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An assessment of construction procurement systems for public urban infrastructure projects

Khotso Dithebe^a, Clinton Aigbavboa^a, Ayodeji.E Oke^a

University of Johannesburg, Auckland Park, Johannesburg, 2006, South Africa

Abstract

Project delivery systems play a significant role for the success of public urban infrastructure projects. Without clear and precise procurement selection techniques projects continue to contribute negatively towards infrastructure development. Therefore, the purpose of the study was to determine effective groupings of construction procurement systems for public urban infrastructure projects in South Africa. The data used in the study was derived from primary and secondary sources. Out of the 150 questionnaires distributed, 91 questionnaires were usable, representing 61% response rate. Data from the survey was analysed using exploratory factor analysis. Findings from the data analysis revealed that characteristics of traditional procurement system, develop and construct, management contracting and construction management should be incorporated for public urban infrastructure projects in South Africa. The study recommended that traditional procurement system, develop and construct, management contracting, construction management and project management continue to be utilised for public urban infrastructure projects. However, projects continue to fail as a result of these project delivery systems, therefore the study recommends that processes used to select project delivery systems should be clearly stipulated and dissected before the commencement of any project. Attention should be given to characteristics of different public urban infrastructure projects, as well as the forms of contracts incorporated.

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1. Main text

Masterman [1] defines procurement systems as organisational structures used to execute construction projects suggested by the client, while Rameezdeen and Ratnasabapathy [2] explains procurement system as conditions and ways of successfully undertaking a project in order to achieve the objectives of the client. Public sector suggests appropriate procurement systems for the construction, maintenance and the rehabilitation of public urban facilities. Procurement systems are often categorised as traditional and non-traditional. Rashid et al [3] as well as Griffith and Sidwell [4] outline procurement systems currently used as: Design-Bid-Build; Construction Management at Risk; Design and Build; and Integrated Project Delivery.

Klynveld Peat Marwick Goerdeler (KPMG) International [5] and Love et al [6] explain that there are various procurement methods used for public urban infrastructure projects, therefore the client needs to understand all the available methods, their advantages and disadvantages to ensure that the project is finalised within the agreed time, cost and quality. Bijoy [7] further describes construction procurement as activities and techniques utilised to secure construction of a predefined system for an organisation, this includes organising the construction works and allocating risks to different stakeholders involved in a particular project. While UKESSAYS [8] reveals that, the choice of a particular procurement system fully depends on the type of project, type of ownership to take place, nature of the construction industry in a given country as well as the maturity of the industry.

2. Construction procurement systems for public urban infrastructure projects

Oluwole [9] asserts that the completion of the construction project within the agreed time, cost and quality depends on the type of procurement system selected, hence the internal and external factors that influence the selection of a suitable procurement system [10]. Client's level of knowledge or experience and control, funding means, political and social concerns, understanding of the system, size of the project and technical complexity, quality and price certainty as well as risk allocation are internal factors considered [11]. Whereas external factors that need to be adhered to when a procurement system is selected include; market competition, technology, natural causes and regulatory environment [10].

2.1 Traditional procurement system

Options available under traditional procurement system include; bills of approximate quantities, bills of quantities, specification and drawings, schedule of rates, labour only and cost reimbursement. Traditional procurement method begins with a client brief, on what the client expects to be procured and other necessary specifications on cost. Architects and engineers are responsible for manufacturing designs [12]. Quantity surveyors are also involved in the design phase, where they advise on cost implications of the suggested designs [13]. Thereafter a contractor is appointed based on the designs that were computed by the design team, the client is thus in consensus with both the design team and the contractor. Turina [14] asserts that the design-bid-build widely known as the traditional procurement system is inclusive of three phases, which is the design phase, tendering phase and the construction phase, the process is sequential, the other phase cannot occur before the other one is complete.

2.2 Non- traditional procurement systems

Thwala and Mathonsi [11] elucidates that non-traditional procurement systems were developed to minimise the adversaries of traditional procurement system. Non-traditional system finds collective solutions for financial or political obstacles, further the system establishes common ground to put the design team and the contractor under a single roof in undertaking public urban infrastructure projects. Additionally, the system considers the functionality and management of the built structure [1].

