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Ameyaw E. E[1]., and Chan, A. P.C[2]**.** (2015) Implementing PPP in Water Supply Projects in Ghana: A Model of CSFs**.** In: Mojekwu, J.N., Ogunsumi, L.O., Ojigi, L.M., Atepor, L., Thwala, D.W., Sackey, S. Awere E., and Bamfo-Agyei, E. (Eds) African Journal of Applied Research .(AJAR) Journal, Vol.1,No.1 ISSN 2408-7920 January 2015, Cape Coast, Ghana. 453-469

IMPLEMENTING PPP WATER SUPPLY PROJECTS IN GHANA: A MODEL OF CSFs

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ABSTRACT

The Public-private partnership (PPP) concept has attracted the attention of the Ghanaian government, because it is viewed as a reform tool for resolving underinvestment, inefficiency and absence of dynamism in water supply infrastructure services. Despite the mixed results, to date there has been no comprehensive study on the requirements for their successful implementation. This research defines a set of factors that, when given special and continual attention, would ensure successful implementation of PPP water supply projects. The perceived critical success factors (CSFs) were initially derived from six project cases and extant literature, and verified through a two-round Delphi survey. Factor analysis established five critical success factor groups (CSFGs) as commitment of partners, strength of consortium, asset quality and social support, capacity building, and national PPP unit. These principal factors were then modelled using fuzzy synthetic evaluation method and the model output showed that, overall, these factors have a 'very high' positive impact on successful implementation of water based PPPs. It is hoped that this study will trigger policy development towards PPP practice in Ghana, because these findings have wider implications for legal and regulatory systems, public sector capacity, financing, public procurement, and politics.

Keywords: CSF, PPP, Water, Supply, Ghana

INTRODUCTION

The relationship between quality infrastructure and country competiveness is well-established (Vives et al., 2006). Network utilities, including water, provide essential services for both commerce and manufacturing sectors, thereby contributing to high factor productivity of countries (Newbery, 2000). Economic and social development significantly depends on efficient water infrastructure and failure to develop the sector threatens quality of life and public health, and stifles economic growth (Kessides, 2004).

Despite the sector's crucial role, Ghana's water sector suffers from major constraints that limit its meaningful contribution to economic growth (Ameyaw and Chan, 2013a). Challenges confronting the sector have tended to fall under two broad categories: limited and aging distribution infrastructure, and insufficient treated water and large-scale

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(commercial) water theft. Both constraints explain the prevalence of intermittent supply and result from decades of underinvestment. Annual infrastructure funding deficit for the water sector is around US$0.4 billion (Foster and Pushak, 2011).

Public-private partnership (PPP) is therefore emerging as an astute solution to the numerous sector problems. The first contract, a country-wide urban water management, was awarded in 2005 to Aqua Vitens Rand Limited, following a 15-year, heavily-contested policy process. Since 2008, the current government is continuing with PPP under its economic and social development policy, by launching a PPP policy and appointing a minister in-charge of PPPs.

Globally, efforts to ensure success, and increase private investments have often met with serious constraints, such as unmet private investments and service targets, imperfect risk allocations, high risk premiums, renegotiations, public resistance, and weak regulation (Hall et al., 2005). Following this, PPP results are described as mixed, and key determinants for success have become an important research area, in all infrastructure sectors (Dulaimi et al., 2010; Tiong, 1996; Li et al., 2005).

With existing varied published lists of CSFs, however there is very little consensus on these factors (Dulaimi et al., 2010). Given the distinct characteristics of the water sector (see Ameyaw and Chan, 2013a), its success factors are likely to vary compared to other infrastructure sectors. Phua (2004) shared similar views, arguing that project success factors differ significantly by sector and demographics. This possibly explains why the current knowledge on CSFs for PPPs is limited by country and/or sector perspectives.

