

INFRASTRUCTURE DEVELOPMENT: IMPROVING ON EXECUTION SYSTEMS

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ABSTRACT

The use of the traditional procurement system for the execution of capital construction projects has been subjected to different levels of criticism. Despite this, it is still the method most commonly used for the execution of capital development projects in the public and private sectors in many developing countries. Some of the most prominent criticisms include cost and time overruns, the inability to fast-track the completion of capital projects, huge human capacity in the client and project execution teams and the process being exposed to different levels of dispute adjudication. Nevertheless, these shortcomings can be ameliorated through the pragmatic use of the concept of phased development and the fragmentation of megaprojects into smaller lots for ease of execution. This concept encourages the use of multiple project execution teams, facilitates the simultaneous execution of the different lots and creates an internal drive for healthy competition among project execution teams. This would result in the effective delivery of megaprojects with the possibility of time and cost savings. The exploratory method of qualitative research was adopted in the study of a megaproject, which was fragmented into smaller lots and executed in a higher education institution in Nigeria. The findings reveal that the mega project was executed within the time schedule and with a significant cost saving. Therefore, making contextual improvements in the traditional procurement system and mode of executing mega projects can enhance effective project delivery devoid of the setbacks associated with the traditional procurement system.

Keywords: Capital development projects; Cost and time overrun; Criticisms; Fragmentation; Healthy competition; Traditional procurement system.

1. INTRODUCTION

The governments of the different African nations have developed laudable plans for infrastructure improvements in their countries, yet the basic infrastructure is still in short supply, commonly referred to as their 'infrastructure deficit'. Several authors have explored the issue of the infrastructure deficit in Africa by identifying what they consider as the root causes – the challenges posed to the economic development of the African region – and in many instances, attempts have been made to proffer solutions to the infrastructure problem (Mbaku, 2013; Akhalumeh & Ohiokha, 2013; Ncube, 2013). Infrastructure is a wide subject

with varied definitions. The working definition and area of concern in this paper is that infrastructure is the physical asset which provides comfort and enhances productivity in the workplace; allows the ease of physical movement of people, goods and services from one location to another; enhances communication and provides systems which enhance the health and environmental comfort of communities. Some of these assets are houses, transportation systems, water and waste-water systems and telecommunication systems, to mention a few. This paper will only draw attention to building infrastructure.

In an attempt to propose solutions for the issue of the infrastructure deficit, this paper seeks to address two issues, namely the lack of continuity in governments in Africa and the use of an ineffective project execution model. Several infrastructure developments plan of the different governments of African nations span a long-time frame, usually more than the political life of the government that planned the infrastructure scheme. Actual execution may start and achieve different levels of completion during the tenure of the government that initiated the infrastructure project, but very few are completed and put to functional use (Mitullah *et al.*, 2016; Ogwu, 2016; Zarewa *et al.*, 2018). At the change of administration, many of these uncompleted projects are abandoned. The new administration repeats the circle of its predecessors and develops another set of infrastructure plan which will suffer a similar fate as the ones developed by their predecessors. In effect, numerous uncompleted projects dot the landscape of the African continent. If these projects had been completed, they would have contributed significantly to reducing the infrastructure deficit being experienced in Africa (Mitullah *et al.*, 2016; Ogwu, 2016). It is worth noting that the funds for the majority of these projects were borrowed (Mbaku, 2013) and successive governments are compelled to repay these loans for inactive projects, which further deplete the resources available for the development of other necessary infrastructure.

The deficiencies in planning become obvious and are amplified during construction. Some common characteristics of the majority of the abandoned projects (although some of them can be aptly referred to as 'white elephant' projects) are that they are gigantic. The different elements of the project were started simultaneously with limited funds and huge sums of money were paid beyond the level of project completion. Progress was hampered by overzealous civil servants or political elites and undue control of some donor or financing agencies. The combination of these factors influences the progression during the execution phase of any infrastructure development. However, the story would be different if the actors in both the planning and execution phases adopted the concept of a modular or phased development and instituted the fragmentation of megaprojects into smaller lots for ease of execution. Each module or phase completed is put to use and the lessons learnt during operations are incorporated into implementing subsequent phases. In the same vein, when projects are funded from external loans, phased development allows the project to progressively re-finance itself (Effiom & Ubi, 2016; Adukpo & Leiringer, 2016). Likewise, projects funded from loans, when fragmented into smaller lots for execution, hold the potential of completion of the mega project within a reasonable period and with possible cost savings.

