highest factor loading of each item is shown.

Table 3: Principal component analysis with varimax rotation

Items	Components				Item parameters		
	1	2	3	4	mean	std dev	h^2
Q1		0.861			5.73	1.19	0.75
Q2		0.878			5.60	1.44	0.80
Q3		0.731			5.50	1.45	0.71
Q4		0.635			5.23	1.43	0.78
Q5				0.630	5.27	1.42	0.76
Q6				0.630	4.62	1.51	0.71
Q7				0.614	4.78	1.71	0.68
Q8	0.843				3.81	1.69	0.80
Q9	0.822				4.10	1.64	0.76
Q10	0.718				4.46	1.59	0.74
Q11	0.648				3.86	1.63	0.56
Q12	0.622				3.32	1.70	0.48
AQ13			0.591		3.43	1.37	0.42
AQ14			0.760		3.99	1.40	0.76
AQ15			0.843		3.52	1.42	0.75
AQ16			0.697		3.35	1.30	0.75

DISCUSSION

In stress related research, some studies concentrate on external stressors, some on subjective components such as anxiety and worry, and others on coping strategies (Levenstein *et al.* 1993), although there is no general consensus on their measurement.

In investigating the subjective components of stress for cost estimators, Fliege *et al.*'s (2005) 4x5 perceived stress questionnaire was revised according the expected circumstances in China to a 4x4 version and tested for identifying the dimensions of stress involved. With the exception of Q8 – “*I feel frustrated and depressed*” – the PCA supports the hypothesised 4x4 structure. This anomaly is discussed below in terms of the four dimensions involved, together with the relationship of the results with the findings of previous studies on stress emotional reactions,

The “tension” dimension, comprising Q8-Q12, explains the largest proportion of variance (37.9%) in the data, which is consistent with Jamal's (1984) view of job related tension being regarded as job stress. According to Fliege *et al.*'s (2005) original categorization, Q8 (“*I feel frustrated*”) is not included in this dimension but in the “*worries*” dimension. This may be due to Fliege *et al.*'s selection of 5 items from Levenstein *et al.*'s (1993) original 13 items for this dimension. If we carry out a semantic analysis between Q5-Q7 and Q8, however, it is easy to see that there are no words of “*worry*”, “*afraid*” or “*fear*” in Q8. Additionally, two Chinese words are used to represent “*frustrated*” exactly and they are back translated as “*frustrated and depressed*”. Therefore, it is reasonable to include Q8 in the “*tension*” dimension. Also worth mentioning is the slightly low communality value (0.48) of Q12 and a slight increase (0.009) of Cronbach's alpha value if deleted. This indicates an inconsistent understanding of “*calm*” by the respondents, possibly related to the fact that “*calm*” refers not only to “*not excited or nervous*” but also to “*reasonable and wise*” in the Chinese culture.

The “demands” dimension comprising Q1-Q4 explains 16.6% of the variance in the data. The Cronbach's alpha value is rather high (0.847) but would not increase if any item is deleted. According to Fliege *et al.*'s (2005) explanation, this dimension is actually an extra stressor dimension that is similar to the term “*overload*” mentioned in many stressor studies (e.g. Jamal, 1984; Leung *et al.*, 2005) and different in nature to the other three dimensions.

The “lack of joy” dimension, comprising AQ13-AQ16, explains 10.2% of the variance, and has an acceptable Cronbach's alpha value of 0.749, but would be increased a little (by 0.007) if AQ13 was deleted. Additionally, the communality of AQ13 is comparatively low (0.42), indicating some confusion among respondents when answering Q13 (“*I feel I am doing the things that I like*”), which is similarly reflected in Levenstein *et al.*'s (1993) factor analysis results where the factor loading on this item in the “*lack of joy*” factor is also comparatively low.

The “worries” dimension, comprising Q5-Q7, explains 5.4% of the variance, and has a high Cronbach's alpha value (0.803) that would not increase if any item was deleted. The issue of Q8 is discussed above. To remain in the “*worries*” dimension, the wording of Q8 needs to be changed to such as “*I am afraid of/fear frustration*” with a greater emphasis on “*worries*”.

Investigating the differences among variables is a very informative way to understand multi-attributes of the sample. As shown in Table 3, items under “*demands*” sub-dimension among participants have comparatively high mean values than items in

other dimensions, indicating these young cost engineers experience a general “overload” feeling. The average value of this sub-dimension (5.52) is higher than that (4.13) of the “work overload” feeling among their counterparts in Hong Kong according to a 7 point Likert scale survey by Leung *et al* (2005). Additionally, Leung *et al* (2005) found that “work overload” factor is the most predictive stressor of stress of construction cost estimators in Hong Kong. This difference may be related to the extensive construction work that needs to be done to cope with the rapid urbanization in Mainland China, where the sub-sector of construction cost consultancy reached 80.685 billion RMB and 237,100 employees in 2011 after a 10% annual increase rate for several years (Shi *et al.* 2014). With such a fast increase in workload and employees, therefore, it is not surprising to find that current employees experience high “demands”. According to results shown in Table 3, young construction cost estimators also experience intense “worries” but with a little less “tension” and less still “lack of joy”.

CONCLUSIONS

The applicability of Fliege *et al*'s (2005) revised perceived stress questionnaire is tested and confirmed. Some critical issues are mentioned and discussed concerning the potential for the questionnaire to be applied in understanding the stress of workers and professionals in more general context and explore interactions of these sub-dimensions with stressors in the construction research. Since the hypothesised 4x4 structure of stress is supported with empirical evidence from young Chinese construction cost engineers, the topic would benefit from further research in general treating stress as a multi-dimensional concept.

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