2.2.1 Integrated procurement system (design and build)

Integrated procurement system is a single corporation providing the design as well as the construction services as asserted by Thwala and Mathonsi [11] as well as Ashworth and Hogg [15], the client does not have to get into contract with the design consultants then the contractor, the process of moving from one corporation to the other is eliminated by this procurement system. Rashid et al [3] reveals that it is ideal to use integrated project delivery, simply to share the risk amongst all the stakeholders involved that include designers, contractor as well as the client through partnership agreements.

2.2.2 Management procurement system

The client appoints a management organisation to provide the designs and manage the construction works, rather than having different organisations handling the designs as well as managing the construction works, during this form of procurement system the client is more involved as compared to other procurement systems [11]. Davies et al [16] asserts that a management organisation is appointed to handle all phases of the public urban infrastructure project, including the designs as well as the construction works. There are several kinds of management procurement systems: Design and management; Management contracting; and Construction management.

2.2.3 Construction management

The contract of works is direct between the client and the contractor, thus providing the employer larger control of the project. Subsequently, the employer has a larger control of the project the management contractor cannot determine

when the project will be completed as well as what the final cost will be [17]. Thwala and Mathonsi [11] refers to CM procurement system as construction management at risk (CMR), the CMR acts as a consultant to the client during the design phase and as a contractor during the construction phase, during the construction phase the CMR ensures to deliver the project within the required time, quality and cost.

2.3 Public-private partnerships

Babatunde et al [18] discusses that public-private partnerships (PPP) are initiatives undertaken by the government to include private participation in delivering basic public urban infrastructure to various municipalities within a nation. While National Planning Commission [19] describes that PPP is a contractual obligation between the public and private sector, private firm agrees to construct and operate the built facility for a specified term.

3. Research methodology

Geographical area for the study was across South Africa. Targeted areas comprised of locations where the researcher had access to and where infrastructure projects were taking place or have taken place. The target population that replied the questionnaires was inclusive of the Department of Water and Sanitation, water boards, metropolitan, public entities (Trans-Caledon Authority Tunnel), civil society (eminent individuals/ corporations), building and construction professionals, private firms as well as banks who have financed water infrastructure projects in South Africa. A quantitative approach was undertaken for assessing construction procurement systems in South Africa. The study adopted a convenience sampling approach. 150 questionnaires were distributed, but 91 were usable, representing 61% response rate. Primary data was collected using close-ended questionnaires. The questionnaire had two sections, in addition to the cover letter. The duration to complete the questionnaire was 10 minutes. The first section presents the demographic information of the respondents while the second aspect details questions on construction procurement systems of public urban infrastructure projects. Statistical Package for Social Sciences (SPSS) was used for exploratory factor analyses.

4. Findings

4.1 Demographic information for respondents

Employment organisations for respondents revealed that building and construction sector was dominant with 23.1%, while public entities came second with 18.7%, metropolitans third with 13.2%, water boards fourth with 11% and the Department of Water and Sanitation last with 9.9%. Respondents' years of experience reveal that 45.1% had experience between 4-8 years, 28.6% had experience between 9-15 years and 19.8% had experience up to 3 years. From the 91 questionnaires used, 47.3% of the respondents participated or took part in water infrastructure projects, while the remaining 52.7% did not participate in any water infrastructure projects in South Africa. Respondents' involvement in water infrastructure projects show that 52.7% did not take part in any water infrastructure projects, while 14.3% participated in two (2) projects and 11% took part in three (3) projects.

4.2 Exploratory factor analysis for construction procurement systems

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy achieved a value of 0.859, exceeding the recommended minimum value of 0.6, Bartlett's test of sphericity was also statistically significant (less than 0.05) with a value of 0.000, thus supporting the factorability of the correlation matrix, this is represented in Table 1. A total of 3 components with eigenvalues of above 1.0 were extracted using a factor loading of 0.5 as the cut-off point. The final components extracted accounted for 70.9% of the total cumulative variance, shown in Table 2. This is above the 50% threshold criterion for extracted factors to be explained in factor analysis. Varimax rotation was conducted to interpret the three components of construction procurement systems, which gave rise to the pattern matrix shown in Table 3. The components were labelled as a result of a close relation observed between the variables of each component. (i) Design and build options, (ii) management and (iii) labour and alliance, were labels given to each component.

