Ameliorating the Effects of Time Overrun in the Execution of Capital Infrastructure Projects

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Abstract

Considerable effort and resources are being devoted to infrastructure development in many developing economies. Unfortunately, many of these mega projects remain ideas for many years, some abandoned at different stages of completion and the few that were completed were achieved with significant time overrun. The uncompleted projects have contributed to the increase in infrastructure deficit. Therefore, the effective management of the time component during the execution of capital infrastructure projects significantly increases the possibility of completing parts of or the complete project on schedule, thus reducing the negative effects of inflation. In this regard, it is imperative to explore a functional approach on how to achieve the execution of capital projects on schedule. The multiple sites case study strategy of qualitative research, using comparative analysis, was adopted to examine how building and highway improvement projects were executed within their time schedules. The findings revealed that the concept of phase development and fragmentation, using multiple contractors, was used for the execution of the projects. The two projects were executed within the time schedule, reducing the infrastructure deficit, ameliorating the negative effects of inflation, and resulting in value for money for the client.

Keywords

Fragmentation of capital, Infrastructure development, Infrastructure deficit, Multiple contractors, Phase development.

1. Introduction

The effectiveness of infrastructure delivery is influenced by many factors, which include, but is not limited to the procurement method, the mode of execution, competency in planning and management of the execution process, and availability of adequate resources. However, focusing on the mode of execution, if the concept of phase development and fragmentation is appropriately crafted into the execution of the proposed capital project, the approach holds the potential of the timely completion of the projects, reducing the incidence of abandoned projects and infrastructure deficit. This approach also enhances the end-user's satisfaction, the effective use of resources, ameliorating the negative effects of inflation and ensuring that the client receives value for the money invested in the project (Watermayer 2014). Ameliorating the negative effects of time overrun in capital development projects has been a major concern for infrastructure project stakeholders. It is helpful to consider adopting the concept of phase development and fragmentation (among other prospective solutions), to ameliorate the negative effects of time overrun during the execution of capital infrastructure projects. Adopting this concept allows the effective use of available project funds and reduces the negative effects of inflation. The phase that is completed and put to use, serves the need of end-users and provides a possible source for revenue generation. During the operation of the completed phase any lapses observed should be noted and used to improve the development of subsequent phases.

Similarly, when a capital project is executed through a single project execution team's (PET) members (especially contractors), the single contractors work at their own pace, and provide reasons to justify their delay in meeting the scheduled timeline (Ogbeifun et al. 2018). Conversely, the contractors engaged in the execution of the different lots of the fragmented project adopt the principles of self-regulation, which challenges each contractor to use adequately skilled project personnel, work within their own time schedule and in collaboration with other contractors through sharing their knowledge and resources (Bogsnes 2014). In this regard, all contractors working in the fragmented project, draw funds in time from the project funds, allowing for the judicious use of the project funds, and reducing the negative effects of inflation. This enables the client to receive value for the money invested in the project. Therefore, the fragmented parts and ultimately the whole project is completed within the planned time schedule (Ogbeifun et al. 2018).

The concept of phase development and fragmentation of capital projects can be adopted for the execution of any infrastructure type project. To be effective in this approach requires adequate planning, comprehensive documentation of the content of each lot or bundle of work, a suitable procurement method, purposive selection of PET members (especially the contractors) and the use of a competent independent project manager or project management organisation.

This paper presents a comparative study of two capital projects, a building project in Nigeria and a highway infrastructure project in South Africa, where the principles of phase development and fragmentation were adopted. The objectives of the study are to evaluate the influence of the concept on the project completion time and receiving value for money.

2. Literature Review

2.1 The Question of Infrastructure Deficit

The concept of infrastructure deficit simply suggests the lack of or limited number of the required infrastructure and infrastructure types necessary to meet the developmental needs for economic growth of a country (Ogbeifun et al. 2018). Some of the problems affecting the successful execution of planned infrastructure schemes can be traced to project governance. The majority of planned infrastructure projects in developing economies are executed with borrowed funds and the execution of these projects usually span many years, possibly longer than the political life of the governments that initiated the projects (Ncube 2013). If these projects are not completed during the electoral term of the government that initiated them, succeeding governments may not continue from where their predecessors stopped. The uncompleted projects will not be available to meet the infrastructure need envisaged during planning, therefore constituting an infrastructure deficit (Effiom and Ubi 2016).

