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Procurement-related critical factors for briefing in Public Private Partnership projects: The case of Hong Kong

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28   **ABSTRACT**

29   Public private partnerships (PPP) are widely used for construction project procurement.

30   However, the briefing stage of PPP projects has been largely overlooked, although it has

31   a far-reaching influence throughout the project life cycle. In response, we rectify this by

32   exploring the critical factors involved. A set of 15 procurement-related factors are first

33   identified from the existing literature. Then the effects of four background variables on

34   the factors are tested with Hong Kong government data by an exploratory factor analysis

35   extracting four major dimensions. The relationships between these dimensions and

36   background variables indicate the need to take the background variables into account

37   when ranking the factors. The ranking of the factors is then obtained by considering their

38   weighted importance. Finally, the final practical value of the results is discussed.

39   **Keywords:** Critical factors, procurement, briefing stage, public private partnership,

40   factor analysis, Hong Kong.

41

INTRODUCTION

Projects that require private companies in 'design, financing, construction, ownership and/or operation of a public sector utility or service' are called Public-Private Partnership (PPP) projects (Akintoye et al., 2003).

Decisions made in the early stages of a project have a far-reaching influence on the remainder of its cycle (Gray, 2008, p.21-57; Ahmadjian and Collura, 2012) – synonymous with the terms 'architectural programming' and 'program' (Yu, 2006). The briefing stage in Hong Kong is an early stage that greatly influences a project and collects views from all stakeholders.

The briefing process identifies and clarifies the client's objectives and requirements of the procurement (Wood and Ellis, 2005). As an effective and efficient briefing stage is expected by both public and private sectors, accurate information is needed of client requirements to make sound and timely decisions (Tang and Shen, 2013). A good briefing process helps stakeholders form good relations and make valuable decisions for a project. Poor briefing, on the other hand, restricts the exchange of information and clarification of requirements, wasting time and delaying the whole project process. As a result, briefing needs to be well prepared and structured (Tang et al., 2013). Abdel Aziz's (2007) analysis of USA guidelines for the successful implementation of PPPs indicates that briefing decisions, such as the delivery system to use, provide the greatest benefits to the public or users. Rebeiz (2012) uses a BOOT illustrative case study to shown how important is increasing the pool of potentially interested and qualified foreign

63 construction firms and investors in the briefing stage for the ultimate success of PPP

64 projects.

65 Since the importance of the briefing stage in PPP projects has been largely overlooked

66 (Kelly, 2003), this paper explores the critical factors in successful PPP project briefing.

67 Specifically, the paper identifies the critical success factors for effective and efficient

68 briefing in PPP projects. A mathematical model is developed to rank the factors to

69 identify their relative importance levels. Suggestions are then be made on ways of

70 improving the briefing stage of both public and private sectors.

71 Initially, the briefing stage is described of both conventional projects and PPP projects,

72 focusing on the influencing factors from the literature review for further analysis. In the

73 research method section, a questionnaire survey is described that collected public sector

74 opinions on the critical factors involved. The questionnaire contains two parts:

75 background information concerning the project and the extracted critical factors. This is

76 followed by a factor analysis of the data, and examination of how background variables

77 affect the critical factors. Finally, the factors are ranked with the aid of a mathematical

78 model.

79 **PROCUREMENT FACTORS IN BRIEFING**

80 There are many forms of PPP, such as the outright privatization of previously state-

81 owned industries (Ahadzi and Bowles, 2004) and contracting out of services (Tang et al.,

82 2010). The latter includes refuse collection and cleaning by private firms (Robinson and

83 Scott, 2009) and the use of private finance in the provision of social infrastructure

84 (Carrillo et al., 2006). PPPs in the USA are defined as contractual agreements between a

85 public agency and a private sector entity to allow for greater private sector participation

86 in the delivery and financing of transportation projects (Federal Highway Administration,

87 2007).

88 The UK Construction Industry Board (CIB) (1997, p.5) defines briefing as:

89   *the process by which a client informs others of his or her needs, aspirations*

90   *and desires, either formally or informally, whilst a brief is a formal document*

91   *which sets out a client's requirements in detail.*

92 Kelly and Duerk's (2002) a more process-oriented definition is one of gathering,

93 analyzing, and synthesizing information needed in the building process in order to inform

94 decision-making and decision implementation. In the USA, architectural programming

95 approaches include: design-based architectural programming, knowledge-based

96 architectural programming, agreement-based architectural programming, and value-based

97 architectural programming (Hershberger, 1999).

98 Figure 1 summarizes the PPP briefing structure (EU, 2008). The central column consists

99 of briefing steps which give an introduction on what to do during the briefing, while the

100 left hand column indicates the deliverables for the whole stage. Some deliverables

101 involve more than one step. For example, the first deliverable - to assemble and develop a

102 business case - consists of the first four steps. The right hand column represents the

103 timeline of the briefing stage and process for writing a brief. The briefing session in PPP

104 projects occurs approximately halfway through the bid preparation period (The

105 Construction Industry Board, 1997). This allows the government's potential transaction

106 advisors to consider which elements of the project need clarifying before finalising their

107 bids.