More importantly, studies on CSFs for implementing PPP water supply projects are limited and country-specific. In addition, there is no research to date on CSFs for water supply PPPs in Ghana. Against this background, the specific objectives of the current study are to (a) identify and evaluate the perceived CSFs for implementing PPP water supply projects, and (b) provide a predictive tool to aid public and private parties to assess the possibility of a successful implementation of a project, given a set of CSFs. Strategies to address project success are best exploited at the development phase of a project (Li et al., 2005). This research therefore explores success factors for PPP water projects at their early stages and forms part of an ongoing study to develop a risk allocation model for PPP water supply projects in Ghana (Ameyaw and Chan, 2012, 2013a, b).

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PREVIOUS RESEARCH ON CSFs FOR PPP PROCUREMENT

CSFs are "those few key areas of activity in which favourable results are absolutely necessary for a manager to reach his/her goals…those few areas where things must go right" (Rockart, 1982, pg. 4). The technique has been applied as a management tool in various fields since the 1970s, but introduced in PPP procurement in the 1990s. Tiong (1996) introduced a CSF model for tendering BOT projects and concluded that the financial and technical strength of a promoter is the most important CSF. Qiao et al. (2001) suggested a CSF framework for BOTs in China, while Jefferies et al. (2002) developed a framework of CSFs based on Stadium Australia, in which strong consortium, efficient approval systems, and innovative financing were the CSFs. Dulaimi et al. (2010) argued that political support and strong private consortium are the CSFs for PPP in UAE. According to Li et al. (2005), 'social support' is a less important project success factor. In the water sector, and in Ghana, however public acceptance of PPP for water supply is a prerequisite for success, because the public is a major stakeholder. Hence, existing CSF frameworks must be cautiously reviewed to establish the extent to which they generalise to our contexts and sectors.

RESEARCH METHODOLOGY

Qualitative approach

To establish the important determinants of PPP water projects success, the qualitative approach included a thorough analysis of local (e.g., Ameyaw and Chan, 2012, 2013a, b), and international (Dulaimi et al., 2010; Tiong, 1996;) water supply projects accessed from the extant literature. The approach offered an effective way to capture and understand the factors that contributed to the success or failure of the studied projects. The preliminary factor list was further reviewed and refined by an international water PPP expert working in Ghana, who confirmed the relevance of all the factors. Following this, a list of 14 CSFs for water PPPs was established.

Quantitative approach

Derived qualitatively, the 14 CSFs were then evaluated numerically by means of a Delphi survey in order to establish the most important CSFs. Ranking-type Delphi method is a suitable tool for factor prioritisation (Schmidt et al., 2001). This study seeks views originating from practitioners' professional and experienced judgment and therefore

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requires practitioners with insights of the country environment, water industry and PPP procurement. The survey targeted public and private institutions with interest and involvement in water PPPs in Ghana. Because PPP procurement is new, purposive sampling and semi-snowballing approaches were deemed appropriate in order to identify well-qualified practitioners.

A two-round Delphi survey was conducted between February and July 2013. A two-round Delphi survey has an advantage of reducing fatigue and optimising response rate among participants, yet permits both feedback and revision of original scores. Round one questionnaire was solely based on the outcome of the qualitative approach, in which the experts were required to rate the relative importance of each perceived CSF based on a seven-point grading system (1 = extremely low importance and 7 = extremely high importance). A panel size of between 10 and 50 with adequate representation to ensure diverse opinions are suggested (Powell, 2003). A panel size of 41 experts from diverse backgrounds was appropriate to allow diversity of opinion. The panel was formed on the basis of a participant’s years of relevant experience, professional background and knowledge, and position in his/her organization.

Panelists were selected from Ghana Urban Water Limited (7), Ghana Water Company Limited (10), Public Procurement Authority (3), PPP Advisory Unit (6), private water developers and consulting firms (11), and Public Utilities Regulatory Commission (4). Three broad classifications can be provided according to the participants’ positions in their institutions: project and financial analysts and consultants (11), directors (6), and managers (24) – e.g., water production/distribution managers, projects and contracts managers, customer care managers, water managers).

Fuzzy synthetic evaluation (FSE) method

FSE is more practical a tool for evaluating multiple criteria decision-making (Lo, 1999). In factor evaluations that require respondents’ subjective knowledge, FSE has the merit of objectifying the resulting judgmental or subjective data.