The aim of this paper is to demonstrate how the fragmentation of a mega building project led to fast-tracking the execution, timely completion and savings in the cost of executing the project. The saving was then used for landscaping the project environment. The outline of this paper commences with a literature review to provide a theoretical foundation from existing research on how to ameliorate the menace of infrastructure deficit through appropriate project governance. The third section explores the research approach, which is a single case study and exploratory method of qualitative research. Section four

provides information on the research findings and the discussion. The fifth section provides a conclusion based on the research finding and makes appropriate recommendations.

2. LITERATURE REVIEW

This section provides information on the causes of the infrastructure deficit and possible remedies, the importance of project governance and the dynamic use of the appropriate procurement instrument.

2.1 The question of infrastructure deficit

The concern about understanding the question of the infrastructure deficit in Africa should start with exploring the root causes of this phenomenon and then identify ways of ameliorating it. Mbaku (2013) cited two African countries with laudable long-term infrastructure projects. One is represented by the Kenyan government's desire to link South Sudan to Northern Kenya to develop that corridor and specifically expand business activities in the Lamu port. These projects were estimated to cost \$25 billion. Similarly, the South African government proposed to spend \$97 billion on infrastructure upgrades. In an attempt to execute the infrastructure upgrade, the government in 2010 introduced the Infrastructure Delivery Management System (IDMS) as a way of accelerating infrastructure delivery. The IDMS encapsulates a system for planning, budgeting, procurement, delivery, maintenance, operation, monitoring and evaluation of infrastructure. It is a toolkit of interrelated or interacting elements that establish processes which transform inputs into outputs (National Treasury, 2012).

One common denominator of these two proposals was that the funds for the proposed infrastructure were to be borrowed. This is a common feature in most African countries. It is worth noting that the execution of these projects will span many years, possibly longer than the political life of the governments that are initiating these projects. If these projects are not completed during the electoral term of the government that initiated them, the question arises if successive governments will continue from where their predecessors stopped. If these questions are not addressed, the incomplete projects will increase the existing frustration emanating from the infrastructure deficit. However, if the incumbent governments are diligent in their planning, follow through with the implementation phases, commit the designated funds judiciously, create functional institutions and structures for effective project execution, these will ameliorate the excesses of overzealous civil servants and political elites and reduce the incidence of infrastructure deficit on the continent (Mbaku, 2013; Effiom & Ubi, 2016).

The twin problems affecting the successful execution of planned infrastructure projects are ineffective execution models and a lack of continuity in governance. Effiom and Ubi (2016) cited the incidence of the 338 km road, commonly referred to as the 'east-west' road network, in Nigeria. This project was initiated during the military era in the early 1990s and was still not completed by 2016. If each successive government had embraced the concept of continuity in governance and executed a portion of this major project during their tenure, the road network would have been completed, functional and reduced the menace of infrastructure deficit. The incidence of infrastructure deficit will remain with us until we are ready to address some of the identified constraints. These constraints include deficiencies in planning, institutional inefficiencies and regulatory bottlenecks, 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 maintenance of existing assets (Ncube, 2013; Akhalumeh & Ohiokha, 2013). It is sad to note that finance is a major constraint in Africa's quest for infrastructure development despite

the rich natural endowment of the region. If our natural resources are harnessed effectively and the infrastructure development schemes are thoughtfully planned and executed, we have the potential of financing more infrastructure projects with relative ease (Ncube, 2013; Effiom & Ubi, 2016). Addressing the infrastructure deficit requires a commitment to effective planning, adequate client project governance, a functional execution model, continuity in governance and the judicious use of the available resources (Brady & Davis, 2010; Adukpo & Leiringer, 2014).