Effiom and Ubi (2016), cited the incidence of the 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 the year 2016 the project was still not completed and had featured in many debates until 2021. This is because succeeding governments did not buy into the principle of continuity of governance, which encourages succeeding governments to continue where the previous ones 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 resurrected, 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, constituting a defect in the initial project proposal. 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 awarding the contract to a single contractor. However, if the project planners had adopted the principle of phase development and fragmentation, it would have been possible to progressively execute portions of the road network to completion for functional use. Thus, this project would have been completed in the 1990s when the inflation index was low and it would have ameliorated the menace of the infrastructure deficit.

The incidence of infrastructure deficits will remain with us until we are ready to address some of the critical constraints, which 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 commitment to effective planning, adequate client project governance, functional execution models, continuity in governance and the judicious use of available resources (Brady and Davis 2010; Adukpo and Leiringer 2016. Therefore, adopting the principle and practice of the concept of phase development and

fragmentation, linked to the use of appropriate procurement methods, can significantly influence the project completion time.

2.2 Procurement Method and Project Execution Models

The level of success achieved during the execution of any capital construction project is significantly influenced by the project procurement method and project execution system or model (Pourrashidi et al. 2017). Some common project procurement methods used for the execution of capital projects in the public and private sectors in many developing economies are the traditional design/bid/build (DBB) and design/build (DB) systems (Babatunde et al. 2010; Idoro 2012). Each of these procurement methods has different variants, enabling the client to select the one most suitable for the execution of his project. Depending on the variant adopted, the project may be executed using a single contractor or many contractors, where the project is divided into smaller lots.

The traditional method of contract procurement can be described as the process where the three phases of DBB are treated as three separate tasks (Babatunde et al. 2010). Adopting the DBB system requires an adequate quantity and quality of human capacity in every phase of the project, by both the client and PET members (Escamilla and Ostadalimakhmalbaf 2016). The client may decide to adopt the variant of using a single contractor to execute his capital project, or the variant of fragmenting the capital project into smaller lots, requiring multiple contractors. However, by adopting either method (single or multiple contractors), each contractor has a direct contractual relationship with the client, allowing the client to measure the performance of each organisation. Single contractors work at their own pace, with no competitor(s) to benchmark their performance against. They often provide reasons to justify their delay in meeting scheduled timelines (Ogbeifun et al. 2018). Conversely, as one among many contractors, each contractor is compelled to work at a steady pace commensurate with other contractors. By allowing the simultaneous execution of the different portions of the whole project through knowledge sharing, healthy competition, and indirect benchmarking, there is the potential that the different components of the whole project will fit into each other seamlessly and be completed within the time schedule of the whole project (Ogbeifun et al. 2018; Fagbenle et al. 2018).

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 are significantly influenced by the quality of their subcontractors and the harmonious relationships that exist between them (Akintan and Morledge 2013; Fagbenle et al. 2018). The research by Dainty et al. (2001), identified serious concerns among subcontractors bordering on mistrust and scepticism in the relationship between the main and subcontractors. The perception of many subcontractors is that their relationship with the main contractor is shrouded in insincerity, where the main contractor uses the subcontractor to enhance their cash flow, enabling the main contractors to remain stable in the uncertain climate of the construction industry (Akintan and Morledge 2013). The main contractors adopt this practice of using subcontractors or specialist contractors to reduce their overheads, operating costs, and maximise profit aiming to efficiently deliver projects (Akintan and Morledge 2013). This approach has often positively impacted on project delivery. Unfortunately, many of the main contractors focus more on maximising profit rather than building long-term relationships with subcontractors. Other negative attitudes of main contractors that impair cordial relationships with subcontractors, observed by the authors Akintan and Morledge (2013) include:

- Main contractors' authoritative attitudes.
- Delayed payment to subcontractors, with the clause 'paid when paid".
- Lack of trust between main contractors and subcontractors.
- Selection of subcontractors through competitive bidding using lowest price.
- The use of stringent contract agreements and conditions that erode the rights of the subcontractors.
- The subtle transfer of the project risks to the subcontractor.
- The subcontractors, at best, are 'seen and not heard', usually neglected during decision-making processes.
- The main contractor views the suggestions from the subcontractor more from the point of cost rather than added value.

Unfortunately, efforts aimed at getting main contractors to deal fairly with their chain of subcontractors have mainly been unsuccessful. Irrespective of the fact that standard contracts stipulate periods within which subcontractors should be paid, such specified periods are repeatedly ignored, with subcontractors often being stretched to the limit before getting paid.

These negative attitudes demoralise the subcontractors, stifle innovation, reduce productivity, causing delays and inhibiting improvements in the efficacy of the project delivery process (Dainty et al. 2001; Akintan and Morledge 2013).

2.3 Design and Build

The DB procurement system integrates the fragments of DBB into one contract which allows the contractor and PET members to be involved in the project from inception through to completion (Idoro 2012). There are different variants of the DB system, like concession, turnkey, build, operate and transfer. Some of the common modes of operating the DB system include:

i. Pure DB: the design and construction team are in the same organisation, commonly referred to as a 'consortium'.
ii. Partially integrated DB: here, the consortium invites other consultants or contractor(s) to execute specific or specialised functions within the project.
iii. A third variant is where different organisations (consultants and contractors) form a conglomerate or a consortium or joint venture, using the instrument of 'memorandum of understanding' (MOU), like the one used in alliance contracting. In this regard, the collaborating consultants and contractors do function in their areas of expertise (Idoro 2012; Jefferies et al. 2014).

Generally, during project execution, in variant (i) a single contractor is engaged, while in variants (ii) and (iii), multiple contractors are engaged (Ogbeifun et al. 2018a).

If the procurement process is objectively executed, the DB approach provides an opportunity for recruiting suitable experts to execute the different components of the project. If not, the DB consortium may be a mere conglomeration of preferred participants of the coordinating contractor or consultant (Jefferies et al. 2014). In the latter, the client does not receive value for money (Ruparathna and Hewage 2015). The compromise in the selection of PET members is rampant when the consortium owes greater allegiance to the sponsors of the project than the client, beneficiary or end users. The result is an infrastructure project that does not exactly meet the need of the end users. If the client doubles as the project sponsor, the DB system of project delivery holds the potential of delivering quality projects within the time schedule, especially if the client is ready to absorb attendant risks, including cost overrun (Brady and Davis 2010).

Whatever the procurement system adopted, the quality of contractor(s) has a significant influence on effective infrastructure delivery. Therefore, the process of selecting the contractors should be given critical consideration.

2.4 Contractor Selection Process

The contractor is the most visible active force, among the PET members, whose actions significantly influence the effective delivery of the construction project (Ogbeifun et al. 2018b). Therefore, the selection of this group of actors requires due diligence. Contractor selection involves a multi-faceted decision-making process with multiple selection criteria. The selection of quality contractors holds the potential of engaging adequately resourced contractors with knowledge of the project at hand, reducing the incidence of rework, capable of producing an overall quality project, which is delivered on schedule, at reasonable cost and enabling the client to receive value for money (Jafari 2013; Ruparathna and Hewage 2015, Mkazi et al. 2021).

