

Mode of executing infrastructure projects and employment opportunities

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Abstract:

The triple problems of unemployment, underemployment and the lack of skills development in developing economies can be addressed significantly through infrastructure development. It facilitates the blend of educational training and workplace experience for skills development. Therefore, it requires crafting a suitable flow of procurement instruments to achieve these objectives. This research evaluated three executed infrastructure projects, Projects 1, 2 & 3, with the objective of identifying the most suitable mode of execution that provided the highest employment opportunities. The case study strategy of qualitative research was considered most suitable. The data was obtained predominantly from project operation documents, such as minutes of meetings, companies' organisational structures, documents from the websites of organisations, and published articles. At the time of this research, all the projects examined had been concluded. It was not possible to interact with the project personnel and the research relied solely on available project operation documents. The research revealed that the concept of a single contractor was used in the execution of Project 1, while Projects 2 & 3 were executed via the multiple contractor approach. The employment opportunities at all levels were higher in Projects 2 & 3 compared to what was achieved in Project 1. Therefore, adopting the concept of segmentation of a capital infrastructure project holds the potential of creating more employment opportunities. In doing so it will ameliorate the triple problems of unemployment, underemployment, and the lack of skills development. Thus, in the developing economies, the concept of segmentation of capital infrastructure projects should be considered for the execution of all infrastructure types.

Keywords:

Employment opportunities, multiple contractors, procurement instrument, segmentation, single contractor.

1 Introduction

In most of the developing economies, unemployment, underemployment and the lack of skills development are critical problems deserving attention. To achieve success during the execution of capital infrastructure development requires the engagement of an adequate number of project personnel, in terms of quality and quantity. The common experience, in many developing economies is that professionals from the engineering

and the built environment professions are contributing to the increase in the number of unemployment and underemployment. The research effort of Ianchovichina *et al.* (2013) suggests that infrastructure development is a veritable avenue for creating direct and indirect employment, to ameliorate the unemployment situations in the Middle East, Northern African countries and by extension, other developing economies. However, the size of the workforce employed in any infrastructure development project is influenced by the procurement system and method of executing the project. In many instances, infrastructure development projects are executed using the ‘single contractor’ concept who engages a limited number of professionals. It is worthy of note that the process of developing employable professionals requires a blend of formal training in appropriate educational institutions, complemented with progressive on-the-job exposure in the construction industry. These trainings include the ability to design and implement suitable project schemes, site management, monitoring and evaluation, quality control, resource management, safety, skills development for all levels of construction workers. Achieving client and customer satisfaction, ensuring profitability and competitive advantages (Oyewole & Dada, 2019).

This paper presents the research on three infrastructure development projects in Nigeria and South Africa, referred to as Project 1, Project 2 and Project 3. Project 1 was a building construction project awarded to a single contractor. Similarly, Project 2 was a building construction project, fragmented into smaller lots and awarded to multiple contractors. Project 3 was a road rehabilitation project, where two work packages were bundled together and awarded to a joint venture (JV) of four contractors and a specialist services provider as the fifth contractor. Projects 2 & 3 provided more employment opportunities at all levels compared to that of Project 1.

The paper progresses from the review of relevant literature in Section 2, to presenting information on infrastructure deficit, the roles procurement system and mode of execution of infrastructure projects have on the human capacity required for the execution of infrastructure projects. Section 3 explains the research approach adopted, which is the case study strategy of qualitative research. The data was collected through contextual analysis of project operational documents. The section on research findings and discussion clearly shows that the mode of execution of infrastructure projects (through single or multiple contractors) significantly influences the number of employment opportunities. The final section provides the conclusions and suggests practical application of the research results.

2 The Review of Literature

2.1 The question of infrastructure deficit

The concept of infrastructure deficit simply suggests a lack of or limited extent of the required infrastructure and infrastructure types necessary to meet the developmental needs for economic growth of a country (Ncube, 2013). Some of the problems affecting the successful execution of planned infrastructure schemes can be traced to project governance. Many planned infrastructure projects in developing economies are executed with loans, and the execution of these projects usually span many years, often longer than the political life of the governments that had initiated the projects (Ncube, 2013). If these projects are not completed during the electoral term of the government that

initiated them, successive governments may not continue from where their predecessors stopped. The incomplete projects will not meet the infrastructure need envisaged during the planning, therefore constituting an infrastructure deficit (Effiom & Ubi, 2016).

