Questionnaire for Construction Worker Risk Taking (Q-CWRT) in Hong Kong

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ABSTRACT

Accident prevention is a major health and safety concern in the construction sector and understanding risk-taking behavior plays an essential role in this initiative. The efficient measurement of workers’ risk-taking propensity would be a pragmatic approach. Several instruments can be used for measuring risk-taking behavior, but instruments pertinent for construction workers are rare. This study aims to establish a questionnaire for construction workers’ risk taking (Q-CWRT) by adapting the explained theory of planned behavior (ETPB), which consists of organizational, workplace and individual-related factors. This questionnaire includes 188 valid samples (156 male and 32 female), and 12 factors with 41 items were extracted based on the results of exploratory factor analysis. The Q-CWRT goodness-of-fit results were achieved (CMIN = 1.4, CFI = 0.925, TLI = 0.912, RMSEA = 0.046, SRMR = 0.0625, and $p < 0.05$) using confirmatory factor analysis. This study demonstrated the potential of the proposed new and prominent instrument that would help employers in acquiring better understanding of factors that contribute to improving safety performance.

Keywords: Risk taking, Construction workers, Questionnaire, Factor analysis, ESK-JES

1. Introduction

Risk taking is highly correlated with occupational accidents and injuries (Yule & Flin, 2007) and construction incident on the other hand has a prominent contribution to the overall industrial accidents in Hong Kong. As risk-taking behavior can vary with respect to the different domain-related situation (Johnson, Wilke, & Weber, 2004), a risk-taking measurement tool for the construction industry was eagerly proposed; however, such development in the allusion of construction workers’ risk behaviors is extremely rare. The present study was designed to focus on this aspect and aimed to enact an easy-for-site-use instrument for surveying construction workers’ risk-taking propensity so as to enable safety scientists and stakeholders to timely deploy due mitigation measures.

Massive literature was reviewed, the Questionnaire for Construction Worker Risk Taking (Q-CWRT) was thereby based on the theory of planned behavior (TPB) with due expansion to suit the attributes of the construction workers. Subfactors relating to workers’ behavioral-based safety were identified and shown in Table 1. Organizational, workplace, and individual-related factors were also categorized. Seventy items (including 8 items for demographic concerns) for the 16 subfactors were initially used for the commencement of the questionnaire design in accordance with previous studies.

2. Aims and Objective of this Study

The aims of this study were to evaluate the factor structures of the Q-CWRT through the exploratory factor analysis and to determine its validity, reliability, and goodness of fit by means of the confirmatory factor analysis.
The objective of this study was to develop an alternative measurement tool for the industry to precisely survey the risk-taking propensity of the construction workers to facilitate the timely deployment of relevant arrangements for the improvement of the site safety performance accordingly.

### Table 1. Factors regarding construction workers’ behavioral-based safety and accident.

| Categorized factors | Subfactors                                                                 | Source |
|---------------------|---------------------------------------------------------------------------|--------|
| Individual-related factors | Family influence (FI) | (Shappell & Wing, 1997) |
|                     | Financial needs (FN) | (Reale, 2007) |
|                     | Lifestyle and SES (L & SES) | (Shappell & Wing, 1997) |
|                     | Attitude towards safety in cases & procedures (ATSM P) | (Cavazza & Serpe, 2009) |
|                     | Risk perception (RP) | (Palich & Bagby, 1995) |
|                     | Cognitive bias (CB) | (Palich & Bagby, 1995) |
|                     | Perceived behavioral control (PBC) | (Kim & Helweg-Larsen, 2002) |
|                     | Personality trait (PT) | (Zuckerman, 1990) |
| Organizational factors | Safety supervision & inspection (SSI) | (Fung, Tan, & Au, 2005) |
|                     | Safety culture (SC) | (Fung, Tan, & Au, 2005) |
|                     | Work Kend & workplace (WKWP) | (Fung, Tan, & Au, 2005) |
|                     | Social influence (SI) | (Zohar & Luria, 2005) |
|                     | Safety reward & punishment policy (SRPP) | (Smith, Roe, Burke, & Landis, 2005) |
| Workplace factors | Workplace conditions (WC) | (Ghosn, 1992) |
|                     | Safety equipment availability & design (SEAD) | (Ghosn, 1992) |

### 3. Method

The questionnaire survey with quantitative analysis was adopted in this research to reflect the construction workers’ risk-taking propensity. A seven-point Likert scale was used and was ranked from 1 to 7 for all of the items, except that of the demographical measurements. A method used in the lower bounds on the sample size for structural equation models formulas (Westland, 2010; Soper, 2016) were adopted to estimate the minimum but acceptable sample size. The anticipated effect size was taken as 0.3 for medium (Jo & Muthén, 2009), and the desired statistical power level was set at 0.8. The latent variable was originally 12, and the observed variables were 41 in pursuit of a hypothesized model. The probability level was set at 0.05. A recommended minimum sample size of 147 was then calculated according to the A-Priori Sample Size Calculator (Westland, 2010).

