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Soft Team-Building Support System on Tender Evaluation Committees In Public Procuring Entities

Danlami Ebenezer SALLA[1*], Shehu Ahmadu BUSTANI[2], Sani Usman KUNYA[3], Anas ADAMU[4], Janet Mayowa NWAOGU[5]

[1] *Department of Quantity Surveying, Faculty of Earth and Environmental Sciences, Bayero University, Kano, Nigeria*, E-mail address: edsalla.qs@buk.edu.ng
[2] *Department of Quantity Surveying, Faculty of Earth and Environmental Sciences, Bayero University, Kano, Nigeria*, E-mail address: sbahmad.qs@buk.edu.ng
[3] *Department of Building, Faculty of Environmental Technology, Abubakar Tafawa Balewa University, Bauchi*, E-mail address: sukunya@atbu.edu.ng
[4] *Salbrix Nigeria Limited, Abuja*, E-mail address: adamuanas@gmail.com
[5] *Department of Building and Real Estate, Faculty of Construction and Environment, The Hong Kong Polytechnic University, Hong Kong SAR*, E-mail address: janet.nwaogu@connect.polyu.hk

Abstract

The Nigerian Public Procurement Act (PPA, 2007) is still lagging in its vague definition of the requisite qualifications for procurement managers. Hitherto, tender evaluation committees have been constituted arbitrarily without any feed-forward structure. An advanced close-ended support system for constituting tender evaluation committees is hereby presented. A theoretical concept was followed by a design science methodology. A deterministic team-building model for tender evaluation committees is demonstrated. The optimisation algorithm relies on an additive analytical sequence and a complex factoring of anticipated group interaction. Match models, which proactively determine the effects of complementary participation of team players were adapted. It is an emerging technical solution for a relatively ignored research concern, which now makes a scientific team-building process in procurement possible through itinerant simulation. The deterministic strategy was validated by a hypothetical entity case while augmenting a few data entries. A restrictive decision space was created to enable the determination, identification and composition of tender evaluation team members' inclusion criteria in a committee. A questionnaire drawn from ten (10) procurement managers from Nigeria helped validate the soft team-building model. The support system is inflexible for accommodating probabilistic entries where target data is discontinuous. Minimising the discretionary assemblage of personnel to evaluate tenders is a potential benefit of adopting the support system. Public procuring entities can deploy the soft team-building support system with little adjustments to accommodate entity-specific peculiarities.

Keywords: Public Procurement, Team-building, Tender Evaluation Committee, Support System, Public Procuring Entities, Nigeria

1. Introduction

Public procurement entails the government's purchase of goods and services, warranting the definition of functions in the procuring entities to optimise policy gains [1,2]. Public procurement promotes such other gains as environmental and social objectives [3] , with expanded economic benefits on behalf of a disadvantaged social group [4]. The extant laws [5] serve as a regulatory tool for supporting the creation, distribution of social value as well as environmental gains [6,7,8].

Procurement systems are subject to external oversight by regulatory authorities [9]. According to [10], team-building significantly affects team development. Therefore, arbitrary (open-ended) use of discretion in constituting the Technical Evaluation Committee (TEC) in procuring entities should be discouraged. Such will provide possible feedback measures on equal opportunities to procurement

personnel. The use of a scientific, methodical framework can promote a feed-forward process probe on team evaluation [11]. A reliable team formation process is a pathway for improving procurement decisions [12], supporting transparency [13], enhancing compliance with audit norms [14], and the realisation of sleek lead times in procurement decisions [15]. By such scientific approaches, a backward integration or feedback check on the front-end action of a procurement manager towards team formation can be realised. Although reputable academic platforms posit team-building and group formation methodologies as a social and psychological engagement [16,17,18,19], such support systems are generally weak in aiding decision-making on team formation within the public procurement system [20]. Therefore, a novel team-building methodology is developed in this study to fill that gap in the literature.

2. Advances in Team Formation and Development

Team formation helps to ensure that a team works collaboratively and efficiently despite their heterogeneity, subjectivity and diversity in cognition [21,22,23]. Team development for tender evaluation depends on the task demand in the procuring entity. Advances in information systems and clamour for their adoption in procurement decisions evert need for the consideration of the socio-technical attributes of the tender evaluation teams in the team-building process [24,25]. A deterministic team-formation system will help procurement managers proactively review the team-formation process since their actions can be subject to feedback reviews.