Therefore, it is necessary to introduce systems that will assist in filtering prospective contractors with the aim of selecting the most suitable one(s) for infrastructure projects to be executed. In practice, the contractor-selection process follows a two-stage process, known as pre-qualification and post-qualification stages (Jafari 2013). The pre-qualification process involves inviting many contractors to submit the information required by the procuring client, to identify an array of eligible contractors, which is required for the post-qualification phase (Jafari 2013). The information in the pre-qualification document should be as comprehensive as possible. The examination of the documents submitted by each contractor should include physical verifications. The category or categories of contractors to be invited for pre-qualification should be specified to ensure that the shortlisted contractors will be approximately of equal capacity and capability. Some of the information required should include essential attributes and key factors (Doloi 2009; Alzahrani and Emsley 2013), as summarised in Table 1.

Table 1: Essential attributes and key factors

S/No	Attributes	Key factors
1	Financial attributes	Up to date audited account for not less than three years, showing history of cash turnover, credit history and cash flow.
2	Management and technical attributes	Staff qualification, quality, quantity, and experience of technical personnel; Knowledge of suitable construction method(s) for the project under consideration; suitable work programme or project timeline.
3	Past experience and performance attributes	List and size of completed projects in the last five years, with certificates of practical completion; project time and cost overrun, if any, with reasons; evidence of uncompleted projects with reasons; evidence of conflict, disputes, or litigation with reasons; experience of construction activities in the region of the proposed project.

The result of the pre-qualification stage is the shortlist of suitable contractors. In the second stage – the post-qualification stage – the shortlisted contractors are invited to tender for the construction project. The submission of each contractor is examined to establish their technical competency, balanced pricing and workable schedule or project timeline. This information forms the basis for selecting the most suitable contractor(s), and not necessarily adopting the practice of 'lowest bidder' (Jafari 2013; Deep et al. 2017).

Literature has confirmed the reality and factors responsible for infrastructure deficit, identified the potential in adopting the concept of phase development and fragmentation of the execution of capital development projects, as possible panacea, which is the focus of this paper.

3. Research Method

The multiple sites case study method of qualitative research was adopted (Yin 2014). The strength of case study method of research is that it allows the researcher to observe and study the different aspects of the same subject, putting each part in relation to the whole in the environment where they operate (Braun and Clarke 2006). This method is useful when holistic, in-depth investigation is needed (Green and Thorogood 2009).

The focus of this research was to explore how the concept of phase development and fragmentation of a capital project was implemented in the two projects selected for this research. The data was collected through interviews, comparative analysis of the documents, minutes of site meeting and periodic reports for the execution of capital projects, one in Nigeria and the other in South Africa. An interview guide with open-ended questions was used to collect information from respondents. The participants were purposively selected from the strategic and tactical leaders of the PET members. The analyses of the qualitative data followed the principle of content analysis (Hsieh and Shannon 2005). To ensure reliability and validity of data, the information on the same subject obtained from the consultants was correlated with the information from the contractors and the project operational documents, by adopting the principle of triangulation (Turner et al. 2015).

The analysis of the research findings revealed that the two projects were executed, first by selecting a phase of the larger project and fragmentation of the chosen phase into smaller lots or work packages. The respective lots or work packages were executed within the time schedule, thus, completing the chosen phase on schedule. The details of the research findings are discussed in the findings and discussion section.

4. Findings and Discussion

4.1 Background of the Projects

The two projects used for this research are, a building project situated in a higher education institution in Nigeria and a road network development in South Africa. The building project is the construction of a phase in the development of the infrastructure for the use of the faculty of Environmental Sciences, tagged as Project 1. This project is a two-storey building, divided into seven lots and awarded to seven different contractors. The project was funded by a special infrastructure development agency of the Federal Government of Nigeria. One of the operating clauses of this agency is that all approved projects must be completed within twelve calendar months, otherwise, the benefiting institution cannot access any further allocation of funds for other projects. Work in the seven lots started simultaneously in February 2013 (Ogbeifun et al. 2018). During the tender stage, the project execution timeline was set at ten months; allowing for a two-month float. Each contractor developed his timeline, with none of the

contractors exceeding nine months. However, from the cumulative timeline developed by all the contractors, the project adopted ten months as completion time. Each contractor worked steadily and achieved the milestones set out in the project schedule. The individual lots and the whole project were delivered earlier than the scheduled ten months, with cost savings and no compromise on quality.