The method has been adopted in many studies in diverse fields, including: health risk assessment (Sadiq and Rodriquez, 2004), risk assessment in drilling projects (Liu et al., 2013), risk allocation (Xu et al., 2010), and performance measurement (Yeung et al., 2012). And because factor assessment is multi-layered and subjective in practice, FSE is more suited to such situations. The writers applied this tool to model the success index of a given critical success factor group (CSFG), and the overall success index of PPP water

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projects, given a set of CSFs. According to (Xu et al., 2010), FSE requires three basic elements:

1. A set of basic criteria (factors) $\pi = \{f_1, f_2, \ldots\ldots, f_m\}$, where f = success factors, e.g., f_1 = government commitment, f_2 = adequate financing, …, f_{14} = internal coordination within government.
2. A set of grade alternatives $E = \{e_1, e_2, \ldots\ldots e_n\}$; e = factor estimations by panelists, e.g. e_1 = not important (NI), e_2 = very low importance (VLI), e_3 = low importance (LI), e_4 = moderate (M), e_5 = important (I), e_6 = very important (VI) and e_7 = extremely important (EI), for level of importance of the success factors.
3. Establish the weightings of the basic criteria as: $W = (w_1, w_2, \ldots, w_n)$.
4. For every object $u \notin U$, there exist an evaluation matrix $R = (r_{ij})_{m\times n}$. In a fuzzy environment, r_{ij} is the degree to which alternative e_j satisfies the criterion f_j. It is presented by the fuzzy membership function of alternative e_j with respect to criterion f_j.

The combination of these basic elements produces the evaluation results, using equation (1):

$$D = W \circ R \tag{1}$$

where, D denotes the final evaluation; W is the weighting vector; R is the fuzzy evaluation matrix; and ◦ denotes the fuzzy composition operator. FSE usefulness is based on its ability to treat vague and linguistic variables, which can be used for approximate reasoning (Sadiq and Rodriquez, 2004). The composition of equation (1) is best handled by the following fuzzy mathematical function (Lo, 1999):

$$M(\bullet, \oplus), b_j = \min\left(1, \sum_{i=1}^{m} w_i r_{ij}\right) \ \forall b_j \in B \tag{2}$$

QUANTITATIVE APPROACH RESULTS

Resulting data from the Delphi survey was analysed using SPSS 21.0. Statistical tests performed on the ordinal data are: descriptive analysis (mean and frequency), Cronbach alpha reliability test, and factor analysis. Round-by-round results of the Delphi survey are presented in Table 1. The degree of consensus leveled off during the two rounds, from 0.163 to 0.166 in round one and two, respectively. This means that two rounds was optimal for this Delphi study. However, the low values of W indicate weak agreement among the panelists (Schmidt et al., 2001). Moreover, internal consistency of the dataset was tested using Cronbach alpha model, which states that the alpha value must be greater than approximately 0.70 (Norusis, 1993). The alpha-value for the 14 CSFs is 0.824, suggesting

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good internal consistency reliability.

Table 1 Round-by-round Delphi results

ID	Critical success factor (CSF)	Round one Mean index	Round one Ranking	Round two Mean index	Round two Ranking	Criticality
3	Government (political) commitment	6.71	1	6.80	1	extremely important
4	Adequate financing	6.39	2	6.39	2	very important
2	Public acceptance/support	6.15	4	6.24	3	very important
7	Strong and competent private partner	6.22	3	6.22	4	very important
6	Effective regulatory and legal structures	6.12	5	6.20	5	very important
14	Strong and competent public partner	6.12	6	6.20	6	very important
1	National PPP policy and implementation unit	6.05	8	6.17	7	very important
10	Strong commitment from project partners	6.07	7	6.15	8	very important
5	Local capacity building for utility staff	5.71	10	5.90	9	very important
11	Quality water asset and workforce	5.78	9	5.88	10	very important
8	Competitive tendering	5.71	11	5.80	11	very important
9	Profitable water supply projects	5.63	12	5.78	12	very important
12	Flexible contracts with fair risk allocations	5.63	13	5.73	13	very important
13	Internal coordination within government	5.54	14	5.66	14	very important

CSFs for PPP water projects

Analysis of the two-round survey data generated mean importance indexes for the 14 CSFs, ranging between 5.66 and 6.80, as reported in Table 1. This implies that the importance of all the CSFs range between "very important" and "extremely important". This suggests that all the 14 success factors are deemed 'critical'.