3. Methodology

3.1 Functional Role Categorisation (Coding Forms)

This study adopted a design science methodology by categorising members' functions by defining their roles in the tender-evaluation decision-making process. The codes depict tender evaluation teams as relatively rigid and that their behaviour and roles do not alternate in a single tender evaluation exercise where change(s) do not occur significantly. Therefore, the definition of functional roles for each member is slightly fixed. The following terms are important for team member' designation according to their role functionality: the Orienteer (O), the Giver (g), the Seeker (s), the Recorder (r), the Recorder (r), the Follower (f), the Attacker (a), the Gate-keeper (gk), the Protagonist (p), the Supporter (su); and the Neutral (n). The neutral (*n*), passively comes to term with the idea of other members of the tender evaluation team. The neutral serves as an audience in the group discussion. Technology is minimizing the influence of the neutral (*n)*. When security concerns are pertinent, the neutral serves as a good watch against possible interference by vendors of the information system, especially for cloud-based support systems. See; [26].

3.2 Team Formation Methodology for an Entity Case

A team formation technique was adopted, carefully separating the tender evaluation team from their command interaction in terms of their functionality. The direct and indirect contributions of the team and its members' contribution to solving the evaluation problem were computed using augmented data with a novel solution (peculiar to the procuring entity). Each team member's direct contributions are associated with the team's professional action in tender evaluation. The team is viewed as a target group, distinct from a procuring entity from where they operate. Therefore, the aggregate performance of the team is attributed to the tender evaluation task. A vector space indicates the group as an object (team members), defined by their knowledge, abilities and skills (KSA) within the decision space. The information is presented as a set of nodes defined by a target vector. The technique is repeated by constructing a target vector, predefined as an optimal way tenders are evaluated for prospective bids. An overall performance vector (sum vector of the team outcome), the angle (ø) between the diagnosed and the target team engages the principle of selection and enables the measurement of productive and non-productive demands, which is the focus of the tender evaluation outcome. Table 1 shows the team options to guide the selection.

Table 1 Group/Team Options

Team options	Optimal variant	Custom variant	Source/Justification
Team' Rating (>70%)	0.58	0.5	Literature
**Team Efficiency (%)	8	8	Computed
Mean Compatibility Threshold	0.53	0.51	Literature
Skewed Choices (%)	14	19	Computed

**Team efficiency computed as the sum of participants Source: Entity Case

In order to simplify the reference point for rating the team, a minimum threshold score of >70% was pegged, signifying excellence in rating. Skewed choices signify the relationship between available manpower in the procuring entity and team composition. Table 2 shows the available team options.

Table 2 Individual Team Options

Identity (Not by a unique ID)	Professional Index (%)	Team Index	Compatibility Level	Leadership Order
Member 1	32	0.46	0.75	1
Member 2	15	0.02	0.80	2
Member 3	22	-0.22	0.50	3
Member 4	15	0.06	0.70	4
Member 5	4	0.05	0.46	5
Member 6	5	-0.03	0.59	6
Member 7	4	0.02	0.41	7
Member 8	3	0.01	0.40	8

Source: Case Study Note: Total Team composition = 8 personnel

Table 3 shows the psychological assessment of the group, with reference to the records on their psychological and compatibility coefficients for team members as they relate to each other.

From Table 3, missing values (***) imply insufficient data for computation. While the blank spaces show non-available data as augmented or hypothetical figures adopted were not consistent with demonstrated patterns by other players within the tender evaluation team.

[27] demonstrated a detailed formation algorithm that showcased the step-by-step sequence in the configuration of vectors in the decision space, as shown in Table 3.