The second project, tagged Project 2, is a portion of the Gauteng freeway improvement project (GFIP), South Africa. This is a long-term freeway upgrade and expansion project, which entails the eventual upgrade and construction of about 561 km of freeways (Weidemann 2010). The project was divided into four phases and timelines, for execution. The phases are, Phase A1, A2, Phase B and Phase C. 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 1 were scheduled for completion in 2010, but was adjusted to 2011 (Weidemann 2010). Furthermore, some of the work package connected to the successful hosting of the 2010 World Cup was isolated for speedy execution. This paper will focus on Work Packages C and F, commonly called 'the Ben Schoeman Freeway'. The two work packages were awarded to a joint venture corporation with five collaborating contractors. These work packages were executed successfully and ready for use for the 2010 World Cup. Similarly, all the projects in Phase A1, were successfully completed by the 2011 scheduled date.

4.2 The Practice of Phase Development

The two projects used for this research adopted the principle of phase development by addressing a portion of a mega project. Table 2 provides information on the content of each lot of Project 1. Each lot was awarded to a separate contractor.

Table 2. The description of fragmented portions (Lots) of the building project

Lot	Description
Lot 1 – Block 28	A 2-storey block, consisting of male toilet facilities for utilization by Blocks 29, 32 and 33, and other existing facilities
Lot 2- Block 29	A 2-storey block that houses staff offices
Lot 3 – Block 32	A 2-storey structure that houses studios, classrooms and offices
Lot 4 – Block 33	A 2-storey structure that houses exhibition rooms and studios
Lot 5 – Block47A	A 2-storey structure that houses exhibition rooms and studios
Lot 6 - -Block 49	A single-storey structure that houses the conveniences and staircase linking other existing and adjoining facilities
Lot 7 – Block 50	A single-storey structure that houses senior staff offices, boardroom and seminar rooms

Project 2 consisted of the upgrade of about 185 km of freeway, a phase in the proposed 561 km project of the GFIP, South Africa. The 185 km project was further subdivided into several work packages and awarded to groups of contractors, as shown in Table 3.

Table 3. Contractors and work packages

S/No	Contractor(s)	Work package
1	Siyavaya Joint Venture (JV), comprising Group 5, Power Construction, Liviero, Umso Construction and Bophelong Construction	Work packages A and E
2	GFI Contractors JV, comprising WBHO, Sanyati Construction, Rainbow Construction, Glash Construction, Munasi Civil Contractors and Patula Construction	Work package B
3	GLMB JV, comprising Aveng (Africa), Moseme Road Construction and Boitshoko Road Surfacing	Work packages C and F
4	Basil Read JV, including Roadcrete, Chavani Construction and Dipcivil (BRCD)	Work package D
5	CMC JV, comprising CMC di Ravenna South Africa and G4 Civils	Work package G

6	Raubex Construction	Upgrade of the R21
7	Power Group	Upgrade of the R21 section 1 and 2
8	Tosas	Subcontractor for bituminous binders
9	ETC JV	Multilane free-flow tolling system
10	Jet Demolition	Demolition of Allandale I/C bridge
11	ARQ Consulting Engineers	Design of the Lynnwood Glen pedestrian and pipe bridge
12	Cadcon - subcontractor of BRCD JV	Manufacture of the Lynnwood Glen pedestrian and pipe bridge
13	Beka	Luminaires
14	Esorfranki Civils	Work package J
15	Goba SSI JV Partners	Gillooly's flyover
16	Goba SSI JV Partners	Road upgrades from the N1 Buccleuch I/C to 14th Avenue
		The road upgrade from the N3 Buccleuch I/C to the N3 Gillooly's I/C and from the Gillooly's I/C to the Jet Park I/C.

While the projects, in Table 3, were executed simultaneously to achieve the proposed completion date of 2011 for the GFIP Phase 1, the Ben Schoeman Freeway, Work packages C and F, were among the priority projects to be completed before the commencement of the 2010 World Cup. The content of this portion of the project is shown in Table 4.

