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The Influence of the Planning and Execution Mode on Effective Infrastructure Delivery

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Abstract

The twin principles of phase development and fragmentation, as execution models, have made a significant impact on effective infrastructure delivery. However, recent experience seems to negate these assertions. Therefore, this research aims to evaluate how these two principles were used in the execution of two identical road projects, named Project A and Project B, and the impact of the following four factors on their execution, namely, the practice of phase development and fragmentation, contractor selection, project planning and management as well as the project funding system. The principles of 'Content Analysis Study', a qualitative research strategy, were adopted as the research method. The findings revealed that Project A was successful in the factors evaluated and the chosen phase was completed within schedule. In contrast, Project B failed. This project initiated in 2006 was still a work in progress in 2023. The conclusion is that the purposive use of the principles and practice of phase development and fragmentation can facilitate effective project delivery.

Keywords

Fragmentation, Infrastructure delivery, Phase development, Project planning and management

1. Introduction

Developing infrastructure projects in phases is a practice as old as infrastructure development itself. It means taking a portion of the entire planned project for execution within a limited time frame. This tool has been used successfully to manage short-, medium and long-term infrastructure development plans, allowing steady progression in infrastructure development over time, according to priority and purposeful resource allocation (Graumann 2010). However, in recent years, although this age-long principle is still being used, it has left in its trail many unsavoury results, thus, increasing the incidence of delays, abandoned projects and infrastructure deficits (Ogbeifun et al. 2022). The failures being experienced in the use of this tool could be attributable to deficiencies in planning, promoting political correctness instead of pursuing a developmental programme, defective execution models, poor resource allocation and lack of continuity in governance. To ameliorate these deficiencies, it is reasonable to integrate the concept of fragmentation into the execution mode of the chosen phase. This concept suggests that the chosen phase should be contextually sub-divided into several lots or work packages of related components, functional sections,

services or specialisations (Ogbeifun and Pretorius 2022a). The contracts for each component and specialisation within each work package are awarded to purposively selected contractors; each contractor has direct contractual relationship with the client and a relationship with each other in the joint venture relationship (JV), through the instrument of a memorandum of understanding (MOU). This approach facilitates the timely completion of the projects within the chosen phase on schedule, within reasonable cost, and quality and achieves value for money (VFM) (Ruparathna and Hewage 2015).
This paper presents the objectives, the literature review, where strategic planning, the application of the principles of phase development and fragmentation, as well as the roles of contractors are evaluated. Next is the discussion on the research method, the results and discussions on the research findings, before drawing conclusions and closing with suggested recommendations.

1.1 Objectives

The focus of this research is to evaluate the impact of the four chosen factors (the practice of phase development and fragmentation, contractor selection, project planning and management as well as the project funding system) on the execution of two road infrastructure projects (referred to as Project A and Project B) that have used the principles of phase development and fragmentation during the execution of the projects.

2. Literature Review

Strategic or forward infrastructure planning must be comprehensive, incorporating the collective foresight and active participation of all relevant stakeholders (Ogbeifun 2016). It must ensure that the planned infrastructure is 'fit-for-purpose', allowing minor adjustments for adaptive reuse, changes in technology, services and the dynamic future. During the planning phase of any infrastructure, the content, components and project execution documents should be subjected to wide consultation with the relevant stakeholders (Weigand et al. 2014). The planning phase should adopt the integrative and contextual use of the principles of flexible design. The concept of flexibility in infrastructure development can be achieved through the practice of *flexible or probabilistic design* and adopting *horizontal or vertical* phase development during project execution (Hansen and Olsson 2011). This is synonymous with the use of a modular approach in infrastructure development. This principle was used for the development of the Court Square Two project, part of the Citigroup Campus in New York City, reported by Guma et al. (2009) and cited in Ogbeifun (2016). The project was designed as a 36-storey building to provide accommodation for more than 4 500 employees. During execution, the first 15-storey portion of the building was developed, accommodating about 1 800 employees. The subsequent phase included the horizontal expansion of the 15 original floors from 39 700 to 66 500 gross square feet and a vertical expansion of the building from 15 to 36 storeys (Ogbeifun 2016). Similarly, the concept of probabilistic design was used in the design of Addenbrooke's Hospital, Cambridge, UK. At the planning phase, a complete and detailed design was prepared for the proposed 1 000-bed hospital, with the possibility of expansion to a 1 200-bed capacity in the future. Adopting the principles of flexibility and phase development, the hospital management commenced development with a 700-bed space, with a contingency plan: "We will decide whether to expand the hospital or not in 5 years' time. If total growth in demand over these 5 years exceeds 10% then we expand to a total of 1 000 beds, if the growth exceeds 15% then we will increase to 1 200 beds. Otherwise, we will not expand" (De Neufville et al. 2008, p. 4). In adopting the principle of flexibility in design, the generic design usually should provide for extra capacity in the foundation, frame and construction process to allow for flexibility in adapting subsequent phases to meet current needs, changes in technical installations and adaptive use of space (Hansen and Olsson 2011). This approach can be used for the development of any infrastructure type.