Table 3 Paired Compatibility Values

Member	Pl_1	Pl_2	Pl_3	Pl_4	Pl_5	Pl_6	Pl_7	PI_8
Member 1	***	0.01	0.00		0.00	0,00	-0.07	0.00
Member 2	0.00	***	0.70	0.15	0.00	0,00	0.55	0,35
Member 3	0,35	0.84	***	0.69	***	0.76	0.70	***
Member 4	0.82	1.00	0.88	0.10	1.00	0.98	***	0.84
Member 5	0.55	0.98	0.95	***	0.52	1,00		1.00
Member 6	0.42		1.00	0.55	0.74	***	1.00	1.00
Member 7	-0.28	1,00	1,00	-0.03	0.74	1.00	1.00	0.52
Member 8	0.82	1.00	***	***	1.00	0.98	***	0.82

Source: Case study data **Note:** *** = missing values

4. Data Analysis, Result and Discussions

4.1 Formalisation for a Team of Eight (8)

An initial contingent of eight (8) personnel (Ω_1, Ω_2, Ω_3… Ω_8) formed the tender evaluation team to handle tender evaluation tasks; Y_1, Y_2, …, Y_r. (the tasks are simplified to include advertisement and call for tender, tender collection/evaluation actions and tender decision as discrete events in the tendering process). Using the principles of relativistic psychometrics (the vectors for assessing the qualities of the personnel was developed through a mathematical translation of corresponding angular

coordinates in the Minkowski space [28,29]. The relationship is plotted in the decision space, as displayed in Figure 1. The Figure shows personnel in the subspace of the category of operational tools, which are indicated as $Ω_1$, $Ω_2$, $Ω_3$, $Ω_4$, $Ω_5$, $Ω_6$, $Ω_7$, $Ω_8$ in the subspace of the tools that were categorised for operation in the tender evaluation process (G_1, G_2). Similarly, Z_1 and Z_2 are the target vectors of tasks Y_1 and Y_2. R_{ij} are the individuals' contributions (by each player) in the tender evaluation decision. The professional vector of each group, Z_1 and Z_2 are expressed as the sum of the first, second, third, up to the eighth (8^{th}) personnel as predetermined. R_1 and R_2 are the team ratings on the tender evaluation task; Z_1 and Z_2. These are shown with the target vector and adjustable bar (in green) as the optimisation plane on team formation in Figure 1.

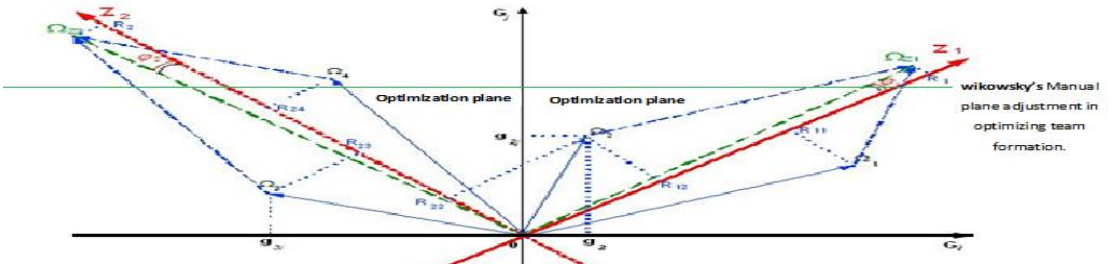

Figure 1 Target vector with adjustable decision optimization plane

The $Ω^2_{zi}$.Cosø connotes the productive efforts, while the expression, $Ω^2_{zi}$.Sin^2ø indicates the unproductive efforts. Cos2øi represents the efficiency coefficient of the group. The minimum value of the unproductive efforts can be set by the procuring entity. At an unrealistic or wrong decision point, the value of x_i is 0, as the personnel's compatibility regarding their procurement skills cannot be self-investigated. Personnel can rank a contingent tender evaluation team by their preferences: "who are my preferred team players according to the team categorisation, based on the personnel availability". The counterpoint in *Mikowski's space* has to satisfy the preliminary query: "who amongst the personnel is least likely to augment my evaluation decision?" Therefore, the procurement manager can find an optimal team by such a simple feed-forward. $Cos^2 \cdot ø_i$ shows the projected effectiveness and efficiency of the tender evaluation team. The threshold value for an effective team is set by the procurement manager.