Table 4. Content of Work Packages C and F

Contractor	Work package	Description
Grinaker-LTA, lead partner in the GLMB JV	Work packages C and F	The scope of work included adding extra lanes to the roads, upgrading intersections, and constructing new bridges to improve the flow of traffic. The projects included a 23 km stretch of road between the Buccleuch I/C and the Brakfontein I/C on the N1, referred to as Work package C and the 17,6 km section of highway between the Geldenhuys I/C and the Buccleuch I/C on the N3, referred to as Work package F
Jet Demolition		The demolition of the Geldenhuys I/C and the Buccleuch I/C on the N3

The Ben Schoeman Freeway has several underpasses and overpasses, which include the Woodmead Drive underpass, Maxwell Drive underpass, Le Roux Avenue overpass, Alexandra Avenue underpass and Nellmapius Road overpass (Weidemann 2010). Before the upgrading, the Ben Schoeman Freeway was a six-lane dual carriageway facility (three lanes per direction). The upgrade included:

- Widened to five lanes per carriageway
- Bridge widening at the Jukskei River
- Placing beams at Le Roux overpass
- Brakfontein I/C – adding a third lane
- Demolition of Allandale I/C bridge (Weidemann 2010)

Other work included, continuous auxiliary lanes provided between the on-ramps and off-ramps of all consecutive access I/Cs, which involved the following significant activities:

- The structures of all overpasses and underpasses were widened to complement the expansions of the freeway.
- All I/Cs and their cross-roads were upgraded to provide additional capacity on the freeway.
- Eight new bridges were constructed as part of the I/C and freeway upgrades (Weidemann 2010).

Graumann (2010) provided the following additional details on Work Package C (Table 5). The project is located on the N1 Freeway between the Buccleuch I/C linking the N3, N1 and M1 in the south, and the Brakfontein I/C linking the N14 and N1 in the north. This section of the N1 Freeway includes two system I/Cs (Buccleuch and Brakfontein) and five access I/Cs (Allandale, New Road, Olifantsfontein, Samrand and Old Johannesburg Road). Construction work for the upgrading of the Ben Schoeman Freeway commenced on 26 May 2008. According to Weidemann's (2010)

report on progress during a site meeting in 2009, the project stakeholders were satisfied that the Ben Schoeman Freeway project was still "on track and within the parameters of time and cost allowed within the conditions of the contract" (Weidemann 2010).

Table 5. List of contractors in work package C & F

S/No	Contractors
1	GLMB JV
2	Aveng (Africa)
3	Moseme Road Construction
4	Boitshoko Road Surfacing
5	Jet Demolition

Two important project governance systems that were adopted in the execution of these projects, were awarding contracts for specific work packages to JV organisations and the use of specialist contractors to execute specialised portions of the work in some of the work packages. The application of these governance approaches is demonstrated in the execution of the Work Packages C and F. In Table 5, contractors 1-4 are members of the JV, while contractor 5 is the specialist service provider for demolition who concentrated his efforts in executing the demolition of the two I/Cs in the project. This organisation was not a subcontractor to the main contractor, but a specialist contractor engaged by the client to provide a specialist service to the JV contractors.

The benefits of adopting the principles of phase development, as an option for the execution of capital infrastructure projects include savings on time, effective use of available funds and achieving value for money and customer satisfaction (Atkinson 1999; Watermayer 2013; Ruparathna and Hewage 2015). It would have been possible to salvage parts of many abandoned capital projects dotting the landscape of many developing countries or reduce the negative effects of time and cost overrun if the concept of phase development was adopted.