108   *\<Insert Figure 1. here\>*

109   Kelly et al. (1992) argue that the major weakness of the current briefing guide is that real

110   assistance to clients and designers is too general and implicit. Similarly, Kamara and

111   Anumba's (2001) case studies and industrial survey to investigate the briefing process

112   identify the limitations of current practice and that the general framework for briefing is

113   inadequate. Kelly and Duerk (2002) also note that mandatory design guides do not

114   adequately consider the requirements of either the public sector or large corporate

115   organizations. Outdated or irrelevant design guides may lead to inappropriate or even

116   incorrect design decisions. Each project has a specific briefing stage and the briefing for

117   one project is never repeated for other projects. A regular review of the lessons learned

118   from previous briefings and checking the progress of ongoing briefings should be key

119   characteristics involved. Also, exposing hidden agendas by clear representation and

120   recording of project goals is an important function of brief writing.

121   Comparing the briefing stages of conventional and PPP projects, some procurement-

122   related steps not in conventional projects are needed in PPP project briefing. For example,

123   preparing a Public Sector Comparator (PSC) is one of these steps. A PSC is the estimated,

124   risk-adjusted cost of delivering a project - expressed in terms of the net present cost to the

125   government, and using a discounted cashflow analysis to adjust the future value of the

126   expected cashflow to a common reference date. This enables a comparison with bids and

127   makes allowance for the cost of government borrowing (EU, 2008). Papajohn et al's

128   (2011) examination of U.S. transportation found the government should consider the key

129   legal issues impacting on PPPs to include procurement, financing, project characteristics,

130   and legal authority of the owner, in addition to a political environment favoring PPPs.

131 Meng et al. (2011) use three case studies in China to identify CSFs for Transfer-Operate-

132 Transfer urban water supply projects, some of which make the procurement process more

133 effective and efficient. Regan et al. (2011) examine whether the current volatility and

134 uncertainty of capital markets in Australia affects the feasibility of privately financed

135 infrastructure and specifically the PPP method of procurement. Ho and Hsu (2013) use

136 game theoretic analysis to help project owners choose better bid compensation strategies.

137 Cruz and Marques (2014) find that alternative methodologies for calculating the discount

138 rate and different assumptions can lead to completely different results, biasing the final

139 decision. Finally, Ye et al. (2013) examine procurement systems under China's unique

140 culture and social background and identify the key factors considered in compiling tender

141 prices.

142 These issues show that it is crucial to identify the critical factors that affect its success as

143 this will benefit both public and private sectors in PPPs in the briefing stage. This paper

144 therefore focuses on these factors in relation to procurement. In all, 15 procurement-

145 related factors are identified based on the existing literature. These factors have been

146 tested in previous studies for their importance in the PPP approach and briefing stage and

147 are summarised in Table 1. For example, Leung et al. (2008) recommend that "formal

148 briefing sessions" and "regular formal meetings" influence project success and

149 participant satisfaction. Yu et al.'s (2008), Hong Kong questionnaire survey, found

150 significant implications for construction industry practitioners in producing their

151 guidelines for the briefing process and for writers in drafting 'how-to' briefing guides.

152 The Construction Industry Board (1997) suggest that "clear and agreed objectives",

153 "carefully thought-out requirements" and other factors are critical, while Blyth and

154   Worthington (2001) also identify "defining the process", "timely decision taking" and

155   other key areas as essential to briefing success. Lee and Schaufelberger (2014) use case

156   studies in East Asia and the Pacific to identify factors such as government interference,

157   conflict of interest among parties, delays in government agency support, and political

158   *force majeure*, must be identified at the briefing stage of BOT project development and

159   manage them through contractual agreements and financial arrangements clearly

160   specified in the terms and conditions.

161   *<Insert Table 1. here>*

162 **RESEARCH METHOD**

163 **Data collection**

164   A questionnaire survey was conducted from March to May 2009 to collect public-sector

165   opinions on the importance of each of the 15 factors in PPP project briefing. The pilot

166   study involved three interviews, with two interviewees being officers in HK government

167   departments and one from a local construction company. All interviewees have over 10

168   years' working experience in the construction industry and have been involved in PPP

169   projects at least once. Only those who had work experience of PPP projects in HKSAR

170   government departments were selected for the survey sample (Cheung and Chan, 2011).

171   Overall, 500 questionnaires were sent out and 122 responses were collected, yielding a

172   response rate of 24.4%. Returns were received by respondents from the Architectural

173   Services Department, Buildings Department, Drainage Services Department, Efficiency

174   Unit, Environmental Protection Department, Highways Department, and Transport

175   Department. All these Departments have had experience with PPP projects.

176   The questionnaire comprises two sections. In the first section, background information on

177   the type of the PPP project, the nature of the PPP project, role played in the PPP project

178   and experience in the PPP project, was requested. In the second section, the procurement-

179   related factors which might affect the success of briefing were rated on a scale of 1-5

180   (Zarkada-Fraser and Skitmore, 2000), where 1 represents 'strongly disagree' and 5

181   represents 'strongly agree'. A five-point Likert scale is in common use for research of

182   this kind as it is simple enough to answer and yet still provides sufficient information

183   concerning different degrees of the same attribute (Chan et al., 2011; Yeung et al., 2008).

184   Respondents answered the questionnaire based on a particular PPP project in which they

185   had participated in Hong Kong.