Effiom and Ubi (2016), cited the incidence of a 338 km road project in Nigeria, commonly referred to as the “east – west” road network. This project was started during the military era in the early 1990s, but by 2016 the project had still not been completed and had featured in many debates until 2021. This is because successive governments did not buy into the principle of continuity of governance, which encourages successive governments to continue where the previous ones had stopped. In this regard, any portion of this road that was partially constructed, but abandoned for a long time, had deteriorated. Whenever this project is resumed, the earlier built and deteriorated portions would have to be rebuilt, thus wasting time and resources. This circle of start and stop has contributed to the project not being completed. This is a common scenario where project development and the contract documents are prepared for the execution of the entire length of the project and the contract awarded to a single contractor. However, if the project planners had adopted the principle of phased development and segmentation, it would have been possible to progressively complete the different portions of the road network to finalisation. Thus, this project would have been completed when the inflation index was low, and it would have ameliorated the menace of the infrastructure deficit.

The incidence of infrastructure deficits will remain until we can address some of the critical constraints. These include deficiencies in planning, ineffective execution models, inadequate allocation and management of resources (finance) for preparation and implementation of planned projects, corruption, low capacity of adequate human resources and the maintenance of exiting assets (Ncube, 2013). However, addressing infrastructure deficits requires a commitment to effective planning, adequate client project governance, functional execution models, continuity in governance and the judicious use of available resources (Adukpo & Leiringer, 2016). Therefore, adopting the principle and practice of the concept of phased development and segmentation, linked to the use of appropriate procurement methods and a suitable mode of execution, can positively influence the project completion time.

2.2 Procurement systems, mode of execution and project personnel requirements

The project success factors achieved during the developmental phase of infrastructure projects are influenced by the project procurement system, mode of execution, the project management structure, roles of project stakeholders, the quality of contractors, the human capacity and capability of project personnel in terms of quality and quantity (Porrashidi *et al.*, 2017). In many developing countries, especially Africa, the traditional procurement system of design/bid/build (DBB) and its variants, is the most common project procurement method used, in the public and private sectors, for the execution of capital infrastructure projects. The traditional procurement system uses the concept of a single contractor, a multiple contractor system or hybrid thereof during project execution (Babatunde *et al.*, 2010).

The traditional contract procurement system (DBB) is where the three phases of design, bid and build are treated separately. The project execution team (PET) members in the different phases are sought for through a competitive bidding process (Babatunde *et al.*, 2010). Adopting the DBB system requires sourcing of adequate components of the human capacity, in all PET members of the project, in the different phases of the project (Escamilla & Ostadalimakhmalbaf, 2016). Infrastructure development projects may be executed through the use of a single contractor or segmenting the capital project into smaller lots, requiring multiple contractors. Adopting either mode of execution (single or multiple contractors), means that each contractor has a direct contractual relationship with the client, allowing the client to measure their performance. Single contractors work at their own pace, with no competitor(s) to benchmark their performance against. On many occasions they justify their delay in not meeting the scheduled timeline. When they are one of many contractors, each contractor is compelled to work at a steady pace commensurate with other contractors. This option allows for the simultaneous execution of the different portions of the project through knowledge sharing, healthy competition and indirect benchmarking. This enables the different components of the project to fit into each other seamlessly and being completed within the time schedule of project (Akintan & Morledge, 2013).

In some instances, when single contractors are used for the execution of infrastructure projects, they rely on subcontractors for the actual execution. The ability and capability of main contractors to effectively deliver capital infrastructure projects is significantly influenced by the quality of their subcontractors and harmonious relationships that exist between them (Akintan & Morledge, 2013). Research has identified some concerns among subcontractors and main contractors bordering on mistrust and scepticism in their relationship (Loosemore & Lim, 2021). The main contractors adopt the practice of using subcontractors or specialist contractors to reduce their overheads and operating cost to maximise profit (Akintan & Morledge, 2013). In many instances, this approach has positively impacted on project delivery. Unfortunately, some of the main contractors focus more on maximising profit rather than building long-term relationships with subcontractors.