Incorporating the practice of fragmentation into the execution of the chosen phases can enhance the pace of infrastructure delivery. In many developing economies, the common mode of project execution is the practice of bundling the different components and specialisation of a project into one project execution document and awarding it to a single contractor or its variant of main and sub-contractors (Akintan and Morledge 2013). The single contractor has no competitor, works with no sense of urgency, engages a limited number of project personnel, and provides excuses for low or lack of appropriate performance (Ogbeifun et al. 2022). Similarly, when the option of main and sub-contractors is used, the outcome of the project is influenced by the competency and relationship management between the main and sub-contractors (Akintan and Morledge 2013). Conversely, by adopting the practice of fragmentation, the chosen phase is sub-divided into several lots or work packages of related components, functional sections, services, or specialisations (Ogbeifun and Pretorius 2022a). The contracts for each component or specialisation, within each work package, are awarded to separate contractors, possibly in a joint venture (JV) relationship. Although independent, they maintain a relationship with each other through memorandums of

understanding (MOUs). This approach facilitates the timely completion of the projects on schedule, within reasonable cost, quality and achieves value for money (VFM) (Ruparathna and Hewage 2015).

The performance of any chosen contractor significantly influences the project's outcome. A positive outcome thus requires a painstaking selection process. To achieve this, a two-step approach can be adopted, first, through the pre-qualification of prospective contractors and secondly, by inviting pre-qualified contractors to tender for the infrastructure project (Jafari 2013). In the pre-qualification phase, the invitation information document should be comprehensive, detailed and tailored towards the characteristics and peculiarities of the proposed project. Further information required should include the synopsis of the project, the categories and specialisations of prospective contractors, with evidence of completed projects (Jafari 2013). This approach will assist in filtering the respondents, ensuring that the array of contractors to be selected is of similar capacity and capability. The invitation document should include a penalty clause for multiple applications from the same group, using different names. After pre-qualification, the shortlisted contractors are provided with the tender documents for bidding. The contractors' submissions go through the tender adjudication process, following the procurement criteria stipulated by the client, leading to the selection of the most suitable contractor(s) and not necessarily the lowest bidders (Deep et al. 2017). The selected contractors could be stand-alone organisations or members of a JV relationship (Mba and Agumba 2018). When this two-stage process of contractor selection is carefully followed, without prejudice, the process holds the potential of engaging quality contractors and guaranteeing effective project execution.

3. Methods

The case study strategy of qualitative research was adopted (Yin 2014). A case study research strategy requires an intensive, in-depth and purposive study of a small portion of a larger problem to understand the research scenario, to make sense out of the data collected, and to proffer solutions to the research questions (Gerring 2004). Since the two projects are older than ten years and had experienced several changes in their project execution team (PET) members, the data were obtained predominantly from project operation documents, the websites of organisations, newspaper publications and published articles. The data collected were analysed by adopting the principles of 'Content Analysis Study' (CAS), also known as qualitative document analysis (QDA). CAS can be described as a detailed and systematic examination of the contents of a group of related bodies of materials to identify patterns, themes, or biases on a specific research interest (Leedy and Ormrod, 2001). Similarly, QDA is a research method used for the rigorous, systematic evaluation of archived information in different (printed or electronic) formats (Bowen 2009). A typical CAS or QDA process includes finding, selecting, and identifying the areas of analysis, verification, appraising and synthesising data contained in documents (Bowen 2009). Essentially, CAS or QDA are more detailed and focused literature evaluations than the generic literature review. In this research, the focus of the document analysis is to identify how the four chosen factors for this research played out in the two projects.