186   **Preliminary findings**

187   Among the different types of PPP projects, about one third of the respondents had

188   worked on road projects (34%), followed by drainage projects (30%), waste transfer

189   stations (13%), theme parks (9%), tunnels (7%), schools (5%) and rail projects (2%). Of

190   the four different natures of projects, slightly more than half of the projects involved

191   refurbishment (53%), followed by new build (34%) and schemes comprising both new

192   build and refurbishment (13%). In terms of roles played in PPP projects, 51 respondents

193   are engineers (42%), followed by client representatives (23%), administrators (10%),

194   contract managers (8%), surveyors (7%), financial managers (5%), architects (2%), and

195   contractors/suppliers (3%).

196   Note that the bulk of respondents (77%) were not directly involved in briefing, leaving 23%

197   of respondents directly involved in briefing. Despite this, their active involvement in a

198   project is expected to provide useful data. This applies especially when briefing is

199 perceived to be part of the inception stage of a project, as professionals who work on later

200 stages of a project should be able to provide opinions on how to improve the briefing

201 stage for the benefit of these later stages.

202 For example, an engineer involved only in the later stages of a project, such as the

203 maintenance stage after the concession period when PPP projects are delivered back to

204 the host government, may wish to correctly record the decisions made and change the

205 contents of the brief to save cost and avoid dissension (Yuan et al., 2012a, 2012b, 2013).

206 For another example, a client representative not involved in the briefing stage may

207 identify missing client requirements and/or misunderstandings when the concept or detail

208 design is completed, and want to clearly identify and fully understand the client

209 requirements during the briefing stage to save project time. Soomro and Zhang (2013)

210 investigate the actions and decisions of private-sector partners by evaluating 35 failed

211 transportation PPPs around the world, and suggest a better understanding of partners'

212 actions and decisions and their influence on project success would be beneficial at the

213 briefing stage.

214 **DATA ANALYSIS AND DISCUSSION**

215 **Factor analysis**

216 An exploratory factor analysis was conducted to identify the latent dimensions that affect

217 the briefing stage. The purpose of this was to reduce the amount of work needed to test

218 the effect of background variables on the factors (as described in the next section). The

219 total percentage of variance explained was used to determine the number of components

220   involved (Chan and Lee, 2008). This was obtained by principal component analysis with

221   varimax rotation to generate factor loadings for the extracted components.

222   Prior to the factor analysis, the data samples were analysed to check their appropriateness.

223   The Kaiser-Meyer-Olkin (KMO) test and Barlett's test were conducted. The KMO

224   measure of sampling adequacy examines whether the partial correlations among variables

225   are small (Khazanchi, 2005). The KMO test value should be greater than 0.5 for a

226   satisfactory factor analysis to proceed. Bartlett's test of sphericity determines whether the

227   correlation matrix is an identity matrix, which would indicate that the factor model is

228   inappropriate. The null hypothesis should be rejected prior to factor analysis. The test

229   results indicate that the KMO measure was above the threshold of satisfaction (=0.755),

230   while the significance value of Bartlett's test was sufficiently small (=0.000). Therefore,

231   both measures support the undertaking of a factor analysis.

232   A total of four dimensions were extracted from the factor analysis with eigenvectors

233   greater than one and accounting for 61% of the common variance as shown in Table 2.

234   The scree plot was also indicates that the contributions are relatively low after the fourth

235   component. This is consistent with the preceding conclusion that the four dimensions

236   offer a reasonable summary of the data. Each dimension consists of a set of factors.

237   According to Hair et al. (1998), the item-total correlation should exceed 0.5 for

238   identifying significant loading. From Table 3, the loadings for all 15 factors exceed 0.500

239   ($p < 0.01$) with the sole exception of one factor with a factor loading of 0.481, which was

240   still included in the subsequent analysis since it is only marginally significant in

241   exploratory research (Hair et al., 1998).

242   *<Insert Table 2. here>*

243 *<Insert Table 3. here>*

244 The four extracted dimensions were labelled as follows:

245 (1) *Client requirements and decisions for briefing* contains the following four

246   factors (shown with their factor loadings): 'adequate time for the briefing

247   process' (0.685), 'good record of decisions made' (0.507), 'identification of

248   client requirements' (0.671), and 'thorough understanding of client

249   requirements' (0.684).

250 (2) *Briefing documentation and flexibility* contains the four factors of 'time for

251   freezing of brief documents' (0.578), 'flexibility of briefs to cater for changes'

252   (0.576), 'feedback from completed projects' (0.764), and 'clear and precise

253   briefing documents' (0.775).

254 (3) *Clear briefing process and control* contains four the factors of 'clear goal and

255   objectives' (0.695), 'experience of the brief writer' (0.778), 'clear end user

256   requirements' (0.672), and 'control of process' (0.481).

257 (4) *Stakeholders' involvement in briefing* contains the three factors of

258   'development of a framework agreed by the key parties' (0.653), 'consensus

259   building' (0.708), and 'proper priority setting' (0.777).

260 The means, standard deviations, Cronbach alpha, and correlations are presented in Table

261 4. The means indicate that respondents rated Clear briefing process and control (4.41) the

262 highest, followed by Clients' requirements and decisions for briefing (4.08), Briefing

263 documentation and flexibility (3.90), and Stakeholders' involvement in briefing (3.82).