Furthermore, adopting the practice of a single contractor for an infrastructure project, limits the number of functional project personnel at all levels. In practice, majority of the single contractors would engage one set of technical execution teams (TET) from the relevant engineering and built environment professionals. Sometimes, professionals such as architects and engineers are made to double as project manager, builders, or quantity surveyors. These professionals may not be engaged on full time throughout the duration of the project but invited to site when their functions are critically needed. On the other hand, when the concept of fragmentation is adopted, the contractor for each lot engages adequate numbers of TET professionals for the execution of their lot and the TET members stay with the project from inception to completion. Similarly, the client may maintain a set or multiple sets of project personnel, depending on the number of projects being executed simultaneously. Consequently, the prospect of more employment opportunities at all levels of the construction is higher when using multiple contractors, compared to the use of a single contractor (Pourrashidi *et al.*, 2017).

The literature reviewed confirmed that the execution of capital development projects provides more opportunities for gainful employment and that the variant of segmenting capital projects into smaller lots holds the potential of a higher number of employment opportunities at all levels. This is the focus this paper.

3 Research Method

The case study strategy of qualitative research was considered most suitable for this research. Case study method of research provides the opportunity for in-depth exploration of the phenomenon of the research subject, allowing the researcher to observe and study the different aspects of the same subject, contextual relationship of the parts to the whole in the environment where they operate (Green and Thorogood, 2009, Yin, 2014). Since the projects for this research have had been completed earlier, the data was obtained predominantly from project operation documents, such as minutes of meetings, companies' organisational structures, documents from the websites of organisations, and published articles (Maguire & Delahunt, 2017).

The qualitative data collected was analysed by adopting the principles of content and qualitative document analysis (QDA). QDA is a research method for rigorous, systematic reviewing or evaluating of documents, both printed and electronic. Document analysis requires that data is examined and interpreted to elicit meaning, gain understanding and develop empirical knowledge (Bowen, 2009). The approach is used to facilitate impartial and consistent analysis of written information and provides useful information about trends and gaps. A typical QDA process includes finding, selecting and identifying the areas of analysis, verification, appraising (making sense of) and synthesising data contained in documents (Bowen, 2009). Documents that may be used for systematic evaluation as part of a study take a variety of forms. They include advertisements; agendas, attendance registers and minutes of meetings; manuals; background papers; books and brochures; diaries and journals; event programmes (i.e., printed outlines); letters and memoranda; maps and charts; newspapers (clippings/articles); press releases; programme proposals, application forms, and summaries; radio and television programme scripts; organisational or institutional reports; survey data and various public records. Scrapbooks and photo albums can also furnish documentary material for research purposes. These types of documents are found in libraries, newspaper archives, historical society offices and organisational or institutional files (Bowen, 2009:27).

The project documents analysed revealed that Project 1 was executed through the procurement process for single contractor and had one set of relevant TET members from engineering and built environment professionals. Similarly, Projects 2 & 3 were executed through the concept of fragmentation, which involve the use of multiple contractors, and each contractor engaged an adequate number of TET professionals. The details of the research results are presented and discussed in Section 4.

4 Findings and Discussion

This section progresses from the discussion of information on the background of the projects used for this research, to the presentation and discussion of the research findings.

4.1 Background of the projects

Projects 1 & 2, used for this research, are building projects executed in Nigeria. Project 1 is an administrative building, two upper floor heights with three distinct wings interconnected through a central circulation core. The project was divided into two phases, namely, the construction of the main building, as phase one. The components of the second phase include the construction of a generator house, supply, and installation of electrical machines (generator and transformer), as well as external works and landscaping. The works on both phases commenced simultaneously in March 2012, awarded to a single contractor, with the expected completion time of 48 months. However, in December 2018 the project was still not completed. The client diplomatically disengaged the contractor and completed the project in 2020 through an alternative project procurement system. Project 2, a two-storey building, is a phase in the development of the faculty of Environmental Sciences infrastructure. The project was divided into seven lots, awarded to seven different contractors and the work started simultaneously in February 2013, with a completion schedule of Twelve (12) calendar months. The project manager decided to set the project completion time for ten months, allowing the float period of two months. Each contractor developed his own timeline, worked steadily and achieved his milestones and delivered their portions of the project within the scheduled ten months, with evidence of cost savings and satisfactory quality.

