EMPIRICAL EVALUATION OF ROAD REHABILITATION PROJECTS ON ABA – OWERRI ROAD (A CASE STUDY OF ABA-OWERRI ROAD)

BY

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A RESEARCH THESIS SUBMITTED TO THE POST GRADUATE SCHOOL FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (MSc) DEGREE IN PROJECT MANAGEMENT TECHNOLOGY

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DECLARATION

I Ebunuwa John Ifeanyi hereby declare that the research project entitled “Empirical Evaluation of Road Rehabilitation projects on Aba-Owerri Road” was written by me and that it is the correct record of my own research work. It has not been presented for a degree in another institution. I will not present it or cause it to be presented for a degree in another institution. All sources of information have been appropriately acknowledged using references and other acceptable methods.

Signed --------------   Date ---------
Ebenuwa John Ifeanyi

CERTIFICATION

This research work entitled "Empirical Evaluation of Road Rehabilitation Projects - A Case Study of Aba-Owerri Road" by Ebenuwa John Ifeanyi with Reg. No. 20094717258 meets the regulation governing the award of Masters of Science (MSc) degree of Federal University of Technology Owerri (FUTO). The work has made original contribution to knowledge. It should be submitted to Postgraduate School for approval.

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DEDICATION

I dedicate this research to my lovely wife, Mrs. Beatrice Oluyemisi Ebenuwa and my Children for their support during and encouragements throughout the programme.

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I am highly indebted to God Almighty for opening my eyes to see things I could not see, and the inspiration to embark on this programme. May the name of the Lord always be exalted in Jesus Name - Amen.

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ABSTRACT

The study examines the Empirical evaluation of Road Rehabilitation Projects (RRP) of Aba-Owerri Road in Eastern part of Nigeria. The motivation for the study was due to deficiencies and inability of conventional Gantt chart scheduling techniques in addressing problems of time and cost overruns in road rehabilitation projects. Gantt chart failed to identify, isolate and exercise tight control on critical road rehabilitation activities that control the project duration. A total of four RRP identified to have suffered time overrun when scheduled and executed with Gantt chart were used for the study through experimental research design. The work breakdown structures of the RRP depicted in their respective Gantt charts were reschedule with an analytical tool of Critical Path Method (CPM). By inferential network analysis and results, the CPM easily displayed, effectively identified and isolated critical path activities which influenced and increased the project duration by seventeen months (15- 32) thus representing one hundred and thirteen percent (113%) upward review in project cost and time management. As part of effort to further confirm the results above, a more scientific approach was applied with the use of a micro software which also confirm the realistic project durations to be 32 months The conclusion is that it was obvious that work programme-chart (Gannt Chart) is reasonably effective only when applied to uncomplicated tasks, especially those involving a limited number of activity dependency, which means it cannot effectively handle the complexity inherent in most projects with a large number of activity. The study therefore recommends the adoption and institution of network scheduling technique (CPM) for scheduling of large scale RRP so as to complete the projects on schedule and contain cost and time overrun.

Keywords. Network Scheduling Techniques, Road Rehabilitation Project, Gantt chart, Critical Path Method, Critical Activities, Time Overrun and Experimental Research Design.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Network scheduling techniques are employed in large projects involving a large number of activities, when project scheduling becomes very complex, the use of conventional methods of scheduling like the work programme-chart will not be effective. This project consists of many activities which have some logical interrelationship between themselves. Scheduling techniques offers solution to optimization of project time, and also refers to the process of laying out all the actual activities of the project in the time order in which they are to be performed, keeping in view of the logical sequences.

Network diagram is a graphical flow plan of the activities that must be accomplished for completing the project. It arranges the activities in logical sequence, following the precedence- succulence relationships between the activities. Network based scheduling of project comes handy in solving complex project scheduling problems.

The term work programme can be likened to programme progress chart or programme of works as rightly used in my place of work (federal ministry of works).

The progress chart is a pictorial representation showing the various activities involved in a project. It depicts the proposed activities of a project with their estimated time duration. Normally when contract is awarded to a contractor, the client or the promoter usually state in simple terms the commencement and completion dates of the contract, and once the site is officially handed over to the contractor, it is expected that he (contractor) at the request of the Engineer submits his work programme to the Engineer whose onus it is to accept or reject the submission.