2.2 The importance of project governance and procurement systems

The success or failure of any infrastructure project can be linked to the nature of the project governance. Project governance, in this paper, will be limited to the daily project administrative style and the procurement tool for executing the project. Two common project governance approaches adopted during the execution of infrastructure projects are where the lead consultant doubles as project manager (PM) or where a project manager (PM) or project managing organisation (PMO), independent of any consultant participating in the project, is engaged to coordinate the execution of the project (Love *et al.*, 1998; Iyer & Banerjee, 2016). Some of the inherent weaknesses in the former approach are that the consultants tend to drag out the project for longer than necessary for their personal benefit. Then, when the PM is required to adjudicate in any site dispute that affects his discipline, he will be serving as a judge in his own case. Such a situation may introduce some level of bias. Conversely, if the PM or PMO is independent of other consultants, this approach has the potential of driving the project to achieve its timeline, thus reducing the probability of time and cost overruns (Love *et al.*, 1998; Iyer & Banerjee, 2016). However, the procurement system and the variant adopted can influence the project governance system (Muhammad *et al.*, 2015). The following paragraphs will concentrate on the traditional procurement instrument for executing capital infrastructure projects and the suggested improvement in the existing system.

The traditional method of contract procurement can be described as the process where the three phases of design, bid and build are treated as separate tasks (Babatunde *et al.*, 2010). In managing the three separate phases, there is a fourth dimension which plays a mediating role: the client. Adopting the traditional procurement system requires an adequate quantity and quality of human capacity in every phase of the capital project, in both the client and project execution teams (Escamilla & Ostadalimakhmalbaf, 2016). The fragmentation of the capital development process into three mutually exclusive components sometimes contributes to problems of effective communication and coordination during project execution resulting in conflict between the client, consultants and contractors (Ojo *et al.*, 2006). During the execution of the construction project, the mega project is usually awarded to a single contractor. Due to the complexity of the project and obstacles encountered during execution, the project takes longer than planned to result in time and cost overruns.

The proposed improvement on the traditional system being suggested in this research is the use of the concept of fragmenting mega infrastructure projects into smaller lots for ease of execution. Doing so enhances the possibility of fast-tracking the execution of the mega-project within record time and preventing cost overruns. In this regard, multiple project execution teams, especially contractors, will be engaged in the execution of the project. The respective contractors will adopt the self-regulatory principle (Bogsens, 2014) in the execution of their portion of the project, resulting in healthy competition, desiring to perform at their best among their peers, thus indirectly benchmarking their operations (Iyer & Banerjee, 2016; Ayodeji *et al.*, 2017). Although

multiple contractors are engaged in the project execution, the different lots are administered using identical contractual conditions for all participating contractors.

Literature is awash with the shortcomings of the traditional procurement system, citing a higher unit cost of construction, slower delivery speed and the huge cost of project administration in terms of human capacity, logistics and management of interests (Ogunsanmi, 2015). However, the research effort of Ojo *et al.* (2006) reveals that time and cost overruns are not the same across the board, but relative to the project cost threshold. The authors identified four groups of cost threshold: 0-1 million naira; 1-5 million naira; 5-10 million naira and 10-100 million naira. The projects within the second threshold (1-5 million naira), incurred a lower time overrun of 18.98%, while the projects in the fourth threshold (10-100 million naira), attracted the least cost overrun at 9.13%. Therefore, it may be safe to suggest that fragmenting capital development projects into smaller lots in the fourth threshold might assist in the effective management of such projects within specified cost limits including the possibility of achieving time savings as well.

Majority of the literature reviewed identified some of the root causes of the infrastructure deficit in Africa, but very few identified project governances as a possible solution. The focus of this paper is to demonstrate how the effective execution (governance) of a mega capital project can reduce the net infrastructure deficit in an organisation, country and Africa as a whole.

3. RESEARCH METHOD

The single case study and exploratory method of qualitative research were adopted. The case study method is seen and employed as a research strategy dealing with specific issues. It allows intense observation, provides opportunities to study different aspects, puts each part in relation to the environment where it operates and tasks the creativity of the researcher to provide a 'voice to the voiceless' (Braun & Clarke, 2006). This method is useful when a holistic, in-depth investigation is needed (Green & Thorogood, 2009). The population was the three clusters of stakeholders on the construction project namely the client, consultants and contractors. However, the sample was limited to the project execution team leader, representing the client; the project architect who also doubled as the project manager representing the consultants; and two site project managers representing the contractors. The data collection tools include interviews, the evaluation of minutes of site meetings, site instruction notes and the payment certificates. To ensure the validity of information in qualitative research, be it a single or multiple site case studies, the information from any one of the clusters of respondents should be correlated with the response from the other stakeholders, by adopting the principle of triangulation (Yin, 2013; Turner *et al.*, 2015). The interview questions were designed in such a way that each cluster responded to identical questions. The data was analysed by adopting the principle of content analysis of interview records (Hsieh & Shannon, 2005). The sample questions used in the interview guide, titled "Research questions on project administration/governance" is as follows:

Research questions on project administration/governance

An open-ended question on project administration was used to elicit information from the client representative, consultant architect - who also doubled as project manager and two site project managers who represented the contractors. Excerpts from their responses are included in the research findings and discussion section.