The two identical road development projects used for this research are referred to as Project A and Project B. Project A is part of the Gauteng Freeway Improvement Project (GFIP) in South Africa, while Project B is part of the East-West Road network in Nigeria. The synthesis of information gleaned from the documents facilitated the understanding of the project dynamics, success or failure in the execution processes, and enabled the development of suitable themes for discussion. The details of the research results are presented hereafter.

4. Results

4.1 Project A: The South African Freeway Improvement Project in Gauteng

This road project is a portion of the Gauteng Freeway Improvement Project (GFIP), in South Africa, which involves the upgrade, rehabilitation and expansion of existing roads and auxiliary services of about 561 km of the national road network (Weidemann 2010). The execution of the associated projects spans four different phases, Phase A1, A2, B and C. In the generic plan of the GFIP, the execution of Phase A1 commenced in 2008 and was initially planned to be completed in 2010, but was extended to 2011. Other phases scheduled for execution were subject to the priorities of the government and the availability of funds. Furthermore, some of the work packages for Phase A1 were classified as priority projects essential for the hosting of the FIFA World Cup, in 2010. This group of projects includes work packages C & F, used for this research. The details of the project are shown in Table 1.

Table 1. Content of work packages

S/No	Work packages	Description
1		1. Work package C is a 23 km stretch of road, between the Buccleuch I/C and the Brakfontein I/C on the N1
		2. Work package F is a 17.6 km section of the highway between the Geldenhuys I/C and the Buccleuch I/C on the N3
		3. The construction of interchanges (I/C) at Buccleuch and Brakfontein; five interchanges at Allandale, New Road, Olifantsfontein, Samrand and Old Johannesburg Road; underpass at Woodmead, Maxwell Drive and Alexandra Avenue; overpass at Le Roux Avenue and Nellmapius Road; bridge widening at the Jukskei River
		4. The construction of additional lanes to the roads, upgrading and rehabilitation
2	Demolition	The demolition of the Geldenhuys and Buccleuch I/C on the N3 and I/C at Allandale

Phase A1 is about 185 km of the proposed freeway improvements, involving a substantial upgrade of the identified portions of road and interchange (I/C) modifications on the N1 and N3, sections of the N12 and the R21 road network (Weidemann 2010). This phase was sub-divided into fourteen work packages, using the principle of fragmentation. They were awarded to fourteen different contractors, specialists and JV organisations, as shown in Table 2.

Table 2. 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 & Power Group	Upgrade of the R21 sections 1 & 2
7	Tosas	Subcontractor for bituminous binders
8	ETC JV	Multilane free-flow tolling system
9	Jet Demolition	Demolition of Allandale I/C bridge
10	ARQ Consulting Engineers	Design of the Lynnwood Glen pedestrian and pipe bridge
11	Cadcon - subcontractor of BRCD JV	Manufacture of the Lynnwood Glen pedestrian and pipe bridge
12	Beka	Luminaires
13	Esorfranki Civils	Work package J
14	Goba SSI JV Partners	Construction of Gillooly's flyover
		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.

Furthermore, some of the work packages linked to the successful hosting of the 2010 FIFA World Cup were given extra attention. One such portion of the project was the Ben Schoeman Freeway, work packages C and F, sub-divided into five lots. The first four Lots were awarded to four different contractors in a JV relationship and the fifth Lot was awarded to a specialist contractor, as shown in Table 3 (Ogbeifun and Pretorius 2022a).