In most cases the contractor usually fine-tune the work programme in order to conform with the commencement and completion dates as stipulated in the contract document, even when he knows that the contract duration is not realistic.

Work programme is drawn in order to have a pictorial view of the logical sequence of operations and their interrelationship and to have an estimate as to when the project is likely to be completed. It is only a project in the future.

The chart is a simple graphic tool that relates the planned progress to time schedule. The convention is to enumerate along the ordinate, the conventional Y axis, the project activities in order of first activity at the top and the last activity at the bottom, with the time scale along the abscissa (on top or below); the X axis. Each scheduled activity is represented by a bar that extends from its planned start date to its anticipated finished date.

A number of people require planning for proposed or future programmes of work of varying complexity and for varying purposes. A comprehensive planning has to be made before the commencement of the actual construction of a project. The project manager who carries out preliminary planning and scheduling of a project during design and planning stages has the advantage of producing a cost effective design. Such a manager should have a good knowledge of construction procedures/method, resources (materials, equipment and personnel) and management skills.

1.2 PROBLEM STATEMENT

Many road rehabilitation projects in Nigeria have either been abandoned or failed, which could be attributed to lack of scheduling efficient techniques to contain with multiple and concurrent activities (tasks), especially those involving a limited number of activity dependencies. However, road rehabilitation projects are characterized by so many activities with huge amount of resources to be deployed to the projects. Because of the large number of the activities involved in this project, work programme-chart is ineffective, hence the need to develop Network scheduling techniques to determine if it can address the complex nature of road rehabilitation project vis-a-vis Aba-Owerri road. In spite of these characteristics, the work programme - chart has a number of crippling disadvantages along which are:-

a. Its inability to easily display the relationship and nature of inter-dependencies between project activities.
b. Its inability to easily display, effectively identify, and isolate those activities, generally referred to as critical activities, that uniquely control and influence a project's duration.
c. Its inability to effectively quantify the effect of delay or change of scope on an activity or chain of activities on the entire project.

d. Its inability to effectively handle the complexities inherent in most projects.

1.3 OBJECTIVE OF THE STUDY

The main objective of this study is to develop a network scheduling technique in place of existing work programme - chart of the ongoing rehabilitation project of Aba-Owerri Road in Abia and Imo State. Specifically, the study sought to

i. Establish if the project took shorter or longer time than scheduled.
ii. Investigate the likely cause of variation in scheduled project time if any.
iii. To ascertain the actual completion time for the project.

1.4 RESEARCH QUESTIONS

i. Did the project take more or less time than the scheduled time?
ii. What could be the likely course of variation in scheduled time?
iii. What was the actual completion time for the project?

1.5 JUSTIFICATION FOR THE STUDY

Government projects often time are scheduled to be completed at a known date. It is discovered from study and site check that these projects more often than not are reviewed several times before completion thereby increasing the actual cost beyond budgeted cost. In a worst case scenario, the projects are abandoned. The sordid site of most projects has necessitated this study with a view to investigating what could account for consistent review of projects and to establish why proper project scheduling is worth undertaken before any project is bided for preparatory for execution. The significance of this study is that on completion of this project, the client and the contractor who executes this project will appreciate the concerted effort made in applying strategic thinking to approach this project by adopting network scheduling techniques. It is also significant because it is economically, environmentally, educationally and safety-wise beneficiary to immediate communities where the project is sited and other systems using the road.

Another significance of this study is the application of strategic thought of Henry Gantt that brought about the development of bar chart and hence specialized bar chart is also referred to as Gantt chart.

The study is expected to impress upon project planner the need to factor in some contingencies and unforeseen elements that are likely to delay project completion time so as to reduce periodic review of already existing project agreement and forestall abandoning of project.

Getting the exact completion time for a project will help in proper and near to exact bidding for project in terms of resource involvement. Consequently, it intends to inform project managers of the need to undertake feasibility study of project sites and not having to rely on experience gained on similar project elsewhere as a guide to bidding. By contributing to extant literature, the study promises to be a sure guide to future study on project management and scheduling.