4. FINDINGS AND DISCUSSIONS

This section provides information on the project used for this research, how the concept of phased development and fragmentation of a megaproject into smaller lots was adopted. Section 4.1 provides a background to the project, section 4.2 is concerned with the project timeline, section 4.3 presents stakeholders' opinions and section 4.4 concludes this section with a general discussion.

4.1 The background to the project

The project, which is the subject of this research, is part of the facilities designed for the Faculty of Environmental Sciences' complex. Based on available funds, the client and project manager decided to adopt the principle of phased development and fragmentation of megaprojects into smaller lots. In this regard, a functional portion of the complex was earmarked for execution. The funding for this project came from the 2013 Presidential NEEDS Assessment Intervention, of the Nigerian government. One of its conditions was that all approved projects, in an intervention year, must be completed within twelve calendar months before the institution can access a financial allocation for subsequent intervention years. The portion earmarked for execution was sub-divided into lots according to functional services and along the expansion joints, for ease of execution. The details are shown in Table 1.

Table 1. The construction of the Inner Ring Segment, Faculty of Environmental Sciences divided into smaller lots

Lots	Time (Months)		Cost (Million Naira)	
	Estimate	Actual	Estimate	Actual
Lot 1 - Block 28: A 2-storey block consisting of male and female toilets/conveniences for utilization by blocks 29, 32 and 33, among other existing facilities	3	All projects were completed within schedule	51.5	49.8
Lot 2 - Block 29: A 2-storey block that houses some staff offices	4		53	40
Lot 3 - Block 32: A 2-storey structure that houses studios, classrooms and offices	8		242	241.7
Lot 4 - Block 33: A 2-storey structure that houses exhibition rooms and studios	9		119.5	118.9
Lot 5 - Block 47A: A 2-storey structure that houses exhibition rooms and studios	5		39.3	35.3
Lot 6 - Block 49: A single-storey structure, which houses the conveniences and the staircase linking other existing and adjoining facilities	6		46	43
Lot 7 - Block 50: A single-storey block that houses some senior staff offices, boardrooms and seminar rooms	6		58.3	58.2
Total	9		609.4	586.9

In a typical traditionally procured contract, the clauses for a lump sum and contingency items are generally administered with less satisfaction and is in most cases abused. These clauses were contained in the conditions of the contract for each lot. In this project, like others, the lump sum items provided a generic amount of money, but actual payment was made for the measured work executed. Since all the lots were executed within a short time frame, there were minimal claims for fluctuations and limited expenditure charged to the contingency fund. The judicious administration of these clauses (lump sum and contingencies) led to

considerable savings in the project, as shown in Table 1. An interesting fact in this project is that each contractor established his own completion time within the generic period provided by the client. With this, each contractor was self-motivated to deliver on his promise.