Table 3. Details of each contractor

S/No	The contractors for work packages C&F	Areas of specialisation
1	Grinaker-LTA Construction and Development Ltd, (Work Package C)	Civil Engineering, Road and Pipelines
2	Aveng Africa (Pty) Ltd (Bridges, Off- and On-ramps and construction of interchanges)	Civil Engineering Contractors
3	Mosme Road Construction (Pty) Ltd (Work package F)	Highway, street, and Bridge construction
4.	Boitshoko Road Surfacing (Work packages C & F)	Road Surfacing
5	Jet Demolitions (Pty) Ltd (Demolition of all interchanges in work packages C&F)	Specialist in Demolitions

The records of the project execution show that all the projects identified for completion before the commencement of the 2010 World Cup were accomplished. Similarly, all the projects in Phase A1 were completed by the 2011 scheduled date (Ogbeifun and Pretorius 2022b). In summary, this feat was achieved through:

(1) The implementation of the purposive phase and fragmentation practice
(2) The selection of competent contractors
(3) Detailed project planning and management, as well as
(4) Adequate funding

4.2 Project B: The East-West Road Project in Nigeria

The East-West Road project in Nigeria is a 731 km stretch of road along the coastal region of Nigeria, from Lagos to Calabar, through Warri and Port Harcourt (Olubomehin 2015). The project was divided into two phases, namely Phase 1: Warri, in Delta State to Oron, in Cross-river State. Phase 2 was from Warri to Lagos, in Lagos State. The documentation (Otobo 2017) indicated that the first phase, a 348 km section of the road from Warri to Oron, was sub-divided into four sections, namely:

(1) Section I – Warri to Kaiama: 87 km.
(2) Section II – Kaiama to Port Harcourt (Onne Junction): 101 km.
(3) Section III – Port Harcourt (Onne Junction) to Eket: 100 km.
(4) Section IV – Eket to Oron: 60 km.

This phase traversed through difficult terrain and can be described as a long path across the many tributaries of the River Niger and River Nun, with forty-three new bridges spanning between 31 to 850 m (Otobo 2017). The environment allows for a very short period of construction each year due to the long rainy season. The decision to execute the construction phase of this project was communicated to the pre-construction team in April 2006. To meet the required Presidential deadline, the supervising Ministry decided to adopt the procedure of selective tender, by inviting five contractors who have worked on road projects in the area and were familiar with the terrain (Otobo 2017). They were:

(1) Messrs Setraco Nigeria Limited
(2) Messrs Dantata & Sawoe Construction Company (Nigeria) Ltd
(3) Messrs Julius Berger Nigeria Plc
(4) Messrs P. W. Nigeria Limited
(5) Messrs Stemco Nigeria Limited

Similarly, Messrs Guy Otobo & Partners Ltd was appointed as the coordinating consultant or project manager for the pre-construction phase (Otobo 2017). Unfortunately, when the contracts for the construction phase were awarded, the coordinating consultant and some of the consultants were side-lined and the contracts were awarded to new entrants. Although the initial designed cost of the project was N277 billion, the project was awarded in 2006 at the cost of N138 billion (Otobo 2017). The justification for this reduction, where and what this fund was expected to achieve, was not explained. Therefore, the available funds were spread thinly across the four sections of the project, without any tangible impacts. Successive administrations have used this project as political bait, by making tacit commitments to

continuing with this project and made different budgetary allocations. Unfortunately, this project that commenced in 2006 was still a work in progress in October 2023.

Reflecting on the information gleaned from the archives for the project execution and the factors evaluated in this research, the evidence from this project can be summarised as follows:

(1) The poor conceptualisation of the project and mode of execution
(2) An abridged method of contractor selection
(3) Inadequate project planning and project management
(4) Inadequate funding

5. Discussion

Table 4 presents the synthesis of information gleaned from the two projects and the developed themes for discussion.

Table 4. Comparative relationships

S/No	Project A	Project B	Suitable themes
1	The implementation of the purposive phase and fragmentation practice	The poor conceptualisation of the project and mode of execution	Purposive phase development and fragmentation
2	Selection of quality contractors	Abridged contractors' selection method	Quality contractors
3	Detailed project planning and management	Inadequate project planning and project management	Project planning and management
4	Adequate funding	Inadequate funding	Project funding

5.1 Purposive Phase Development and Fragmentation

The practice of phase development has been used effectively for executing different infrastructure types over the centuries. In the building industry, two different variants of phase development have been used, namely flexible design or probabilistic phasing, as well as vertical and horizontal phasing. The concept of flexible design or probabilistic phasing was used in the design and development of the Court Square Two project, by designing the full complement of a 36-storey building and executing the project in phases. The first phase of 15 storeys was developed. Progressively, through the practice of horizontal and vertical phasing, the full capacity of the 36-storeys building was accomplished (Ogbeifun 2016).