1.6 SCOPE OF THE STUDY

The project topic is empirical evaluation of network scheduling techniques for road rehabilitation project, (case study- Rehabilitation of Aba-Owerri Road in Abia and Imo States.) Thus the scope and limitation of the study is as stated above. The work programme-chart used here for this study is currently being used for the ongoing rehabilitation of road project. On the other hand/ it is also the objective of this study to compare this two scheduling methods so as to ascertain which of them will effectively present the actual or feasible project duration of the ongoing project.

To say that this project is without limitations is not correct, since this project is the researcher's brain child project. He was able to subdue all manners of constraints which would have made it impossible or difficult to complete this project.

1.7 LIMITATIONS

1. Transforming the Work Programme Chart (Gannt Chart) as submitted by the contractor –Niger Construction Limited to Network Diagram.
2. Applying the Critical Path Method (CPM) of scheduling to identify the critical activities along the critical path in the Network diagram which evidently determined the realistic project duration.
3. Applying the two methods of Mathematical Computations to establish the earliest start time and latest finish time of the twenty one (21) activities in the network which formed the Network diagram. i.e

Forward Pass and Backward Pass methods of computation.

4. The researcher grouped all other limitations and constraints which resulted to stresses and anxieties under "Educational Hazards" which is expected of any research student to bear.

CHAPTER TWO

LITERATURE REVIEW

2.1 CONCEPTUAL REVIEW

Construction projects having identical or similar units, in which activities repeat from one unit to another, require schedules that ensure the continuous usage of resources from one unit to the next and the maintenance of the network logic between activities at the same time (Okmein, 2013). Construction planners widely use Bar Charts (or Gantt Charts), Line of Balance (Linear or Repetitive Scheduling) and Critical Path Method (CPM) to schedule the construction activities.

The most convenient method of scheduling and controlling projects according to Okmein (2013) that have repetitive units is the Line of Balance or Linear Scheduling method. Unlike Bar Chart and CPM, Linear Scheduling provides work continuity between the same activities of successive units in accordance with the resource availability. It leads to the smooth and efficient flow of resources, and requires less preparation time (Okmein, 2013).

Multi-storey building construction, highway construction and pipeline construction projects are some examples of linear or repetitive construction projects. Such projects require the implementation of a set of identical or similar activities from one unit to another as in the case of multi-storey building construction, or from one location to another as in the case of highway construction.

Scheduling of linear construction projects requires uninterrupted usage of resources between similar units and enabling timely movement of crews from one unit to the next (El-Rayes & Moselhi 1998). Maintenance of work continuity leads to advantages such as maximum learning for each crew member, minimum idle time and minimum off-on movement of crew members on a project once work has begun (Ashley 1980).

CPM, which was first developed in the USA, shows the dependency relations between activities, detects the critical activities, reveals the activity float times and computes the minimum project completion time in accordance with network relations. For this reason, CPM is the most convenient means of scheduling, analysing and controlling activity networks (Griffis & Farr 2000; Oberlender 2000).

Successful delivery of highway design projects entails the coordination of several disciplines within Project Development. Project managers must ensure that District Office Branches, Central Office Divisions, the Federal Highways Administration (FHWA), and outside regulatory agencies engage with projects in a timely and responsive manner (Kreis *et al*. 2019). Although project management is a complex task, currently estimated hours and project milestone dates are negotiated *after* the selection of a design consultant. And while estimates are prepared for critical milestones, no detailed schedule is developed to facilitate management of the federal Ministry of Works of the very limited resources it can access in the course of project delivery. As part of the negotiation process (or immediately following its conclusion), the Cabinet should require selected consultants to develop a critical path method (CPM) schedule.

Critical path is the path through a project that has the least duration and scheduling flexibility i.e. a lack of slack or float (Whitaker 2016). The CPM "focuses on identifying all paths through a project and, with the aid of a network diagram determining which of these paths presents the shortest duration and also the least amount of scheduling flexibility as indicated by the length of slack or float" (Whitaker 2016). Critical path is a tool and technique used to develop a schedule. According to Greene and Stellman (2013), developing a schedule is vital to time management. It takes into consideration the various activities, durations, resources, and constraints facing the project manager and creates the project schedule.