Project 3 is a portion of the phase A1 of the Gauteng freeway improvement project (GFIP), South Africa. The Phase A1 involved the substantial upgrading of about 185 km of freeway, including pavement rehabilitation, interchange (I/C) upgrades and land additions on the N1 and N3 sections of the N12 and the R21 road network. The projects for Phase A1 were scheduled for completion in 2010, but was adjusted to 2011 (Weidemann, 2010). This phase was sub-divided into several work packages and awarded to multiple contractors. However, some of the work packages linked to the successful hosting of the 2010 FIFA World Cup were isolated for speedy execution. This included Work Packages C and F, commonly called ‘the Ben Schoeman Freeway’. The two work packages were awarded to a JV corporation with five collaborating contractors. These work packages were executed successfully and ready for use for the 2010 World Cup.

4.2 Comparison of the human capacity

The quantity and level of proficiency of the technical personnel, at the tactical level of leadership, in the development of infrastructure, positively influences the success and ease of project delivery (Pourrashidi et al., 2017). These leaders are responsible for the day-to-day administration of the project, coordinate the translation of strategic decisions into practical realities; they develop and implement the project schedule to achieve the project objectives, ensure quality and have eyes for details. The overall safety in the production process receives their priority attention. They provide senior management

with adequate information for timely decision making, such as decision to make, buy, out-task or outsource and other suggestions on project risk management (Fadun and Saka, 2018). Table 1 provides a comparative analysis of the technical personnel, for Projects 1 & 2, at the tactical level of leadership. The Civil Engineer, in Project 1, supervised the execution of the foundation works, the development of the general structural frame, and left the remaining builders' works to the supervision of the architect and would only visit the site when there is need as and when needed. Similarly, the Electrical Engineer doubled as the Mechanical Engineer, supervised the conduit works for both electrical and mechanical fixtures and visited the site intermittently. During site meetings, the most regular contractors' representatives, at the tactical level, were the project manager, architect and quantity surveyor.

Conversely, in Project 2, the respective contractor had adequate complement of technical personnel. In Lots 1, 5 & 6 Builders coordinated the civil, structural and building works, while Civil Engineers performed the same function in Lots 2, 3, 4 & 7. Furthermore, each lot had an architect and quantity surveyor. The coordinating role of the project manager was performed by the most senior technical person in each team. Each team, remained on site throughout the duration of the project, actively participated in the monitoring and evaluation processes and delivered their portions of the project on schedule. As shown in Table 1, comparatively, the ration of the professional civil engineer/builder, project manager, architect and quantity surveyor between Projects 1 & 2, is 1:7. Similarly, 1:4 for mechanical and electrical engineers.

Table 1: Quantity of technical personnel

S/No	Project	Technical Personnel at Tactical Level						
		Civil Eng.	Mech Eng.	Elect Eng.	Project manager	Builder	Architect	Q/Surveyor
1	Project 1	1	-	1	1	-	1	1
2	Project 2							
	Lot 1	-	-	-	1	1	1	1
	Lot 2	1	-	-	1	-	1	1
	Lot 3	1	1	1	1	-	1	1
	Lot 4	1	1	1	1	-	1	1
	Lot 5	-	-	-	1	1	1	1
	Lot 6	-	-	-	1	1	1	1
	Lot 7	1	-	-	1	-	1	1
	Total	1(4)	0(2)	1(2)	1(7)	0(3)	1(7)	1(7)

In Project 3, as seen in Table 2, Contractors 1-4 are members of the JV organisation. Contractor 5 is the specialist service provider for demolition, who concentrated their efforts in executing the demolition of the two interchanges in the project.