The continuity or lack of it in governance, critically influences the success or failure in the execution of planned infrastructure projects. During the two-term period of the Obasanjo administration, many national road projects were initiated and completed, which includes the expansion of the initial single lane Lagos-Abeokuta Road into an expressway (2001-2008). Similarly, the 25km of Itigidi Bridge and approach roads, along Aba-Omega-Itigidi-Ediba-Ugep road, in cross River State, commenced in April 2003 and commissioned in 2006. Within the same period, the 50km Abuja-Nyanya-Keffi road was completed in 2006, to name a few (Olubomehin, 2015). However, the Ibadan-Ilorin Road (part of the development of the Lagos-Kano expansion project), which started in 2003, was yet to be completed as of 2013, due to lack of commitment from succeeding administrations (Olubomehin 2015). As observed by Ubani and Ononuju, (2013), when there are changes in government leadership or political affiliations, many on-going public sector civil engineering projects of previous governments may be suspended, neglected, or flagrantly abandoned, without considering the importance's of such projects to national development. That was the bane of the East-West Road project, started in 2006 and still work in progress in 2023. Nevertheless, there are few exceptions. An example, the Lagos State government, between 1999 and 2007, initiated the idea of expanding the Lagos-Badagry expressway, constructed between 1972 and 1974. However, the succeeding administration (2007-2011), kick-started the first phase of the project measuring 7.3 kilometres, between Eric Moore Road and Mile Two in Lagos in 2007. This chosen phase of the project was completed within the first term of four years of the administration, including the light rail facility in the middle of the road (Olubomehin 2015).

Interestingly, Project A, used for this research, made provision for all the routes, parts and generic designs for the GFIP projects from the beginning (Weidemann 2010). During execution, the principles of probabilistic phasing were adopted, with the phrase 'other phases will be executed, depending on the priority of the government and financial

feasibility'. Therefore, the execution of Phase A1, which commenced in 2008 was completed by 2011, including the exigent projects associated with the 2010 FIFA World Cup (Weidemann, 2010).

In contrast, although the concept of phase development was incorporated into the planning, project documentation and execution of Project B, there were observable lapses in the exercise, which included:

(1) The phase chosen for execution was too large for the available funds.
(2) There were deficiencies in planning, project management and resource allocation.
(3) The abrupt change and selection of project execution team (PET) members introduced remarkable disruptions to the project.
(4) Due to the lack of continuity of governance, successive administrations have not demonstrated the required political will to ensure the functional conclusion of the road project.

It is imperative to note that success in the practice of phase development requires that the phase to be executed must be chosen purposively; it must be a functional whole suitable for immediate execution and commensurate with the available resources (fund, capacity and capability). Equally important is the quality of contractors chosen for the execution of the construction phase of any infrastructure project.

5.2 Quality of Contractors

The capacity and capability of contractors significantly influences the overall project execution and the effectiveness of project delivery. Okereke et al. (2022) observed that majority of the construction projects, especially, in developing countries often fail to meet the project 'iron triangle' (time, cost, quality), due to the neglect of adopting suitable contractors' selection criteria during the bidding processes. The authors recommended five critical clusters of criteria, namely, managerial capability and competent supervisory staff; technical ability; financial soundness; competitive tender/bid price; and health and safety policy/performance. The import of adopting suitable criteria during the selection of contractors, include but are not limited to; enabling the client to engage competent contractors for the execution of the proposed project, facilitating the achievement of project objectives and achieving the 'iron triangle' of time, cost and quality, minimising project risks and maximizing overall value to the project. As well as effective use of project fund to achieve value for money (VFM) and mitigate the negative effects of inflation, delay, or abandonment of project.