According to Kreis *et al*. (2019), scheduling process involves; defining the activities, putting the activities in order or sequencing the activities, estimating the resources required to complete the activities, estimating the duration of the activities and developing a project schedule. With this schedule, the project managers can calculate the early start, early finish, late start, and late finish dates for all project activities. Calculations are developed by using forward and backward pass analysis through the schedule network. A forward pass is described by Whitaker (2016) as: "The forward pass is completed by working from left to right and calculating the early start and the early finish for each task", while a backwards pass is to "work from right to left, and you calculate the late finish and the late start for each activity" (Whitaker 2016). The amount of flexibility in a schedule is measured by total float, which is the amount of time that any activity can be delayed before impacting the completion date of the project.

No matter how much a project is scheduled, Kim (2020) posits that, delays by limited supply of resources are common in many construction projects and may cause serious monetary disputes between project participants. Since the dispute resolution may require unnecessary additional time and cost, preventing delays in advance is an important goal in sustainable construction project management. To prevent delays, a feasible plan must be implemented, which reflects limited resources and provides reliable activity information.

Thus, the critical path method (CPM) represents a scheduling technique used in construction project management to provides important information necessary for managing construction projects and serves as a basis for analyzing the impact of delays in the construction process (O'Brien, & Plotnick, 2016: De la Garza, et al. 2017). However, it has a limitation in that it assumes an infinite supply of resources available to perform an activity. Resources such as labour, equipment, and materials are highly limited in many projects, so that efficient resource allocation is essential for sustainable construction project management (Jo *et al*. 2018: Dasovi´c et al. 2020) Delays are common in many construction projects and many delays are caused by limited supply of resources (Khatib, *et al*. 2020: Leicht, et al, 2020). To make up for the delays, additional time and cost may be needed, which tends to cause disputes between project participants. Since the dispute resolution may require unnecessary additional time and cost, preventing delays in advance is an important goal in sustainable construction project management.

To prevent delays, a feasible plan must be implemented, which requires reflection of limited resources. Many resource-constrained scheduling (RCS) techniques, such as the serial method, the parallel method, etc., have been developed to reflect limited resources to create more feasible schedules (Demeulemeester & Herroelen, 2002).

However, the RCS technique does not consider resource-dependent activity relationships (resource links) caused by resource constraints, resulting in loss of important information such as total floats and the critical path (Braimah, 2013). In addition, a regular schedule update to reflect changes during the construction progress can alter the work sequence after the data date, resulting in a plan that is different from the original.

The significance of rescheduling in the field of construction according to Orumie (2020) is to sets time and sequence of the various stages, the linkage between one activities to another to ensure that the deadline can be achieved.

Okmein (2013) posits that, the most important feature of CPM is its ability to specify critical Path (s). Critical path(s) identify the activities which cause delay in timely project completion. For Linear Scheduling to be accepted as a valuable tool, it should also be able to determine the critical activities (Ammar & Elbeltagi 2001). Scheduling techniques applicable to linear projects must be able to provide a synonymous set of critical activities as those calculated by CPM. This ability would provide an analytical or engineering foundation on which a full range of functionality, such as float identification, resource and cost allocation, and schedule updating could be built. Determining the critical path in CPM, or controlling the activity path in a linear schedule, is crucial. It helps in controlling and updating the original schedule. However, these methods are mainly graphic-based techniques.

The construction engineer, project managers, or contractors have to do some planning before bidding for a project such as Rehabilitation of Aba -Owerri Road for construction project. This will help him to reveal the critical factors that will affect the cost and the duration of the project and thus guides him in making a good bid both for financial cost and technical contents. The commonly and widely used techniques available for project planning and scheduling are network scheduling models or analysis which can either be activity on the arrow or activity on the node. The network scheduling techniques include the following;

1. Bar charts and linked bar charts
2. Project evaluation and review technique (PERT)
3. Critical path method (CPM)

2.1.2 Planning may be described as the most veritable tool of management process. It is within its framework that other management policy formulation rest on. In construction projects, various resources are employed, unless with well-articulated planning techniques these resources cannot be appropriately channeled for effective and maximum usage,

2.1.3 In defense of the need for adequate planning in the construction industry, Nuttahl and Jeanes (1989) write that "It is obvious that the projects should be executed with undue delay. However, to build speedily without sacrifice of quality involves bringing together the entire professional and trades in the correct sequence and times, since the work of each relates to the work of the other. Any delay in the arrival or the execution of the work of one group may delay many subsequent activities and probably even the whole project".