In sampling adequacy, the Kaiser–Meyer–Olkin (KMO) test was initially applied to measure the suitability of the harvested primary data during the factor analysis. Maximum likelihood factor analysis (MLFA) was also employed. In this questionnaire, the eigenvalue of the individual factor should be >1 during extraction, and the maximum iterations for convergence was set at 25. Promax oblique rotation was also employed for data transformation as it is comparatively fast and conceptually simple. Besides, IBM® Amos® 22 was used for confirmatory factor analysis (CFA) after the pattern matrix. Goodness-of-fit indices, such as the chi-square ratio, , and degree of freedom (df), were employed for determination. An acceptable chi-square distribution is obtained if the /df ratio is below 2. The comparative fit index (CFI) and the Tucker–Lewis index (TLI) reaffirmed the factors of the goodness of fit. These figures were advanced as the measured values of CFI and TLI that should not be less than the cutoff criterion of 0.90, particularly when /df is <3 (Iacobucci, 2010). The root mean square error of approximation (RMSEA) and standardized root mean residual (SRMR) were used for mirroring the model by virtue of determining the cutoff value, which are lesser than 0.06 and 0.08, respectively (Harrington, 2009).

### 4. Results

188 valid dataset were collected from several representative construction projects in Hong Kong and the total sample size harvested was higher than the minimum level of 119. Of the construction workers, 156 male and 32 female participated in this study for quantitative research. Other demographic results are illustrated in Figure 1 which can be downloaded in this website: [Please inform us for password through email](https://docs.google.com/forms/d/e/1BZ5Ryg5GViAaYHxNiyxOb-ry1Pcyhlmh9ZCQ/edit?usp=sharing). In line with the requirements of data reliability and validity, all items were evaluated using IBM® SPSS® Statistics 22.0 to assess several criteria. Construct validity analysis includes convergent...
and discriminant validities. Convergent validity was reflected by the average variance extracted (AVE) values of the constructs. The values were measured from 0.509 to 0.742. Acceptable AVE values were acquired because all of them were higher than the 0.5 threshold. Apropos to the discriminant validity test, the square root of AVE (SRAVE) of the constructs were estimated and all the SRAVE values were larger than the AVE values of the same constructs. These results indicated that the discriminant validity was achieved properly. All factor loading values for each item were estimated over the moderate level (0.6), except that of item FNLS01 with a marginal level (0.488). This factor loading pattern remains acceptable because it was at least over 0.4. Similarly, reliability was estimated using the Cronbach’s α and composite reliability (CR) of all constructs. Cronbach’s α and CR were calculated from 0.723 to 0.883 and from 0.747 to 0.870, respectively. The values of these two criteria were above 0.7, which means that reliable data with acceptable internal consistency were obtained appropriately. The KMO value of this Q-CWRT was 0.821, which shows that a meritorious result was obtained because it was >0.5. In addition, Bartlett’s test of sphericity yielded a p value (Sig.) of 0.000 < 0.05. In the total variance analysis, over 59.85% of the variability in Q-CWRT can be explained for the first 10 subfactors (see Table 2) which had eigenvalues above 1.

The final factor structure was successfully acquired by analyzing pattern matrix. 41 items were adopted corresponding to the 10 subfactors extracted. The information for the content of the items and the full names of the factors can be referred to in Appendix 1 which can be downloaded from this website: https://docs.google.com/forms/d/1XXNoJ2VZD-Qgv8p-pAeTkRbVBMGWcDCBmN7fYtop5Uw/edit?usp=sharing (Please inform us for password through email). In Table 2, the factors for “RB & ATR” and “RP & ATSMP” were subsequently regrouped into four factors, RB, ATR, RP, and ATSMP, in this study owing to the concern about the theoretical differences between them. In this regard, 12 out of the original 16 factors were eventually used for further analysis in structural equation modelling.

A goodness-of-fit model was acquired after the examination of CFA processed by IBM® Amos™ 22. The ratio (CMIN) of chi-square, χ², to the df was 1.40. This values was small enough, <3. Thus, a better fitting model was thereby obtained. Additionally, CFI and TLI were estimated in at 0.925 and 0.912, respectively, and a goodness-of-fit result of the Q-CWRT model in the sample size was achieved as CFI and TLI that were smaller than 0.9. RMSEA was 0.046, which is lower than 0.06. SRMR was 0.0625, which is smaller than 0.08. In summary, all these estimates indicated a goodness-of-fit result accordingly.