Factor analysis (FA)

FA is a statistical technique for exploring the structure of inter-relationships among a dataset so that the common latent constructs are defined. Principal component analysis (PCA) is more suited for data reduction purposes (Norusis, 1993). Here, using PCA the correlation matrix of the 14 CSFs from the Delphi survey was computed. The value of the test statistic for Kaiser-Meyer-Olkin (KMO) is 0.653, which is greater than the recommended threshold of 0.50 (Norusis, 1993). The value of the Bartlett's test of sphericity is relatively large (=242.696) and the associated significance is small (p-value = 0.000), indicating that the correlation matrix is not an identity matrix (Li et al., 2005).

PCA produced a five-factor solution with varimax rotation after seven iterations, explaining 74.499% of the total variance explained. The factor solutions indicate strong item loadings (0.50+) on each factor, which is greater than the recommended minimum loading of 0.32 (Tabachnick and Fidell, 2001). Details of the factor analysis results are reported in Table 2. The five principal components are labelled as follows:

- Factor 1: Commitment of the partners
- Factor 2: Strength of the consortium
- Factor 3: Asset quality and social support
- Factor 4: Capacity building
- Factor 5: National PPP Unit

These factor-solutions are called critical success factor groups (CSFGs). These CSFGs become the input variables (see next section) for modelling their overall contribution (significance) to successful implementation of PPP water supply projects in Ghana.

Table 2 Factor loading of underlying critical success factors

ID	CSFs and CSFGs	Factor Loading	Eigen value	% of variance explained	Cumulative % of variance explained
Factor 1	*Commitment of partners (CSFG 1)*		4.814	32.955	32.955
CSF10	Strong commitment from project partners	0.866			
CSF14	Strong and competent public partner	0.821			
CSF13	Internal coordination within government	0.807			
CSF12	Flexible contracts with fair risk allocations	0.754			
Factor 2	*Strength of consortium (CSFG 2)*		1.815	12.965	45.92
CSF7	Strong and competent private partner	0.859			
CSF6	Effective regulatory and legal structures	0.838			
CSF9	Profitable water supply projects	0.568			
Factor 3	*Asset quality/social support (CSFG 3)*		1.537	10.978	56.898
CSF11	Quality water asset and workforce	0.831			
CSF2	Public acceptance/support	0.804			
CSF4	Adequate financing	0.570			
Factor 4	*Capacity building (CSFG 4)*		1.408	10.056	66.954
CSF5	Local capacity building for utility staff	0.790			
CSF8	Competitive tendering	0.652			
CSF3	Government (political) commitment	0.569			
Factor 5	*National PPP Unit (CSFG 5)*		1.056	7.545	74.499
CSF1	National PPP policy and implementation unit	0.865			

CSFs: critical success factors; CSFGs: critical success factor groups

After establishing the CSFs through mean analysis and the CSFGs through PCA, the next step is to construct a fuzzy model to indicate the CSFGs' collective impact on project

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success and to determine the factor groups contributing the most to successful execution of PPP water supply projects.

Compute the weightings of the CSFs and CSFGs

The mean score of each CSF and each CSFG (based on round 2 of the Delphi survey) are summarised in Table 3. The mean score for a CSFG is obtained by adding the mean indices of its CSFs. The weighting (*w*) for a specific CSF or CSFG is obtained by normalizing its mean value through the following formula:

$$w_i = \frac{M_i}{\sum_{i=1}^{7} M_i} \qquad (3)$$

where, *w* denotes the weighting of a particular CSF/CSFG *i*; *M* is the mean index of a particular CSF/CSFG *i*; and $\sum M_i$ represents summation of mean ratings of all the CSFs/CSFGs. The weightings of the CSFs and CSFGs are reported in Table 3.