264 *<Insert Table 4. here>*

265 In order to test the extent to which the corresponding factors measure the dimension, an

266 internal consistency reliability test was conducted. A Cronbach alpha value was

267 computed for each dimension. The alpha coefficients ranged from 0.66 to 0.73 which

268 were all greater than 0.6, indicating acceptable and good internal consistency reliability

269 (Zhang, 2006). Moreover, two-tailed Spearman rank correlations between the four

270 dimensions were computed to test the relationship between dimensions. The correlation

271 matrix (in Table 4) indicates that the four dimensions were significantly related to each

272 other. In general, the analysis supports the existence of four distinct but correlated

273 components of the critical factors.

274 **Effect of background variables on the four extracted dimensions**

275 The effect of the background variables on the four dimensions was investigated for, if

276 they exert a considerable influence on the factors, then their effect should be included in

277 estimating the relative levels of importance of the factors. Four background variables

278 were used: "type of PPP project" (e.g. road project, drainage project), "nature of PPP

279 project" (e.g. refurbishment, new build), "role in PPP projects" (e.g. engineers, client

280 representatives), and "experience of PPP projects" (directly involved in briefing, non-

281 directly involved in briefing). These variables are basic and essential for analyzing the

282 effects of the critical factors. Since these categorical variables involve different numbers

283 of groups, they were tested with different statistical methods.

284 From the analysis, no background variable affects the extracted dimension "*client*

285 *requirement and decision for briefing*": this means that illustrating the client

286 requirements well is considered in the same way by all respondents, no matter what their

287 background. Other results are:

288   (1)   Three types of PPP projects - "building", "infrastructure", and "specific

289   projects" -were investigated. An ANOVA test was used and results indicate

290   that type of PPP project did not significantly relate to all dimensions;

291   (2)   As there were three different natures of PPP projects, the ANOVA test was

292   again employed and the results indicate that "nature of PPP project" does

293   significantly affect both the dimensions of *Briefing documentation and*

294   *flexibility* ($p = 0.007$) and *Stakeholders' involvement in briefing* ($p = 0.023$);

295   (3)   The variable "the experience in PPP projects" is a dichotomous variable, so a

296   t-test was adopted. The results indicate that "experience in PPP projects"

297   significantly affects the three dimensions of: *Briefing documentation and*

298   *flexibility* ($p = 0.023$), *Clear briefing process and control* ($p = 0.017$), and

299   *Stakeholders' involvement in briefing* ($p = 0.018$); and

300   (4)   The two roles of "professional" group and "management" group, being

301   dichotomous, were subject to t-tests. These showed that "role in PPP projects"

302   also significantly affects the three dimensions of *Briefing documentation and*

303   *flexibility* ($p = 0.005$), *Clear briefing process and control* ($p = 0.011$), and

304   *Stakeholders' involvement in briefing* ($p = 0.009$).

305   **FACTOR RANKING**

306   **Sample visualization method**

307   Since three of the four background variables exert a significant influence on the four

308   factor dimensions, their effect needs to be considered when identifying the importance of

309 the original factors. In view of this, a sample visualization method is developed to

310 estimate the weighted importance of the 15 factors. The method is described below.

311 Suppose there are N respondents, where N is 122. Each respondent is denoted as

312 $\mathbf{x}_i = (x_{i,1}, x_{i,2}, ..., x_{i,d}) \in R^d$, which is a dimensional vector. Each dimension is an item with

313 values ranging from 1 to 5. The class labels used in pattern recognition (Hastie et al.,

314 2008) are defined based on the indicator of different variables, i.e. the options mentioned

315 above. These variables are used to help distinguish between different data samples.

316 Suppose there are C classes, and the label of $\mathbf{x}_i$ is l_i. Linear discriminate analysis (LDA)

317 produces a linear projection matrix $\mathbf{W} \in R^{d \times m}$ to project the original data onto lower-

318 dimensional data

$$\mathbf{y}_i = \mathbf{W}^T \mathbf{x}_i \tag{1}$$

320 where $\mathbf{y}_i \in R^m$ is an m dimensional vector.

321 To estimate $\mathbf{W}$, two scatter matrices are introduced, which are the within-class scatter

322 matrix $\mathbf{S}_w$ and between-class scatter matrix $\mathbf{S}_b$:

$$\mathbf{S}_w = \sum_{i=1}^{C} \sum_{\mathbf{x}_j : l_j = i} (\mathbf{x}_j - \mathbf{m}_i)(\mathbf{x}_j - \mathbf{m}_i)^T \tag{2}$$

$$\mathbf{S}_b = \sum_{i=1}^{C} (\mathbf{m}_i - \mathbf{m})(\mathbf{m}_i - \mathbf{m})^T \tag{3}$$

325 where $\mathbf{m}_i$ is the mean of class i, and $\mathbf{m}$ is the mean of all data samples. $\mathbf{S}_w$ measures the

326 intra-class variances and $\mathbf{S}_b$ measures the inter-class variances. The optimization of the

327 projection matrix $\mathbf{W}$ is obtained by finding a lower-dimensional space to simultaneously

328   maximize the between-class scatter and minimize the within-class scatter. Compared with

329   principal component analysis, which is based on the total variances ($\mathbf{S}_w + \mathbf{S}_b$), LDA

330   projects the data sample with most discriminative directions (Bishop, 2006). This means

331   that the projected data have the property such that samples with the same label have a

332   clustering property in the projected space. Visualization then helps to identify classes

333   with similar levels of importance but different working experiences. The optimization

334   criterion is formulated as:

335
$$\mathbf{W}^* = \arg \max_{\mathbf{W} \in R^{d \times m}} tr\left(\left(\mathbf{W}^T \mathbf{S}_w \mathbf{W} \right)^{-1} \left(\mathbf{W}^T \mathbf{S}_b \mathbf{W} \right) \right) \tag{4}$$

336   Here tr represents the trace of the matrix. The solution to this criterion has been proven to

337   be the m largest eigenvectors of the matrix $\mathbf{S}_w^{-1}\mathbf{S}_b$ and the optimal value of the criterion

338   is the sum of the corresponding largest eigenvalues (Hastie et al., 2008).