4.3 Achieving Project Timeline through Fragmentation

Project scheduling or timelines are critical tools for effective construction project management. These tools are developed at the beginning of projects and used progressively to evaluate the progress during the life of any project, providing information for effective communication or critique of the construction project (Subramani et al. 2016). At the inception of Project 1, the minutes of the site meetings and interviews with PET members revealed that general site meetings were held every two weeks for the first two months. Thereafter, the site meetings were held monthly and occasionally as the need arose. The occasional meetings were scheduled by contractor(s) with specific consultants **(**Ogbeifun et al. 2018**)**. Although, during the tender period, contractors were requested to develop their project schedule for ten months, none of the contractors exceeded the nine months' timeline. However, ten months was adopted as the project timeline. The contractors demonstrated their commitment to the project and achieved practical completion within their project timeline, as shown in Figure 1 **(**Ogbeifun et al. 2018).

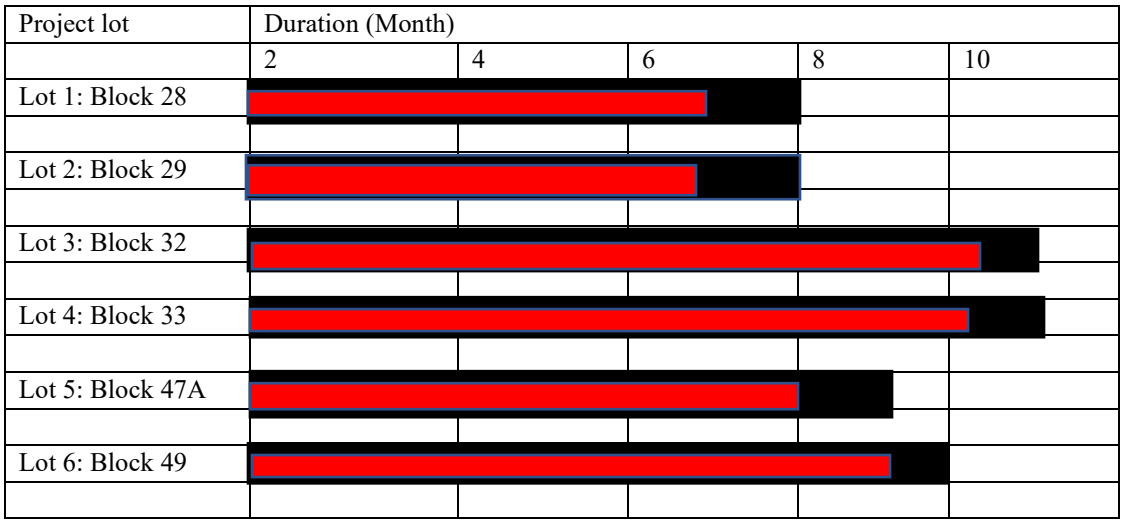

Figure 1. Project timeline

Similarly, in Project 2, the portions of the project that were considered critical to the hosting of the 2010 World Cup and all the projects earmarked for Phase A1, including the upgrade of 185 km of freeway, were completed according to the schedules of 2010 and 2011 respectively. This feat was achieved because the entire Phase 1 of the GFIP project was divided into different work packages, all teams executing the content of their work package simultaneously. This enabled the projects to be completed on schedule.

The success recorded in Projects 1 and 2 would have been difficult to achieve if the projects were bundled into one work package and awarded to a single contractor, no matter how well resourced the contracting organisation might be. If the two projects were awarded to main contractors, who would in turn have engaged other subcontractors, the prospects of completing these projects on schedule would have been questionable. This is because the relationships between main and subcontractors are not always as good as it should be. Several research efforts have identified the 'not-so-good' relationships, between the main and subcontractors, which have constituted significant factors responsible for the delay in the execution of construction projects (Akintan and Morledge 2013; Fagbenle et al. 2018). Conversely, the multiple contractors engaged in Projects 1 and 2, were independent, yet inter-dependent, they had healthy competitive relationships with each other and had a direct relationship with the client, a scenario not practicable in the case of a one main contractor versus subcontractor procurement system (Dainty et al. 2001; Akintan and Morledge 2013).
It is important to note the two salient motivations that amplify the benefits of multiple contractors versus a single contractor (Ogbeifun et al. 2018):

a. Single contractors usually work at their own pace, but being one among many contractors, compels each contractor to work at a steady pace commensurate with the pace of other contractors.
b. Although each contractor is working from different directions or specialties, through knowledge sharing, the different components of the whole project progressively begin to fit into each other.