Table 1. KMO and Bartlett’s test for procurement systems

Kaiser-Meyer-Olkin measure of sampling adequacy		0.859
Bartlett’s test of sphericity	Approx.chi-square	1380.653
	Df	153
	Sig.	0.000

Table 2. 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	8.035	44.641	44.641	8.035	44.641	44.641	5.597	31.097	31.097
2	3.326	18.479	63.120	3.326	18.479	63.120	3.775	20.975	52.072
3	1.409	7.825	70.945	1.409	7.825	70.945	3.397	18.873	70.945

Table 3. Rotated Component Matrix^a

Construction procurement systems	Component		
	1	2	3
<u>Design and build options</u>			
DBFT (design-build-finance-transfer)	0.841		
DBOT (design-build-operate-transfer)	0.839		
DBFO (design-build-finance-operate)	0.826		
BOOT (build-own-operate-transfer)	0.813		
OM (operation and maintenance)	0.786		
BTO (build-transfer-operate)	0.730		
JDA (joint development agreement)	0.676		
ROT (build-operate-transfer)	0.592		
<u>Management Option</u>			
Management contracting		0.936	
Develop and construct		0.911	
Construction management		0.885	
Traditional procurement system		0.748	
BOT(build-operate-transfer)		0.563	
<u>Labour and Alliance</u>			
Direct labour			0.824
Strategic alliance			0.780
Labour only			0.777
Investment management and investment services			0.711
BRT (build-rent-transfer)			0.561

5. Discussion of findings

Thwala and Mathonsi [11] and Bijoy [7] support the findings that public-private partnerships contribute positively to infrastructure development, however the inclusion of project management and direct labour in the same cluster as PPPs was refuted by Olufowose [20] and Devapriya [21]. Babatunde et al [18] as well as Ashworth and Hogg [15] support the findings that items in component two when utilised contribute positively on infrastructure development. Rodriguez [22] as well as Seng and Yusof [23] highlight that traditional procurement system is still the preferred system to conduct infrastructure projects, it minimises tendencies of collusion as compared to other methods, studies further reveal that there are three kinds of contracts that exists, namely: lump sum contracts, measurement contracts and cost reimbursement. Akinola [24] adds that the use of traditional system alone does not always assure successful projects. Zhang and Wang [25], Thwala and Mathonsi [11] and Masterman [1] support the findings that the usage of public-private partnerships is significant for enhancing infrastructure investment. Babatunde [18] and Oluwole [9] share that procurement system selection is essential when selecting a suitable procurement system, time, cost quality are some of the key areas of the criterion. Rashid et al [3] shares that the usage of management contracting, develop and construct, construction management, traditional procurement system and build-operate-transfer have a fulfilling impact on conducting public urban infrastructure projects.

6. Implications

The level of usage of procurement systems such as traditional methods, design-build, management contracting, construction management and project management were rated amongst the most used systems in the construction industry for public urban infrastructure. Despite the level of awareness and usage of these procurement systems, projects continue to delay and ultimately fail as a result of cost overruns, exceeding the agreed time and not complying with quality standards. Therefore, the issue does not necessarily lie with the level of awareness or usage of these systems but how the processes are carried out, where the correct measures taken to select contractors, was the client consulted and whether the time given for procurement processes was adequate. Above all other procurement methods traditional system was the preferred project delivery system for public urban infrastructure projects.

7. Conclusion and recommendation

The results from the secondary data revealed that the procurement systems examined include traditional procurement system, develop and construct, management contracting, construction management, build-operate-transfer, build-own-operate-transfer, design-build-finance-transfer, design-build-finance-operate and joint development agreement. Other systems were inclusive of partnering, project management and strategic alliance. Findings from the questionnaire survey established three components of procurement systems were traditional procurement systems, develop and construct, management contracting, construction management, project management, partnering and build-operate-transfer were categorised in the same component. This confirms a strong relationship between the involved systems for public urban infrastructure projects in South Africa. Findings further confirms that construction project delivery system processes should be vigilantly adhered to, this includes the selection process of determining a suitable system to use for a given project. Attention should be given to characteristics of different public urban infrastructure projects, as well as the forms of contracts incorporated. The study was limited to water infrastructure projects across South Africa.

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