339   **Projection result**

340   Since we use each vector $\mathbf{x}_i$ to represent a sample, the similarity between two samples $\mathbf{x}_i$

341   and $\mathbf{x}_j$ can be represented by a function of Euclidean distance. The smaller the Euclidean

342   distance between the two samples, the more similar they are. Therefore, we can also

343   make use of the Euclidean distance between two projected vectors $\mathbf{y}_i$ and $\mathbf{y}_j$ to

344   approximately represent the similarity. Although this may lose some information, it does

345   not affect the use of the 2D plane to visualize the clustering property.

346   The visualization results are shown in Figure 2. The horizontal and vertical axes represent

347   the scale value of the projected coordinate system. The scale value is a weighted

348   combination of original factor values. The weighting scheme is determined by the

349   projection matrix $\mathbf{W}$. In Figure 2, shows the clustering properties of the samples, i.e. the

350   samples with the same class label projected onto nearby places. Since all the original

351   rating values are normalized to zero mean and uniform variance, many of the samples

352   cluster around zero.

353   *<Insert Figure 2. here>*

354   **Ranking of key factors**

355   By inspecting the 2D visualization of the samples, it is clear that most of the samples are

356   located approximately on a Gaussian distribution near the zero point. To reduce the

357   influence of those clustered away from zero, a class-mean based ranking method is

358   developed. A function of class mean and the total data mean is used to weight the factor

359   agreement values. In particular, the weighting for data $\mathbf{x}_i$ in background variable k is

360   calculated as:

$$w_{l_i}^{k} = \exp\left(-\frac{1}{2}\left(\mathbf{m}_{l_i}^{k} - \mathbf{m}^{k}\right)^{T} (\mathbf{\Sigma}^{k})^{-1} \left(\mathbf{m}_{l_i}^{k} - \mathbf{m}^{k}\right)\right) \tag{5}$$

362   where k is the indicator of different background variables, ranging from 1 to 4 to

363   represent "type of PPP project", "nature of PPP project", "role in PPP project" and

364   "experience of PPP projects" respectively. l_i is the class label for $\mathbf{x}_i$. $\mathbf{m}_{l_i}^{k}$ is the mean of

365   class l_i in background variable k. $\mathbf{m}^{k}$ is the total data mean of the background k. $\mathbf{\Sigma}^{k}$

366   is the total data covariance matrix which is calculated based on all the data samples over

367   background k, so that:

$$\mathbf{\Sigma}^k = \frac{1}{N-1} \sum_{i=1}^{N} (\mathbf{x}_i^k - \mathbf{m}^k)(\mathbf{x}_i^k - \mathbf{m}^k)^T \tag{6}$$

368

369   where $\mathbf{x}_i^k$ is the vector composed of the factors of data $\mathbf{x}_i$ in background k and the

370   weighting coefficient is just the exponential term of a multivariate Gaussian distribution:

$$\frac{1}{(2\pi)^{d/2}} \frac{1}{|\mathbf{\Sigma}^k|^{1/2}} \exp\left(-\frac{1}{2} \left(\mathbf{m}_{l_i}^k - \mathbf{m}^k \right)^T (\mathbf{\Sigma}^k)^{-1} \left(\mathbf{m}_{l_i}^k - \mathbf{m}^k \right) \right) \tag{7}$$

371

372   ignoring the constant term. Moreover, the weighting ranges from 0 to 1. Therefore, if the

373   class mean $\mathbf{m}_{l_i}^k$ in background variable k is distant from the total data mean $\mathbf{m}^k$, a small

374   weighting is given to the samples with that background variable option. Contrarily, if the

375   experience class $\mathbf{m}_{l_i}^k$ in experience type k is near the total data mean $\mathbf{m}^k$, a large weight

376   is given, since the samples of that background variable represent the majority of the

377   collected data. Similar weighting schemes have been widely used in non-parametric

378   kernel methods (Schölkopf and Smola, 2001), neural network-based machine learning

379   (Bishop, 1995), and manifold approximation (Belkin and Niyogi, 2005).

380   Based on the weighting of each background variable option, the weighting for each data

381   sample $\mathbf{x}_i$ is defined as:

$$w_{\mathbf{x}_i} = \frac{1}{4} \sum_{k=1}^{4} w_{l_i}^k = \frac{1}{4} \left(w_{l_i}^1 + w_{l_i}^2 + w_{l_i}^3 + w_{l_i}^4 \right) \tag{8}$$

382

383   where $w_{l_i}^k$ is the weight for $\mathbf{x}_i$ with class label l_i in background variable k. Therefore, if

384   a data sample is in the majority of all of the four background variables, it is allocated a

385   large weighting in calculating the final ranking.