Determine the membership functions for CSFs and CSFGs

Recall that the 14 CSFs were reduced to five factor-solutions for purpose of developing a FSE predictive model. Fuzzy mathematics is used to derive the MFs of individual CSF and CSFG. In this FSE model, the basic criteria (or CSFs) are assumed to be $\pi = \{ f_1, f_2, \ldots\ldots, f_{14}\}$; and the levels of importance of each criterion is assessed as $E = \{1, 2, 3, 4, 5, 6, 7\}$, where 1 = not important (NI), 2 = very low importance (VLI), 3 = low importance (LI), 4 = moderate (M), 5 = important (I), 6 = very important (VI) and 7 = extremely important (EI) for success factor significance.

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Table 3 Weightings for 14 CSFs and five CSFGs for Water PPP Projects

ID	Critical Success Factor (CSF)	MS for CSF importance	Weighting for each CSF	Total mean value for each CSFG	Weighting for each CSFG
CSF10	Strong commitment from project partners	6.15	0.259		
CSF14	Strong and competent public partner	6.20	0.261		
CSF13	Internal coordination within government	5.66	0.238		
CSF12	Flexible contracts with fair risk allocations	5.73	0.241		
Factor 1	*Commitment of partners*			23.740	0.279
CSF7	Strong and competent private partner	6.22	0.342		
CSF6	Effective regulatory and legal structures	6.20	0.341		
CSF9	Profitable water supply projects	5.78	0.318		
Factor 2	*Strength of consortium*			18.200	0.214
CSF11	Quality water asset and workforce	5.88	0.318		
CSF2	Public acceptance/support	6.24	0.337		
CSF4	Adequate financing	6.39	0.345		
Factor 3	*Asset quality/ social support*			18.510	0.217
CSF5	Local capacity building for utility staff	5.90	0.319		
CSF8	Competitive tendering	5.80	0.314		
CSF3	Government (political) commitment	6.80	0.368		
Factor 4	*Capacity building*			18.500	0.217
CSF1	National PPP policy and implementation unit	6.17	1.000		
Factor 5	*National PPP Unit*			6.170	0.072
	Total of mean values of CRGs			85.120	

For a CSF, its MF is derived from the collective scoring of the Delphi panelists. For instance, using *Government (political) commitment (CSF3)*, the survey outcome showed that the panelists ranked the importance of CSF3 as follows: 0% as not important; 0% as very low importance; 0% as low importance; 0% as moderate; 0% as high importance; 19.5% as very important; and 80.5% as extremely important. Hence, the MF of CSF3 is obtained as:

$$CSF3 = \frac{0.00}{NI = 1} + \frac{0.00}{VLI = 2} + \frac{0.00}{LI = 3} + \frac{0.00}{M = 4} + \frac{0.00}{I = 5} + \frac{0.195}{VI = 6} + \frac{0.805}{EI = 7}$$

The MF for CSF3 is written as: (0.00, 0.00, 0.00, 0.00, 0.00, 0.20, 0.81). Using the same approach, the MFs for the remaining CSFs are determined (Table 4). Generating the MFs for the CSFs sets the basis to derive the MFs of each CSFG. Using equation (2), the weightings and MFs of all CSFs within a CSFG are multiplied and added to obtain the MF of that particular CSFG. Here, using *Factor 2 – Strength of consortium (strong and*

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competent private partner, effective regulatory and legal structures, and profitable water supply projects) – as an illustration, the MF is determined as follows (Table 6):

$$= (0.324,\ 0.341,\ 0.318) \times \begin{bmatrix} 0.00 & 0.00 & 0.00 & 0.02 & 0.17 & 0.37 & 0.44 \\ 0.00 & 0.00 & 000. & 0.05 & 0.07 & 0.51 & 0.37 \\ 0.00 & 0.00 & 0.02 & 0.07 & 0.24 & 0.42 & 0.24 \end{bmatrix}$$

= (0.00, 0.00, 0.01, 0.05, 0.16, 0.43, 0.35)

The MFs of the remaining CSFGs are determined in the same way, as summarised in Table 4 under column five (“Membership functions for level 2 (CSFGs)”).