4.2 Validation and Discussions

This section discussed the strategies involved in team-building modelling as demonstrated in the analysis of a hypothetical entity case and Mikowski's spacetime for tender evaluation team-building optimisation by validating the novel strategy. A public procurement manager may set parameters for forming the tender evaluation team through: (i) itemising target procurement personnel for a tender evaluation team, identifying the procurement personnel's qualifications and professional skills for tender evaluation; (ii) assessing the qualifications and relevance of prospective personnel for the tender evaluation task; (iii) compelling personnel to assess one another for their psychological compatibility in the tender evaluation task by ranking the prospective procurement personnel available in the pool based on their expectations of the evaluation team; (iv) automating a merger of data on experts and players available in sister agencies or the public service. Therefore, data can be centralised and incorporated into an integrated personnel data system; (v) automating the generation of results for guiding the procurement managers who are mostly administrators; (vi) the result include measured parameters like assessment of the professional's correspondence in the team-to-task (team rating), assessment of the group efficiency and expected contributions on individual bases for the participating professional. This process allows for proactive monitoring of the team-building process and the progress recorded at a glance.

4.2.1 Hypothetical Entity Case

The team-building support system was demonstrated on team formation for a procuring entity's tender evaluation committee. Eight (8) stages were involved in the team-building process for tender evaluation.

The hypothetical application of a team-building support system serves for the support system validation. Accordingly, the eight steps involved are as follows:

Step 1: Initial decision to constitute a Technical Evaluation Committee (TEC): The first step in the novel team-building support system's validation process is forming the tender evaluation committee expected to assess technical and financial proposals submitted by bidders in the procuring entity.
Step 2: Definition of Committee /Team- task: Prior to the actual tender evaluation, the role of the chairman or head of the team and the members within the workspace are defined, and the methodology and criteria for inclusion of team members are unambiguously spelt out.
Step 3: Human resource availability in procuring entity or the public service: Upon defining the method, process and sequence for assessing and choosing from amongst prospective team members, the authorisation and notification of 'players' on the commencement of the selection process is made.
Step 4: TEC members' ability to function in their roles: A group of six (6) carefully selected procurement managers reviewed the ability of 'players' along with their specified role(s) and function in the tender evaluation team. After inclusion, team members were allowed to accept their team function and role definitions as they recognised the team's expectations and the overall goal of the procuring entity.
Step 8: Suitable Restrictive Decision Space: At the final stage, procurement managers were requested to share their views on the restrictive decision space as boundaries for identifying and choosing team members/players for the tender evaluation committee. Their perception was sought on the team-building process as depicted in the novel decision model.
Nine (9) respondents to the questionnaire were male comprising procurement managers/heads of procurement in public procuring entities. The procurement managers are directly responsible for constituting the team for tender action. Five (5) respondents had years of practical experience between 6 and 10, predominated by graduates in Table 4.
Team features which reflect optimism in the assemblage of a heterogeneous group as anticipated in tender evaluation are evident in the configuration and the restrictive determination of the decision space.
The respondents assessed the team-building decision model for two (2) performance measures on a scale of 1-7, as shown in Table 5. Where 1= Not Applicable (NA); 2 = Very Low (VL); 3 = Low (L); 4 = Average (A); 5 = High (H); 6 = Very High (VH); and 7 = Very Precise (VP). The decision rule is based on the mean item scores, which determine the perception of the respondents on the performance of the novel team-building support model.

Table 4 Respondents for Team-Building Support System Validation

Respondents		Frequency	Percentage (%)
Gender	Male	9	90%
	Female	1	10%
Procurement Expert	Senior Academics	2	20%
	Procurement Manager	6	60%
	Principal, Private Consultant	2	20%
Age	Less than 40 years	4	40%
	45-55 years	5	50%
	Above 55 years	1	10%
Practical Experience in Procurement	0-5 years	1	10%
	6-10 years	5	50%
	10-15 years	2	20%
	16-20 years	2	20%
	Over 20 years	2	20%
Educational Qualification	National Diploma	0	0%
	Bachelors Degree/HND	7	80%
	Masters/Terminal Degree (PhD)	3	30%

Source: Validation survey, 2023

From Table 5, the mean scores for the items as perceived by the respondents are all greater than 4.8. Similarly, the overall mean score for the two items, as shown in the assigned weight, is > 5 (5.44). For a 7-point scale, it implies that the support model is adjudged to be between *High* and *Very High*.

Although the initial target was a decision space that should be very precise, the mean score did not meet the *Very Precise* scale as perceived by the respondents. The respondents checked some aspects of the support system which align with the ideals of constituting tender evaluation teams.