Table 2. Factor loadings of the Q-CWRT adopted from the construction worker sample (RB = Risk Behavior and RI = Risk Intention; for other abbreviations, see Table 1).

| Sub-factors | RH & ATR | SI | SSRC | WC | SEAD | PT | FI | CR | RI | FNLS | RP & ATSMP |
|-------------|----------|----|------|----|------|----|----|----|----|------|------------|
| RB1         | .755     |    |      |    |      |    |    |    |    |      |            |
| RB2         | .754     |    |      |    |      |    |    |    |    |      |            |
| RB3         | .746     |    |      |    |      |    |    |    |    |      |            |
| RB4         | .723     |    |      |    |      |    |    |    |    |      |            |
| ATR1        | .619     |    |      |    |      |    |    |    |    |      |            |
| ATR2        | .658     |    |      |    |      |    |    |    |    |      |            |
| SI1         | .901     |    |      |    |      |    |    |    |    |      |            |
| SI4         | .869     |    |      |    |      |    |    |    |    |      |            |
| SI1         | .664     |    |      |    |      |    |    |    |    |      |            |
| SI2         | .651     |    |      |    |      |    |    |    |    |      |            |
| SSRC2       | .788     |    |      |    |      |    |    |    |    |      |            |
| SSRC3       | .770     |    |      |    |      |    |    |    |    |      |            |
| SSRC1       | .716     |    |      |    |      |    |    |    |    |      |            |
| SSRC4       | .529     |    |      |    |      |    |    |    |    |      |            |
| WCSEAD2     | .886     |    |      |    |      |    |    |    |    |      |            |
| WCSEAD3     | .799     |    |      |    |      |    |    |    |    |      |            |
| WCSEAD1     | .756     |    |      |    |      |    |    |    |    |      |            |
| WCSEAD5     | .544     |    |      |    |      |    |    |    |    |      |            |
| WCSEAD4     | .477     |    |      |    |      |    |    |    |    |      |            |
| PT1         | .917     |    |      |    |      |    |    |    |    |      |            |
| PT3         | .807     |    |      |    |      |    |    |    |    |      |            |
| FT1         | .808     |    |      |    |      |    |    |    |    |      |            |
| FT2         | .608     |    |      |    |      |    |    |    |    |      |            |
| FT1         | .755     |    |      |    |      |    |    |    |    |      |            |
| FT2         | .694     |    |      |    |      |    |    |    |    |      |            |
| CI2         | .871     |    |      |    |      |    |    |    |    |      |            |
| CI3         | .871     |    |      |    |      |    |    |    |    |      |            |
| CI1         | .654     |    |      |    |      |    |    |    |    |      |            |
| CI2         | .829     |    |      |    |      |    |    |    |    |      |            |
| CI1         | .768     |    |      |    |      |    |    |    |    |      |            |
| CI2         | .747     |    |      |    |      |    |    |    |    |      |            |
| FNLS01      | .850     |    |      |    |      |    |    |    |    |      |            |
| FNLS02      | .679     |    |      |    |      |    |    |    |    |      |            |
| FNLS03      | .564     |    |      |    |      |    |    |    |    |      |            |
| RP1         | .591     |    |      |    |      |    |    |    |    |      |            |
| RP3         | .464     |    |      |    |      |    |    |    |    |      |            |
| RP2         | .317     |    |      |    |      |    |    |    |    |      |            |
| ATSMP2      | .590     |    |      |    |      |    |    |    |    |      |            |
| ATSMP3      | .525     |    |      |    |      |    |    |    |    |      |            |
| ATSMP1      | .525     |    |      |    |      |    |    |    |    |      |            |

5. Discussion and Conclusion

The Q-CWRT factor structure was evaluated according to Table 2. This finding satisfied one of the aims of this study in search for factor structure, and 41 items with 8 demographic questions were also enacted for Q-CWRT. 70 original items exist, but 21 items were excluded owing
to the non-significant cross-loadings during the EFA. This achievement forged the Q-CWRT to become more succinct and pertinent for construction workers. The findings finally proved that these 12 factors of Q-CWRT prevailed in the pursuit of the goodness-of-fit test. Two organizational subfactors (safety reward & punishment policy, SRPP and workload & work pace, WLWP) and one individual-related subfactor (PBC) were statistically abandoned, but safety supervision and inspection (SSI) and safety culture (SC) were suggested to combine during the EFA. The quantities of Q-CWRT items were efficiently reduced to 41, which is close to that of SSS (40 items) and DOSPERT (40 statements). The overall duration for the Q-CWRT operation was counted within an acceptable period of 40 minutes on average and its coverage is prominently broad and high for the industry to operate measurement at the site environment.

Acknowledgments

This work was sponsored by Development Bureau of the Hong Kong Special Administrative Region Government [WQ/020/15] and the authors wish to take this opportunity to acknowledge other research team members, namely, Junde S. Z. Li, Kiwi H. M. Wong, and S. S. Man, for their contributions to this study.

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