386   With the weighting value for each data sample, the final ranking score for item j is:

387
$$r_j = \sum_{i=1}^{N} w_{\mathbf{x}_i} x_{i,j} = w_{\mathbf{x}_1} x_{1,j} + w_{\mathbf{x}_2} x_{2,j} + ... + w_{\mathbf{x}_N} x_{N,j} \qquad (9)$$

388   The results are shown in the Table 5 and discussed in the next section.

389   **Discussion**

390   Table 5 lists the ranking of factors related to procurement in the PPP briefing stage

391   according to public-sector opinions. It is noted that the scores presented are lower than

392   the mean values of factors. This is because the scores were calculated in a different way.

393   Therefore, the weighted scores and the mean values cannot be directly compared. Only

394   the ranks based on the two methods can be compared. It is clear that the two ranking

395   orders are not the same when the four background variables are taken into consideration.

396   However, the rank estimated by the sample visualization method is more accurate and

397   reliable.

398   *<Insert Table 5. here>*

399   As shown in Table 5, "clear goals and objectives" are ranked first (=3.1932), followed by

400   "clear end users requirements" (=3.1914). Therefore, in order to maximize the benefit to

401   be obtained from a project, the briefing should provide clear goals and objectives in the

402   form of clear instructions from the client (Abdel Aziz, 2007). End users of the project

403   may have specific requirements. Unfortunately, these requirements are not always made

404   known in the briefing process. Thus, the client has the responsibility to make sure that all

405   the user groups' requirements are heard (Blyth and Worthington, 2001).

406   In third and fourth place are "experience of the brief writer" (=3.1869) and "thorough

407   understanding of client requirements" (=3.0674). Briefing documents specify all the

408   requirements demanded by a project. Brief writers therefore play an important role in

409   capturing all these requirements in a clear overall picture for project stakeholders,

410   including clients and designers (Hyams, 2001). On the other hand, the needs and

411   requirements of all stakeholders should also be included in a comprehensive manner in

412   stating the required end product (Karama et al., 2001). For example, site, environmental,

413   and regulatory requirements should be combined when specifying design requirements

414   "Good record of decisions made" occupies fifth place in the ranking list (=2.9563). The

415   reasons for its importance are similar to those of "experience of the brief writer".

416   Decisions should be clearly recorded in the brief documents by the brief writer for later

417   use. There are many well-known techniques, such as computer-aided tools, that can help

418   in keeping these records (Tang et al., 2010).

419   **CONCLUSIONS**

420   The briefing stage is important for all construction projects, especially PPP-type projects,

421   which are more complex because of the increased numbers, involvement and

422   responsibilities of stakeholders and the longer periods involved. Better briefing can save

423   both time and value in the later stages of projects.

424   The purpose of the research is to identify the critical success factors for the briefing stage

425   of PPP projects. The most important factor is "Clear goals and objectives". This reminds

426   both the public sector and the private sector of their roles at this stage. The same result is

427   also found in research on conventional projects and means that both conventional projects

428   and PPP projects need to provide clear goals and objectives in their briefing stages. The

429   main findings also highlight the need for clarity, experience and understanding these

430 critical success factors. Statistical and mathematical analyses of the data from different

431 Hong Kong government departments regarding the significance of the 15 procurement-

432 related factors also provide the following results:

433   (1)   The KMO test supports the conclusion that the survey data are adequate for

434   factor analysis;

435   (2)   Factor analysis establishes four dimensions of briefing stage procurement:

436   *Clients' requirements and decisions for briefing*, *Briefing documentation and*

437   *flexibility*, *Clear briefing process and control*, and *Stakeholders' involvement*

438   *in briefing*. Also, the effect of four background variables on the four

439   dimensions was tested and partially supported;

440   (3)   Validity analysis and reliability analysis confirm the quality of the

441   questionnaire survey, the soundness of the factor analysis and the internal

442   consistency of the procurement-related factors; and

443   (4)   A new mathematical model, namely the sample visualization method, adopted

444   from Gaussian distribution was used to add weights generated by the four

445   background variables to estimate the weighted ranking scores of factors.

446 The briefing stage of PPP projects has been largely overlooked to date in terms of its

447 importance, although decisions made at this stage have a far-reaching influence

448 throughout the project life cycle. A set of 15 procurement-related factors affecting the

449 success of the briefing stage is first identified based on the existing literature. Then the

450 effects of the four background variables on the factors are tested for the first time with a

451 sample of data from government departments in Hong Kong. The results support the view

452 that the background variables should be taken into account when ranking the factors,

453   which suggests that Factor Analysis should not be used as the only way to analyze

454   questionnaire survey data on this topic.

455   The literature review concerns the briefing stage and relevant procurement studies. A

456   statistical analysis is then conducted in order to obtain solid and credible analysis results.

457   The practical value of the analysis is that the findings facilitate all stakeholders in

458   attending and collaborating in the briefing to increase the value of PPP projects. As the

459   briefing stage is usually led by the public sector, the public sector can use these CSFs to

460   prepare the briefing while obtaining private sector benefits as benchmarks in attending

461   and collaborating at the briefing stage.

462   The limitation of the research is that only factors related to procurement issues and the

463   success of PPP briefing through the perspective of perceptions of PPP practitioners were

464   studied. For further research, these factors could be used in real cases by government

465   departments. In theoretical terms, there are other aspects which impact on the success of

466   briefing stages, such as stakeholder-related, risk-related, and finance-related issues (Tang

467   et al., 2010). Likewise, in practice, these factors should be studied and tested in later

468   research in order to develop a more comprehensive picture of what is needed to improve

469   PPP briefing. Case studies focussing on how proper attention to these factors would have

470   improved the performance of previous PPP projects should also be a subject of further

471   study. The findings of this research need to be tested by studies of briefing in real PPP

472   projects in order to verify the relevance of the analysed briefing factors for the success of

473   entire PPP projects.