Table 2: List of contractors in work Packages C & F

S/No	Contractors for Work Packages C & F	Areas of Specialisation
1	Grinaker-LTA Construction and Development Ltd (Work package C)	Civil Engineering Road, Earthwork and Pipelines.
2	Aveng Africa (Pty) Ltd (bridges, off and on-ramps and interchange constructions)	Civil Engineering Contractors
3	Moseme Road Construction (Pty) Ltd (Work package F)	Highway, Street, and Bridge Construction
4	Boitshoko Road Surfacing	Road surfacing
5	Jet Demolition (Pty) Ltd	Provides professional demolition services

It was quite a challenge sourcing the personnel profiles from the website of the contractors in Project 3, except for that of Aveng Africa, which provided the demography of personnel in four occupational levels. The excerpt for the strategic and tactical levels of leadership is shown in Table 3. This table indicates that the tactical level of leadership had 20 members. As shown in Table 2, this organisation (Contractor 2) was involved in large and highly technical components of the project, compared to the content of the work package of other contractors. In this regard, percentages of tactical personnel are commensurate with the content of the work package for each organisation and was allocated as follows:

- i. Contractors 1 & 3, 60% of 20 = 12
- ii. Contractor 4 40% of 20 = 8
- iii. Contractor 5 25% of 20 = 5
- iv. Contractor 2 = 20
- v. Total = 45

The approximate number of tactical personnel for Project 3 is 45. The number of operational personnel for Aveng Africa (Contractor 2) is shown in Table 4.

Table 3: Strategic and tactical leaders – Aveng Africa (Pty) Ltd

Occupation Levels	Male	Female	Total
Senior management	1		1
Professionally qualified and experienced specialists and mid-management	17	3	20

Table 4: Operational personnel

Personnel Category	Male	Female	Total
Skilled technical and academically qualified workers, junior management, supervisors, foremen and superintendents	110	6	116
Semi-skilled and unskilled workers	526	78	604

Comparing Tables 3 & 4, the ratio of tactical leaders to the operational leaders and general labour force is 1:6 and 1:30 respectively. In building Projects 1 & 2, the ratios are 1:4 and 1:20. Table 5 provides the summary of possible employment numbers for the three projects.

Table 5: Summary of personnel at the tactical and operational levels

S/No	Project	Tactical Leaders	Operational Leaders	General Labour
1	Project 1	5	20	100
2	Project 2	28	112	560
3	Project 3	45	270	1350

As shown in Table 5, the number of tactical and operational personnel engaged in Project 2 (segmented project with multiple contractors) is higher than the ones in Project 1 (single contractor). In practice, it is difficult for any single contractor (on a typical road project) to engage the number of personnel engaged in Project 3 (segmented project with multiple contractors), without the negative effects of duplication and redundancy of personnel.

Irrespective of the infrastructure type, infrastructure development holds the potential of providing direct and indirect employment. Intrinsically, the number of employment opportunities created at both the tactical and operational levels are higher when the concept of segmentation of capital infrastructure projects is adopted, compared to when similar projects are executed through a single contractor.

5 Conclusion

The objectives of this research were to explore the prospects of ameliorating the incidence of unemployment, underemployment and the lack of skills development in the construction industry. The research was done by comparing the employment opportunities in construction projects executed through a single and multiple contractor system.

In many developing economies, considerable efforts are being made to provide access to formal education in the engineering and other built environment professions. Nevertheless, there is need for a blend of formal education with practical workplace training for sustainable skill development. Undoubtedly, infrastructure development processes hold the potential of providing the required blend between formal education and the workplace training. This is possible, during the planning phase, if the procurement system and the mode of execution, are properly crafted to allow for multiple, competent PET members to participate in the execution process, which will significantly influence the number of employment opportunities during the development of typical infrastructure projects. As shown in Table 5, Project 1, a building project, executed through the single contractor concept, and Project 2, another building project, that adopted the practice of segmentation using multiple contractors, achieved different results in duration, cost and employment numbers. The employment opportunities at the tactical, operational and general labour levels in Project 1 & 2, were in the ratio of 1:5. Project 3 (segmented project) provided multiple employment opportunities in the three levels.

In conclusion, the practice of segmentation for the execution of infrastructure projects through multiple contractors holds the prospect of providing multiple (direct and indirect) employment opportunities, skills development opportunities, as well as socio-economic improvements in the communities near the infrastructure projects. Therefore, we recommend that the concept of segmentation of capital infrastructure projects be adopted for the execution of all infrastructure types to ameliorate the challenges of unemployment in developing economies.

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