The prospect of achieving the import of the 'iron triangle' is increased by using multiple contractors as against the concept of a single contractor, during the construction phase (Akintan and Morledge 2013; Ruparathna and Hewage 2015). Multiple contractors on a project create a scenario of a collaborative relationship, which encourages greater integration of all the project participants, allowing them to work as a team, sharing practice knowledge, risks and resources, leading to improved project performance, ensuring effective and timely project delivery, with the prospect of reduced cost, without compromise on quality (Hong and Chan 2014). To ensure success in the collaborative relationship, the parties involved must integrate both formal and informal measures throughout the relational process, which include adherence to the relevant contractual clauses, structure, procedures, decision-making process, effective communication, commitment to achieving overall project objectives, respect for each of the participating members, transparency and accountability, as well as trust (Mba and Agumba 2018). Construction projects executed through collaborative relationship models, of multiple interdependent contractors, hold the potential to achieve higher performance levels than projects managed through a single contractors' system. This is evident as technical performance, delivering each work package and the whole project on schedule, client satisfaction, cost control, and budget leftovers are respected (Ogbeifun et al. 2018). It also holds the potential to achieve higher performance levels than projects managed through a single contractors' system (Akintan and Morledge 2013; Hong and Chan 2014). This is evident in the execution of Project A, that used to concept of multiple interdependent contractors, as opposed to the use of the concept of a single contractor which complicated the execution of Project B. The effectiveness of infrastructure project delivery is influenced by the quality of project planning and the management of the execution phase.

5.3 Project Planning and Management

Delay in the effective completion of construction projects is the inability to deliver the proposed infrastructure within the scheduled delivery dates. Delay is a construction project challenge globally, with higher degree of intensity in developing countries. Zidane and Anderson, (2018), identified the top 10 universal delay factors as: "design changes during construction/change orders; delays in payment of contractor(s); poor planning and scheduling; poor site management and supervision; incomplete or improper design; inadequate contractor experience/building methods and approaches; contractor's financial difficulties; sponsor/owner/client's financial difficulties; resources shortage (human

resources, machinery, equipment); and poor labour productivity and shortage of skills" (Zidane and Anderson, 2018, p.650) The most effective method to minimize delays in road construction projects, is the choice of a project manager with sufficient knowledge and experience relevant to project management (Ondari and Gekara, 2013;
Khair, et al., 2016).
Odeh and Battaineh, (2002) report on 28 highway projects constructed during the period 1996-1999 in Jordan and found "that the average ratio of actual completion time to the planned contract duration is 160.5% for road works" (Battaineh, 2006, p.2). The causes of delay on road development varies, from management support to design specifications, contractor's capacity, and supervision capacity (Odeh and Battaineh, 2002). In the context of this paper, supervision capacity and project management can be assumed as identical. Thus, the success in the execution of any road development project hinges on the effectiveness of the project managers (PM), during the planning and execution phases. A generic list of project managers' competences required for effective management of infrastructure development projects, especially road development should include technical skills, work experience and the ability of information technology application. Others are professional skills, human skills, key managerial competences (i.e., procurement management, risk management and site management), organizational skills and the soft skill of effective communication (Zheng and Qianh, 2022).

The diligence exercised during the project planning phase and the project management skills during project execution significantly influence the success of any infrastructure delivery. The planning phase requires details, thoroughness and comprehensive documentation of the project concept, feasibility studies, stakeholders' involvement, design, funding policy, risk management, project execution process and selection of PET members (Ramanayaka et al. 2020; Wembe 2021). It is worthy of note that ineffective project planning, design, technical feasibility studies and poor monitoring and control of project progress during the implementation phase are instrumental to the failure and abandonment of many public sector civil engineering projects (Ubani and Ononuju, 2013). Unfortunately, during the planning phase of many public infrastructure developments, the sponsors or clients seem to be in a hurry, especially for political reasons. They in turn exert untold pressure on the professionals saddled with the responsibilities of developing the infrastructure framework. In many instances, the resulting project documents are poorly developed (Rahat et al. 2022). However, when due diligence is exercised during the planning phase, suitable project execution documents, execution process, project measurement and control systems are developed, these enhances the effective delivery of the planned project (Ghanbaripour et al. 2020). As demonstrated in the two projects under reference, it is evident that there was adequate planning exhibited in Project A. The phase to be executed was well thought out, and details of the components in each part of the packages were developed for execution. On the other hand, the directive to develop the project documents for Project B, was given in April 2006 and approval for the execution was concluded in May 2006, and initial critical PET members were replaced with new entrants. This suggests that the project documents (design drawings, bill of quantities, specification, cost and time schedule, and contractor selection process) were grossly inadequate for the scope of the project. According to Emujakpore (2012), the failures on the East-West Road project were the result of a combination of factors, including faulty design, the low capability of contractors and poor project management skills of the PET members. However, to achieve success in infrastructure delivery, project planning and project management should include a suitable funding policy.