474   In summary, the main findings highlight the need for clarity, experience and

475   understanding of what is needed for PPP projects and how these needs are represented

476 and documented. Although the respondents of the questionnaire survey are drawn from

477 the Hong Kong public sector, these findings facilitate all stakeholders in attending and

478 collaborating in briefings so as to increase the value of PPP projects. This is likely to

479 contribute to the success of an effective and efficient briefing stage of the majority of

480 PPP-type construction projects world-wide.

481 **ACKNOWLEDGEMENTS**

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Table 1 Procurement-related factors of briefing stages in PPPs

Procurement-related factors	Remarks	Factors adopted from
Clear goals and objectives	Briefing is a process which should have a clear goal and/or objectives.	The Construction Industry Board, 1997; Gurgun and Touran, 2013
Experience of the brief writer	An experienced person is needed to develop a brief.	Yu et al., 2008
Clear end user requirements	A brief needs to elucidate the end user requirements.	The Construction Industry Board, 1997; Kelly and Duerk, 2002
Development of a framework agreed by the key parties	During briefing, the process involved in formulating the brief needs to be agreed by the key parties.	Kamara and Anumba, 2001; Leung et al., 2008
Control of process	The public sector should lead throughout the briefing process.	Leung et al., 2008; Blyth and Worthington, 2001
Adequate time for briefing	Briefing should be allocated sufficient time for its conduct.	Leung et al., 2008; Blyth and Worthington, 2001
Consensus building	A consensus of the brief; contents amongst the various stakeholders needs to be developed during the briefing stage.	Yu et al., 2008
Proper priority setting	The prioritisation of decisions to be made should be agreed by the key parties in briefing.	Yu et al., 2008
Time for freezing of brief documents	A schedule should be set for the completion of the brief.	Blyth and Worthington, 2001
Flexibility of briefs to cater for changes	Sufficient flexibility in briefs should be provided to allow possible future changes.	Yu et al., 2008
Good record of decisions made	Decisions made should be recorded in detail.	Yu et al., 2008; Wang, 2013
Identification of client requirements	The client requirements should be identified during briefing.	The Construction Industry Board, 1997; Kelly and Duerk, 2002
Thorough understanding of client requirements	Client requirements should be thoroughly understood.	The Construction Industry Board, 1997; Kelly and Duerk, 2002
Feedback from completed projects	Feedback from completed projects is needed to improve briefing.	Yu et al., 2008
Clear and precise briefing documents	A clear and precise brief should be available at the end of the briefing.	Yu et al., 2008

Table 2 Rotated Component Matrix(a)

	Component			
	1	2	3	4
Adequate time for briefing	.685			
Good record of decisions made	.507			
Identification of client requirements	.671			
Thorough understanding of client requirements	.684			
Time for freezing of brief documents		.578		
Flexibility of briefs to cater for changes		.576		
Feedback from completed projects		.764		
Clear and precise briefing documents		.775		
Clear goal and objectives			.695	
Experience of the brief writer			.778	
Clear end user requirements			.672	
Control of process			(.481)	
Development of a framework agreed by the key parties				.653
Consensus building				.708
Proper priority setting				.777

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 6 iterations.

Table 3 Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.985	33.235	33.235	4.985	33.235	33.235	2.468	16.451	16.451
2	1.586	10.570	43.806	1.586	10.570	43.806	2.468	16.450	32.901
3	1.433	9.553	53.359	1.433	9.553	53.359	2.114	14.093	46.994
4	1.147	7.645	61.004	1.147	7.645	61.004	2.102	14.010	61.004
5	.997	6.644	67.648						
6	.924	6.161	73.809						
7	.750	5.000	78.809						
8	.639	4.260	83.070						
9	.565	3.764	86.833						
10	.472	3.148	89.981						
11	.435	2.898	92.878						
12	.317	2.116	94.995						
13	.301	2.006	97.001						
14	.258	1.721	98.723						
15	.192	1.277	100.000						

Extraction Method: Principal Component Analysis.

Table 4 Correlations, means, and standard deviations

	Variables	Mean	S. D.	1	2	3	4	5	6	7	8
1	Type of PPP projects	—	—	—	—	—	—	—	—	—	—
2	Nature of PPP projects	—	—	-0.04	—	—	—	—	—	—	—
3	Role in PPP projects	—	—	-0.16	-0.02	—	—	—	—	—	—
4	Experience in PPP projects	—	—	-0.16	-0.04	0.33^b	—	—	—	—	—
5	Client's requirements and decisions for briefing	4.08	0.52	-0.02	-0.10	0.10	0.18^a	(0.73)	—	—	—
6	Briefing documentation and flexibility	3.90	0.53	0.13	-0.29^b	0.22^a	0.22^a	0.49^b	(0.73)	—	—
7	Clear briefing process and control	4.41	0.48	0.10	-0.11	0.22^a	0.24^b	0.40^b	0.38^b	(0.66)	—
8	Stakeholders' involvement in briefing	3.82	0.54	0.13	-0.09	0.24^b	0.18^a	0.35^b	0.46^b	0.26^b	(0.68)

Note: Parentheses in the diagonal cells are coefficient alpha values.