Evaluating the Success Level of each CSFG

The success level of each CSFG to overall project success can be quantified through equation (4) below. The equation is derived from equation (2). Success level:

$$S_i = \sum_{i=1}^{7} R_i \times V \tag{4}$$

where, S refers to the success level of a specific CSFG i (i = Factor1, Factor2, Factor3, Factor4, and Factor5); R denotes MF of a specific CSFG i; and V represents the set of linguistic variables (used in the survey) that normalize the fuzzy evaluation vector. For example, the success level of Factor 2 *(Strength of the consortium)* is quantified as:

$$S_{Factor2} = (0.00,\ 0.00,\ 0.01,\ 0.05,\ 0.16,\ 0.43,\ 0.35) \times (1, 2, 3, 4, 5, 6, 7)$$
$$= 0.00 \times 1 + 0.00 \times 2 + 0.01 \times 3 + 0.05 \times 4 + 0.16 \times 5 + 0.43 \times 6 + 0.35 = 6.0724$$

The success levels of the remaining four CSFGs are quantified in the same way and the results are presented in column 4 of Table 5 under “Success index”

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Table 4 Membership functions (MF) for all CSFs for water PPP projects (Success importance)

ID	Critical Success Factor (CSF)	Factor Loading	Membership function for level 3 (CSFs)	Membership function for level 2 (CSFGs)
Factor 1	*Commitment of partners*			
CSF10	Strong commitment from project partners	0.866	(0.00, 0.00, 0.02, 0.05, 0.10, 0.42, 0.42)	
CSF14	Strong and competent public partner	0.821	(0.00, 0.00, 0.02, 0.05, 0.12, 0.32, 0.49)	(0.00, 0.01, 0.02, 0.04, 0.22, 0.32, 0.40)
CSF13	Internal coordination within government	0.807	(0.20, 0.02, 0.02, 0.05, 0.27, 0.44, 0.00)	
CSF12	Flexible contracts with fair risk allocations	0.754	(0.00, 0.00, 0.00, 0.02, 0.39, 0.17, 0.42)	
Factor 2	*Strength of consortium*			
CSF7	Strong and competent private partner	0.859	(0.00, 0.00, 0.00, 0.02, 0.17, 0.37, 0.44)	(0.00, 0.00, 0.01, 0.05, 0.16, 0.43, 0.35)
CSF6	Effective regulatory and legal structures	0.838	(0.00, 0.00, 0.00, 0.05, 0.07, 0.51, 0.37)	
CSF9	Profitable water supply projects	0.568	(0.00, 0.00, 0.02, 0.07, 0.24, 0.42, 0.24)	
Factor 3	*Asset quality/social support*			
CSF11	Quality water asset and workforce	0.831	(0.00, 0.00, 0.00, 0.10, 0.17, 0.49, 0.24)	(0.00, 0.00, 0.00, 0.05, 0.12, 0.44, 0.39)
CSF2	Public acceptance/support	0.804	(0.00, 0.00, 0.00, 0.05, 0.10, 0.42, 0.44)	
CSF4	Adequate financing	0.570	(0.00, 0.00, 0.00, 0.00, 0.10, 0.49, 0.42)	
Factor 4	*Capacity building*			
CSF5	Local capacity building for utility staff	0.790	(0.00, 0.00, 0.02, 0.05, 0.22, 0.42, 0.29)	(0.00, 0.00, 0.03, 0.04, 0.12, 0.31, 0.50)
CSF8	Competitive tendering	0.652	(0.00, 0.00, 0.07, 0.07, 0.17, 0.34, 0.34)	
CSF3	Government (political) commitment	0.569	(0.00, 0.00, 0.00, 0.00, 0.00, 0.20, 0.81)	
Factor 5	*National PPP Unit*			
CSF1	National PPP policy and implementation unit	0.865	(0.00, 0.00, 0.02, 0.05, 0.17, 0.24, 0.51)	(0.00, 0.00, 0.02, 0.05, 0.17, 0.24, 0.51)