4.2 The project timeline

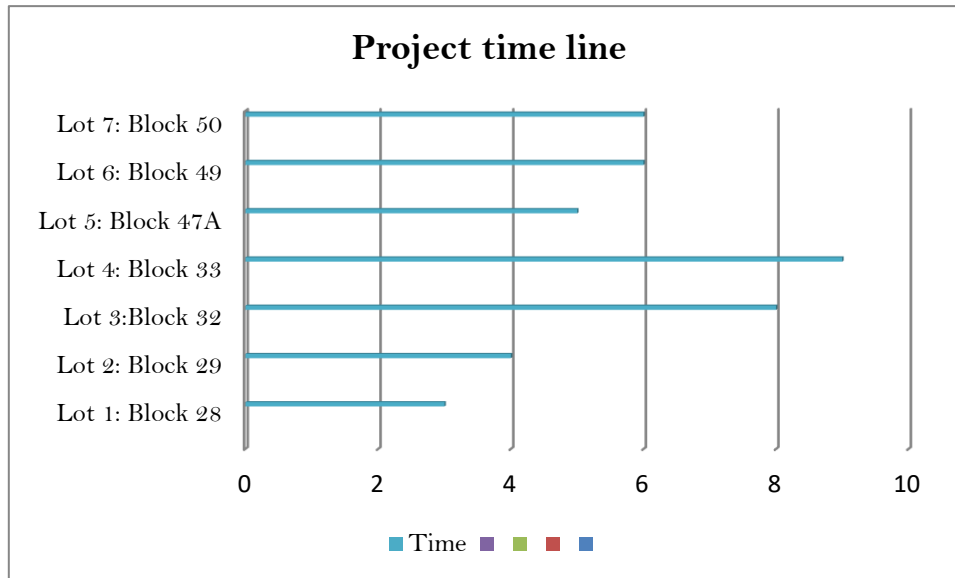


Figure 1. Project timeline

At the time of the tender, each contractor was requested to provide his project execution timeline, within the generic provision that the project was expected to be completed within ten calendar months. An additional two months were provided as a float to cater for any unforeseen delays and to still be able to meet the deadline stipulated by the funding agency. The summary of the project timeline for the different lots in the project is as shown in Figure 1. The timeline was used to monitor the progress and productivity of each contractor.

At the inception of the project, general site meetings were held every two weeks for the first two months. Thereafter, the site meetings were held monthly, as is evident from the minutes of the site meetings. All contractors demonstrated their commitment to the project and were up to date with their time schedules. All contractors achieved practical completion within their project timelines.

4.3 Stakeholders' opinions

The sample of the stakeholders whose opinions are reflected in this paper includes the project execution team of the client, the consultant architect who also doubled as the project manager (PM) and two project managers representing the contractors that participated in the execution of the project.

4.3.1 Client representative

A chief architect in the Directorate of Physical Facilities served as the team leader of the client's project execution team. The team's functions included monitoring the quality assurance, day-to-day project administration and reporting to the funding agency. The Directorate mooted the idea of a phased development in order to effectively use available

funds to deliver a complete and functional facility for academic operation. The concept of fragmentation served two purposes: firstly, to complete the project within a short period of time and secondly to create an atmosphere which encourages self-regulation, allowing the contractors to be an integral part of the project governance. Implementing the fragmentation concept helped in achieving these two objectives. Compared to other mega projects executed through a single contractor, the team leader stated: “Although managing many contractors at the same had its challenges, the benefits outweighed the difficulties”.

4.3.2 The consultant architect

The consultant architect and PM agreed with the client’s representative that managing many contractors on the same project had its challenges. They included dealing with the complaints or requests of many contractors instead of dealing with one organisation, managing the human dynamics of individuals, and raising payment certificates for multiple contractors, just to mention a few. However, the client representative and the PM outlined the advantages of using multiple contractors in the following points:

1. Using the cooperation of some contractors to moderate the excesses of others.
2. Healthy competition and benchmarking between contractors led to quality services with limited areas of dispute.
3. The mega project was executed within a short period of time because all segments of the project started simultaneously.
4. Effective management of lump sum and contingency clauses led to cost savings from each lot. The savings are being utilized in the execution of the landscaping and external works of the projects’ immediate environment.

4.3.3 Contractor’s project managers

During pre-qualification, the project execution team ensured that selected contractors that were invited to tender were of identical capacity. Each contractor was represented by a technical staff comprising of an architect, an engineer or a builder and a quantity surveyor. In addition, the contractors handling lots 3 and 4 had electrical and mechanical engineers in their teams. The most senior professional in each organisation doubled as the site project manager (SPM). The two SPMs chosen for this research were selected at random. Responding to the first question, both admitted that working as one of the contractors on-site initially raised some level of apprehension, especially because some of the contractors on site had big names in the industry. However, after the first month, the technical teams of each contractor blended into the other through sharing knowledge and resources, thus enhancing the smooth execution of the projects. The two SPMs had previously worked on mega projects as single contractors. They observed that single contractors work at their own pace but as one among many contractors, they are compelled to work at a steady pace commensurate with other contractors. Although they are working from different directions, through knowledge sharing, the different components of the whole building fitted into each other. The comments of one of the SPMs aptly described the relationship between the different stakeholders of the project: “The client representative was an excellent moderator, providing information to every inquiry, an umpire who fairly related to each team player. Where necessary, he organised specific meetings with appropriate consultants and contractor(s) in order to address teething problems. The consultants were humane, responded to site meetings, and gave clear instruction and necessary approvals on time. The QS and PM processed the payment certificates on time and the client honoured the certificates timely too.”