[a]$p<0.05$.

[b]$p<0.01$, n=122.

Table 5 Ranking scores of procurement-related factors

Factors	Weighted Scores	Means
1. Clear goals and objectives	3.193	4.410
2. Clear end user requirements	3.191	4.418
3. Experience of the brief writer	3.187	4.410
4. Thorough understanding of client requirements	3.067	4.213
5. Good record of decisions made	2.956	4.066
6. Identification of client requirements	2.941	4.041
7. Adequate time for briefing	2.888	3.984
8. Flexibility of briefs to cater for changes	2.837	3.918
9. Time for freezing of brief documents	2.821	3.902
10. Clear and precise briefing documents	2.819	3.893
11. Feedback from completed projects	2.806	3.869
12. Development of a Framework agreed by the key parties	2.797	3.877
13. Proper priority setting	2.751	3.787
14. Consensus building	2.745	3.787
15. Control of process	2.561	3.533
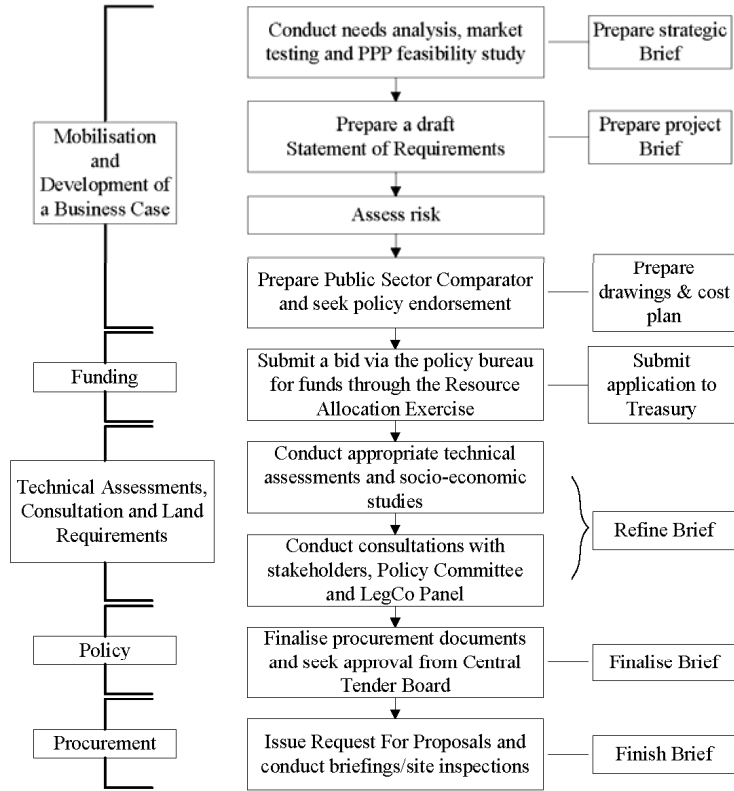
Fig. 1. Structure of the PPP briefing stage (adapted from EU 2008)
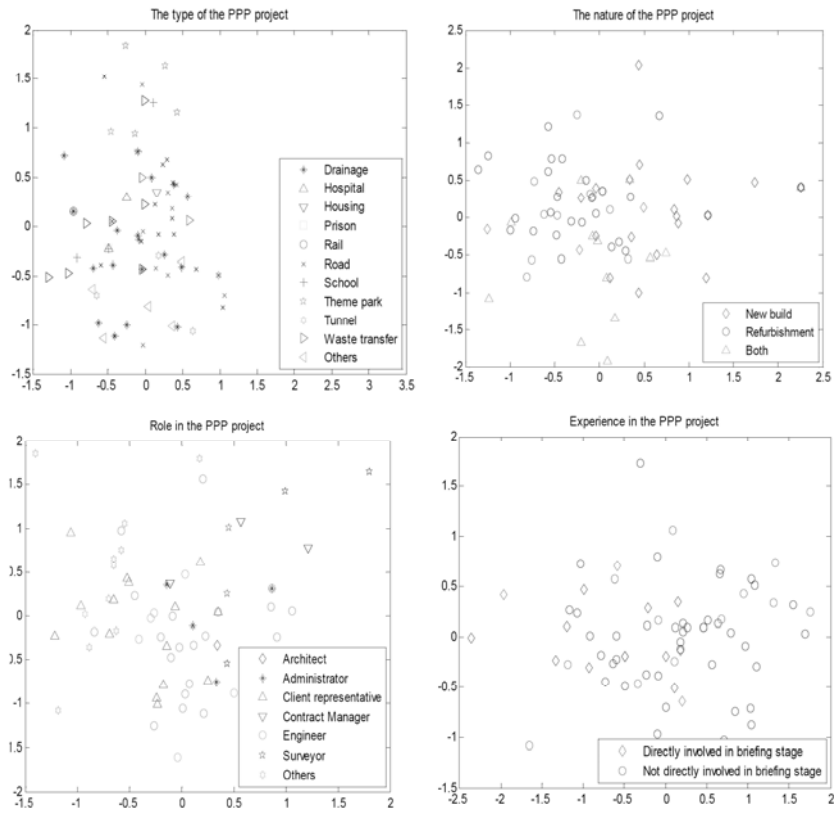
Fig. 2. Projection results of background variables