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Evaluating the Overall Success Level of PPP Water Supply Projects

FSE is associated with three levels of MFs; from levels 3 to 1, where level 3 represents the MFs of CSFs, level 2 concerns MFs of the CSFGs and level 1 represents to MFs of overall success level. As explained earlier, level 3 was derived from the Delphi survey by manipulating the experienced judgments of the 41 panelists using fuzzy mathematics, level 2 was extracted from level 3. The MFs of the CSFGs constitute a fuzzy evaluation matrix for evaluating the overall PPP water supply project success. By considering the weightings and MFs of the CSFGs, the MF of the overall project success level can be normalized through equation (2) as:

$$= \begin{Bmatrix} 0.279 \\ 0.214 \\ 0.217 \\ 0.217 \\ 0.071 \end{Bmatrix} \times \begin{bmatrix} \text{Factor1} \\ \text{Factor2} \\ \text{Factor3} \\ \text{Factor4} \\ \text{Factor5} \end{bmatrix} = \begin{bmatrix} 0.00 & 0.01 & 0.02 & 0.04 & 0.22 & 0.40 & 032 \\ 0.00 & 0.00 & 0.01 & 0.05 & 0.16 & 0.43 & 0.35 \\ 0.00 & 0.00 & 0.00 & 0.05 & 0.12 & 0.44 & 0.39 \\ 0.00 & 0.00 & 0.03 & 0.04 & 0.12 & 0.31 & 0.50 \\ 0.00 & 0.00 & 0.02 & 0.05 & 0.17 & 0.24 & 0.51 \end{bmatrix}$$

$$= (0.00,\ 0.00,\ 0.02,\ 0.04,\ 0.16,\ 0{,}38,\ 0.40)$$

The contribution of the CSFGs to the overall PPP water supply project success can finally be quantified by equation (4) as:

$$S_{overall} = (0.00,\ 0.00,\ 0.02,\ 0.04,\ 0.16,\ 0.38,\ 0.40) \times (1, 2, 3, 4, 5, 6, 7) = 6.0965$$

Table 5 shows the model summary results that contain the success level and ranking of each CSFG and the overall success level. The FSE predictive model shows that the overall success level of PPP water supply projects in Ghana is 6.10. This means that, collectively, the CSFGs are *very important*, and if well combined and given adequate attention would improve the chances of successful implementation of water projects. The model reflects the specific impact or criticality of the CSFs in implementing these projects. It is able to predict or determine how critical a role each CSFG plays in affecting a project's success. This stage is ignored by almost all previous studies on CSFs. This paper therefore makes a contribution in this area. Table 5 shows that *Capacity building* is the top CSFG, followed by *Asset quality and social support*; *National PPP Unit*; *Strength of the consortium* and *Commitment of the partners*. These CSFGs should serve as the approach by which the government and private participants optimise the chances of successful water PPPs. They must have a thorough understanding of, and accord high relevance to, these factors. The

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following briefly discusses the contents of the CSFGs, given space limitation.

Table 5 Determination of overall success index (level 1), success indexes of CSFGs and CSFG ranking

ID	Critical Success Factor Group (CSFG)	Success index	Linguistic	Rank
Factor 1	Commitment of partners	5.9441	very high	5
Factor 2	Strength of consortium	6.0724	very high	4
Factor 3	Asset quality/social support	6.1835	very high	2
Factor 4	Capacity building	6.2039	very high	1
Factor 5	National PPP Unit	6.1710	very high	3
OSI	Overall Success Index	6.0965	very high	

DISCUSSION

CSFG 1: Commitment of Partners. This factor group accounts for 32.955% of the total variances of the CSFs (Table 2) and has a *very high* success index of 5.94 and ranked fifth (Table 5). It consists of four factors: strong commitment from project partners, strong and competent public partner, internal coordination within government, and flexible contracts with fair risk allocations. The achievement of contractual targets of a PPP project is closely linked to a true *strong commitment of the project partners*. Generally, commitment refers to dedication and interest of key actors in a project (Toor and Ogunlana, 2008), particularly, the public client, project team, project sponsor, and project company. They should be committed to time, quality and budget. This means that all project stakeholders ought to be willing to commit their best financial and human resources to the project throughout its lifecycle (Li et al., 2005).