There has been observable disquiet in the use of JV organisations in the execution of construction projects. This is based on historical facts that between 40-70% of JVs have experienced failure (Farrel 2014). Nevertheless, the use of JVs has equally made some remarkable improvements in the execution of construction projects (Mba and Agumba 2018). It is imperative, therefore, that prospective partners in a JV relationship should note and subscribe to the culture of openness, transparency and clear communication; establish clearly defined roles and responsibilities, goals and ground rules; commit to core organisational competencies; apply professional rigour and discipline; work to achieve project timelines, cost and quality, respect for the different partners and focus on achieving mutual benefits (Kale et al.; Hong and Chan 2014). In a nutshell, the factors influencing the success of JVs' involvement in the construction industry include management control, inter-partner trust, effective communication, management of risks and conflicts, as well as understanding and the management of contractual agreements (Adnan et al. 2018; Mba and Agumba 2018). Conversely, the critical factors to be considered in a JV relationship to avoid pitfalls include, but not limited to, cultural fitness, organizational fitness, partner synergy, relationship building and maintaining the relationship, proper management of JV and JV drivers (Mba and Agumba 2018; Samanta and Sinala 2019).
The principle of self-regulation is used in the design of a roundabout system. The roundabout system has been adjudged the most cost-effective system for road traffic management in urban settings. This is because it allows each motorist to operate with limited external control (Bogsens 2014). Similarly, the intrinsic factor underpinning the success in the management of a fragmented project, is the adoption of the 'self-regulation' principle, which allows each contractor, or PET member in the project to execute their portion of the project diligently and in collaboration with other contractors. Thus, delivering their portions of the project and ultimately the whole project on schedule (Hong and Chan 2014; Adnan et al. 2018; Mba and Agumba 2018).

5. Conclusions

The reality of infrastructure deficit will persist in many developing economies because of the poor conceptualisation of projects, faulty execution methods, and corruption, resulting in abandoned projects. The many capital development projects, which would have made a significant impact on the lives of the citizens and improved the

economy have not been completed for functional use and so much money has been tied down or wasted. The synthesis of information from literature shows that many of the capital infrastructure projects in Africa were executed at considerable time overrun, several of them are at ridiculously low level of performance after many years and some have been abandoned completely, amplifying the challenges of infrastructure deficit.

This research demonstrated that the use of the concept of phase development and fragmentation in the execution of capital infrastructure development holds the potential of completing parts of the whole project within a reasonable time and making effective use of the project funds. The prospects of completing a typical construction project are higher when using the multi-contractor setting than in the single contractor scenario. The single contractors work at their own pace, but any contractor working as one among many, indirectly practices internal benchmarking and healthy competition with one another. Achieving the project timeline, schedule or milestone is very important in any construction project. Although contractors provide timelines during tender, many of them, especially the single contractors, do not follow through during construction. Depending on the procurement system adopted, the relationship between the PET members and the project sponsors or client, may influence the capability of the project manager to enforce compliance. However, the 'self-regulation' principle inherent in the multi-contractor approach assists the contractors to keep to their timelines. In addition, the steady progress achieved by the contractors allows them to draw proportionately from the project fund, ensuring that payments made are in line with the work progress, reduce the negative effects of inflation, and provide value for money.

As shown in the two projects used for this research, the phases identified for execution were completed within the time schedule, through the fragmentation of the phases into smaller lots where the contractors worked simultaneously. They achieved their individual timelines and ultimately the whole project was completed on schedule. The application of this concept, therefore, has the potential of reducing the occurrence of delays in the execution of construction projects, abandoned projects and ameliorates the effects of time and cost overrun. It thus allows a client to make judicious use of allocated or borrowed funds. This research recommends that the concept of phase development and fragmentation be adopted contextually for the execution of all infrastructure projects in the engineering and the built environment industry.

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