4.4 Discussion

The major criticisms against the use of the traditional method as a procurement tool for executing capital development projects are that the projects suffer from time and cost overruns, as well as the difficulty of fast-tracking project execution (Babatunde *et al.*, 2010; Ogunsanmi, 2015). The modifications suggested in this research have shown that it is possible to use the traditional procurement system and achieve time and cost savings and fast track the execution of megaprojects. The adoption of the concept of phased development and fragmentation of the mega projects into smaller lots and the simultaneous commencement of the project has assisted in executing the mega-project successfully within the time and cost limits. This research corroborates the findings of Ojo *et al.* (2006), that cost and time overruns in the use of the traditional methods of project procurement are not the same across the board but are related to the cost threshold of the project. Furthermore, Ojo *et al.* (2006) observed that a project within the 10-100-million-naira threshold results in an approximate 9.13% cost overrun. However, in this research, all the projects are within the threshold of 39-242 million naira and achieved both time and cost savings with no overruns. Similar to road traffic management in urban cities, there are many methods of controlling vehicular traffic. Some of the methods include manual control by traffic officers, electronic control through traffic lights and natural control through the use of a roundabout system. The roundabout system has been judged as the most cost and operationally effective because of the 'self-regulation principles' integral in the design and operation, allowing each motorist to operate with limited external control (Bogsnes, 2014). Adopting the self-regulation principles, each contractor in this project, using adequately skilled project personnel, working with their own time schedule and in collaboration with other contractors, delivered on promise the portion of the project allocated to them.

Furthermore, if it is necessary to fast track the execution of the mega-project being executed by a single contractor in order to save time, it would require collapsing many activities, mobilizing more resources at short notice and at an increased cost. In some cases, managing the additional resources on-site can be challenging resulting in redundancy in manpower and difficulties in material storage and handling. Conversely, fragmentation allows for the engagement of large but suitable numbers of specific workforces for each lot as well as adequate stock of relevant materials without the risk of a glut or redundancy. As shown in this research, the seven lots provided employment for seven sets of technical personnel at the tactical level of leadership as against one set, if the single contractor concept had been used. Fragmentation of megaprojects into smaller lots contributes significantly to employment creation and skill development in all the skill sets required in the construction industry (Moavenzadeh, 1978; Kululanga, 2012; Escamilla & Ostadalimakhmalbaf, 2016). Besides the provision of gainful employment and skill development, fragmentation has other economic advantages which include completing projects within time and cost schedule (Table 1), project stakeholders' satisfaction, satisfying the requirements of funding agencies, the judicious use of available funds and ensuring value for money invested in the infrastructure project by the client.

5. CONCLUSION

The solution to the problem of infrastructure deficit starts with the effective conclusion of each phase of a mega infrastructure scheme. The phases, so chosen, should be subdivided into smaller lots and executed simultaneously, thus facilitating completion within a short period of time. This concept of phased development and fragmentation of mega projects for project execution will show administrations planning infrastructure schemes on how to build functional portions of the project. If successive administrators do not continue with the project, the incidence of abandoned projects will be limited to portions of the project. This will go a long way in reducing the incidence of infrastructure deficit. There are challenges in managing many contractors on the same project. Nevertheless, the use of an independent project manager or management organisation, the use of the soft skills of interpersonal relationships, effective communication among project stakeholders coupled with the self-regulatory principle inherent in such team scenarios, can assist in managing the contractors.

Fragmentation of megaprojects into smaller lots holds the potential of adequate and gainful employment, skill development in all the skill sets required in the construction industry, completing projects within time and cost schedules, ensuring project stakeholders' satisfaction, the judicious use of available funds and ensuring value for money invested in the infrastructure project by the client.

The success recorded in the building project, as demonstrated in this research, can be replicated in the development of other infrastructure types. Therefore, we recommend that the concept of phased development and fragmentation of megaprojects into smaller lots be experimented within the development of roads, electricity power generation and distribution systems, water and waste-water systems, and other infrastructure types, in order to allow for the generalisation of the results.

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