CSFG 2: Strength of Consortium. Strength of the consortium accounts for 12.965% (Table 2) of the total variance of the CSFs analysis, ranked fourth with a very high success index of 6.0724 (Table 5). This reinforces the argument that a strong private company significantly contributes to project success (UNIDO, 1996). The factors in this group are strong and competent private partner, effective regulatory and legal structures, and profitable water supply projects. Our study found support for Tiong's (1996) finding that strength of a consortium is a CSF in winning BOT concessions.

CSFG 3: Asset Quality and Social Support. This factor group comprises three CSFs; quality water asset and workforce, public acceptance and support, and adequate financing. It explains 10.978% (Table 2) of the total variance of the CSF analysis and has a *very high* success index of 6.1835 (Table 5) and ranked second, suggesting it plays a critical role in determining project success. A PPP project will not succeed in the absence of any, or all, of these CSFs. This factor lends support to the observations of Hall et al. (2005) and Ameyaw and Chan (2013a) that strong public support and quality water infrastructure are indispensable in water concessions.

CSFG 4: Capacity Building. Capacity building has three CSFs that relate to support environment: local capacity building for utility staff; competitive tendering; and government (political) commitment. It accounts for 10.056% (Table 2) of the total variance of the CSFs analysis, ranked first with a *very high* success index of 6.2039 (Table 5). This means that capacity building group has the highest impact on PPP project success in Ghana. This comes from the perspective in which the private partner is likely to be an experienced foreign company and knowledge transfer and capacity building are critical to help the public sector to sustain efficiency in current projects and localize future projects. This factor and its variables corroborate with the findings of existing literature (e.g., Carrillo et al., 2008; Li et al., 2005; Dulaimi et al., 2010).

CSFG 5: National PPP Unit. This factor accounts for 7.545% (Table 2) of the total variance of the CSFs analysis, ranked third with a success index of 6.1710 (Table 5). Existence of a *National PPP policy and implementation unit* will significantly contribute to project success. A national authority like the UK Treasury Task Force is instrumental in coordinating and overseeing all PPP activities, and research has highlighted this significant role (Carrillo et al., 2008). Carrillo et al. (2008) noted the need for learning from PPP consortium members and capturing project knowledge as a means to ensuring continuous improvement and experience/knowledge transfer to the public sector. In Ghana, the newly-established central authority, PPP Advisory Unit (PAU), at the Ministry of Finance and Economic Planning is charged with the responsibility of initiating ideal projects, in all sectors, where private capital and expertise could be tapped for the delivery of public infrastructure and services. PAU thus should serve as a 'PPP body of knowledge', by capturing, documenting and analyzing local and international PPP experiences in different regions and sectors to develop local best practices, guidelines and regulations.

CONCLUSION

The emergence of PPP, though at its infancy, is providing opportunities to develop and manage water infrastructure and services through private-capital, with little or no public funds. To efficiently tap private funds and expertise for improved value that is beneficial to both sectors, there is a need to develop a CSF model that will contribute to successful implementation of current and future projects. The mixed method approach to project success factor identification and modelling in the current study revealed (a) 14 CSFs, and (b) five CSFGs that have a bearing on PPP water projects (in order): capacity building, asset quality and social support, national PPP unit, strength of consortium, and commitment of partners.

Hence, both private and public participants stand to benefit from a *very high* chance of successful project implementation, if these five CSFGs are combined effectively and given sustained management attention. By this model, the collective impact of all the CSFGs, and each CSFG, to overall project success in terms of its smooth implementation can be described by a single indicator, termed overall success index and success index, respectively. Successful project implementation depends on a combination of all these factors; it will ensure efficient resource use and project implementation approaches.

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