5.4 Project Funding

A Project fund is the total amount of money set aside for the execution of an infrastructure project. This may include expenditures from planning, through execution to commissioning, or be limited to the project execution phase only. This fund may be available in total before the commencement of the project or progressively deployed, from periodic budgetary allocations, throughout the life of the project. Project funds can be generated from different sources, including loan facilities and budgetary provisions (Ncube 2013). The success in infrastructure development is significantly influenced by the project fund, availability and management (Ogbeifun and Pretorius 2022a). To achieve VFM, the project production progress should be maintained, so that the planned project is executed within schedule, and reduces the negative effects of inflation and fluctuating exchange rates (Ogbeifun and Pretorius 2022b).

The budgetary allocation for road development, in many developing economies are not reliable. In Nigeria, the budget for road developments assumed a downward trend from the mid-1980s and became epileptic at the turn of this millilumen. In 2011, it was estimated that the government needed about N3.3 trillion to complete the Federal roads being constructed across the country (Olubomehin, 2015). The situation has not improved in the periods beyond 2011. Unfortunately, although many civil engineering projects are still being initiated, they are based on political reasons more than developmental needs. The funds released for majority of the on-going and new projects are used to only start up the projects and settle political financiers rather than executing the projects (Ubani and Ononuju, 2013). Three

practical approaches could help to ameliorate the incessant cases of failure and abandonment of public sector civil engineering projects. They are: Appropriate legislation that would guarantee the continuity of governance, compelling succeeding administrations to continue the on-going civil engineering projects, at the original site, irrespective of who is concerned when power changes hand from one political party or person to another. Secondly, honouring of payment certificates of completed works, as and when due to enhance contractors cash flow and ensure regular progress of the work with little or no delay (Ubani and Ononuju, 2013). Thirdly, adopt the practice of phase development and fragmentation, according to the available funds (Ogbeifun and Pretorius 2022a).

The amount that can be drawn from the project funds periodically, depends on the production of the contractor(s), as reflected in the project's certificates. Furthermore, adopting the multiple contractor concept holds the potential of increased production and effective use of project funds, compared to the single contractor concept (Weidemann 2010; Olubomehin, 2015). As demonstrated in this research, Project A was completed within the scheduled time and cost limit, thus enabling the client to achieve VFM. On the contrary, Project B is still a work in progress, requiring continuous bailout funds.

6. Conclusion

The focus of this paper was to explore how the integration of the concept of phase development and fragmentation into the planning and execution of infrastructure projects impacts on the effectiveness of project delivery. Four common factors were evaluated in the execution of two identical road projects, one in South Africa and the other in Nigeria. The factors evaluated are the practice of phase development and fragmentation, contractor selection, project planning and management as well as the project funding system. The case study strategy of qualitative research was adopted, using the instrument of content analysis study to unearth the information in the projects' archives. The synthesis of the information gathered enabled the researchers to understand the successes and challenges of the project and develop suitable themes for discussion. The research revealed that Project A was successful because the project planners and sponsors adopted the practice of 'contextual' phase development. The chosen phase was commensurate to the available funds; fragmented into smaller work packages, engaged suitably qualified contractors and an effective project management team. Project A was completed within schedule and at a reasonable cost. In contrast, the failures of Project B are the glaring lack of adequate planning, poorly defined phases, use of a single contractor, poor quality of work, low financial resources and a lack of continuity of governance.

In a nutshell, when the principle and practice of purposive phase development and fragmentation is adopted in the development of capital infrastructure, it facilitates the use of quality multiple contractors, and the different components of the work are executed seamlessly and strategically coordinated, to achieve the objectives of the project. The result obtained using this concept in the execution of Project A is like the results obtained in an earlier research effort by Ogbeifun et al. (2018) on a building project.

In conclusion, this research clearly shows that adopting the principles and practice of purposive phase development and fragmentation facilitates effective infrastructure delivery. Therefore, this research recommends that the concept of purposive phase and fragmentation should be adopted in the planning and execution of all infrastructure types.

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