Table 5 Validation by Model Functionality

Team-building Support System Performance		NA	VL	L	A	H	VH	VP	$\sum x_i$	Mean	Std. Dev.
Assigned Weight		**1**	**2**	**3**	**4**	**5**	**6**	**7**			
Team-building support system conforms to a real-case scenario	No.	0	0	0	1	5	3	1	10	5.99	0.49
	Percentage (%)	0.0	0.0	0.0	0.1	0.5	0.3	0.1			
Achieve the objective of constituting a cognitively diverse yet psychologically balanced technical evaluation team	No.	0	0	0	2	6	2	0	10	4.89	0.47
	Percentage (%)	0.0	0.0	0.0	0.2	0.6	0.2	0.0			

Note: N/A = Not Applicable, VL= Very Low., L=Low., A= Average., H=High., VH= Very High., VP=Very Precise

From Table 6, the mean scores for items as perceived by the respondents were all greater than 4.4. Similarly, overall mean score for considered items are all > 4 each. (4.43). On a 7-point scale, it shows that the support model is adjudged to be between 'Average' and 'Good'. Generally, the following can be deduced from the novel team-building support model, as shown in Table 6. The soft team-building methodology depicts anticipated team formation process in the following ways: (i) the team-building support system sufficiently modelled the team-building process on the tender evaluation committee, (ii) the novel mathematical model is logically comprehensive for team-building; and (iii) the definition and presentation of the decision space may require some improvement for ease of application and interpretation by procurement managers who may be aversed to the restricted decision space.

Table 6 Validation by Model Alignment with Practical Team Building

Team-building Support System' Performance		NA	VP	P	A	G	VG	E	$\sum x_i$	Mean	Std. Dev.
Assigned Weight		1	2	3	4	5	6	7			
Logical sequence	No.	0	0	0	1	5	3	1	10	5.10**	0.48
	Percentage (%)	0.0	0.0	0.0	0.1	0.5	0.3	0.1			
Clarity	No.	0	0	0	2	6	2	0	10	4.90	0.46
	Percentage (%)	0.0	0.0	0.0	0.2	0.6	0.2	0.0			
Inclusivity of socio-cognitive skills	No.	0	0	1	1	5	2	1	10	4.89	0.45
	Percentage (%)	0.0	0.0	0.1	0.1	0.5	0.2	0.1			
Applicability in public procuring entities	No.	0	0	1	1	6	1	1	10	4.51	0.41
	Percentage (%)	0.0	0.0	0.1	0.1	0.6	0.1	0.1			
Encourage professionalism and enhance the proficiency of procurement managers in team-building	No.	0	0	1	1	6	2	0	10	4.49	0.40
	Percentage (%)	0.0	0.0	0.0	0.1	0.6	0.2	0.1			
Practical relevance of the model	No.	0	0	0	1	6	2	1	10	4.45	0.40
	Percentage (%)	0.0	0.0	0.0	0.1	0.6	0.2	0.1			

Note: N/A = Not Applicable., VP = Very Poor, P=Poor, A = Average, G = Good, VG = Very Good, E= Excellent, ** = Highest Mean Score item (Logical sequence of the support model)

5. Theoretical and Practical Implication of the Study

The study contributes to team-building research by designing and validating a team-building support model. Knowledge of team-building modelling and the findings on the potential of improving the efficiency of the team-building process was explored. A team-building methodology that makes process feed-forward possible is now available for public procuring entities. Progress monitoring of the tender evaluation team-building is therefore possible. The study defined valuable attributes of a tender evaluation team's functionality in building the tender evaluation committee for the procuring entities. The advantages of applying the methodology are that the decision space is restricted for the procurement managers in the storming and forming stages of team-building.

6. Conclusion

The overarching objective of this study was to resolve an assignment problem on team-building for tender evaluation as a classical match model problem in team optimisation by a verifiable backward sequence. A technique that makes it possible to predefine optimal targets on tender evaluation team composition for procurement tasks was demonstrated in the study. The 'Member Expert System' was replicated in this study by testing the formation of a tender evaluation team for eight (8) participants (members). The *ex-ante* teamwork was investigated by predefined tender evaluation roles. The complementarities (interdependence) and compatibility of the participating personnel in a group were included according to their expected contributions to the tender evaluation process. The search for a proactive team-building solution pursued in this study was to establish an optimally diverse team composition in a public procuring entity. This is contrary to the open-ended team-building decision space, as suggested in [27].

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