Based on the above assumptions, planning techniques in the Rehabilitation of Aba-Owerri Road construction project when properly and adequately applied, results in timely realization of the project, planning, cost control, commitment, consistency, communication and co-ordination of the project and the parties involved in the project. This planning must clearly identify the work to be done and establish the following:

1) The desired schedule
2) Realistic cost estimates
3) Quality objectives
4) The best contracting strategy.

2.1.4 According to Adams and Barndt (1993), the planning stage of a project life cycle involves the establishment of a formalized set of plans accomplish the initially developed goals. Among planning activities are scheduling, budgeting and allocation of other specific tasks and resources.

The final stage of the project life cycle involves the actual execution of the construction projects. During this stage, materials and resources are procured, the project is produced and performance capabilities are verified. Cost and schedule variances are worked out to determine possible variations from plans during the implementation stage from time to time.

2.2 THEORETICAL REVIEW

It is essential to manage projects effectively through proper planning, scheduling, monitoring and control as projects require heavy investment and are associated with risk and uncertainties.

2.2.1 Network scheduling is a technique used for planning and scheduling large projects in the fields of construction, maintenance, and any other areas.

2.2.2 According to Telsang (2004), network is a graphical representation of a project and it consists of series of activities. An activity is a physically identifiable part of a project, which consumes time and resource. Each activity has a definable start and end. An activity is represented by an arrow.

Figure 2.1

Similarly, an event represents the start or the completion of an activity. The beginning and end points of an activity are events. This is represented in fig 2.2 below

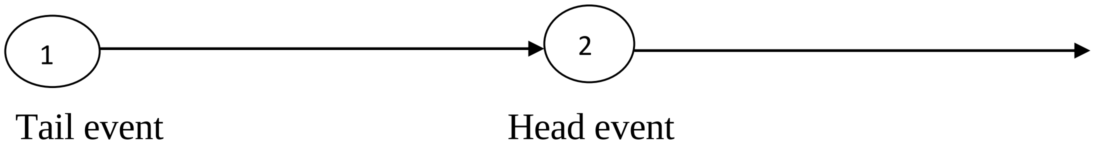


Figure 2.2;

2.2.3 Akpan and Chizea (2002) assert that an arrow diagram used to represent a project has two basic elements;

i) An activity is an element of work entailed in a project, is a task which must be carried out.

ii) While an event, is the start or finish of an activity or group of activities.

According to them, one of the useful bye products of drawing a 'network is that the diagram can be used as a means of communication to persons other than those that prepared it. Both events and activities should therefore be unequivocal statements in positive terms, which have significance within the context of the tasks being considered. In network conventions, time flows from left to right, and head events always have numbers higher than that of the tail events. It is not necessary for all numbers to be in sequence or follow each other in a natural manner, in a network, a number of activities may terminate into a single node called merge node and a number of activities may emanate from a single node called burst node. See fig 2.3 below.

Merge event

Fig. 2.3; nodes

2.2.4 An activity, which depends upon another activity, is shown to emerge from the head event of the activity upon which it depends and only dependent activities are drawn in this way. Fig 2.4 refers.

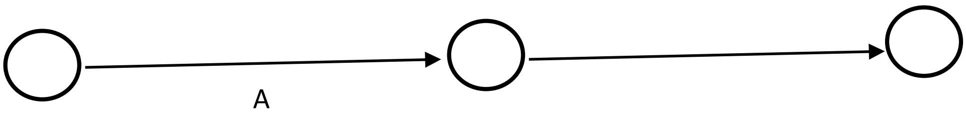


Figure 2.4; Activity B depends on activity A.

Fig 2.5 Activities B and C depends on activity A. Thus activities, which must be completed before starting the activity under consideration, are called predecessor activities. Similarly the activities which have tofollow the activity under consideration are called successor activity

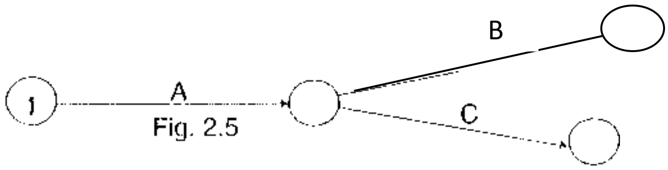


Fig. 2.5

2.3 EMPERICAL REVIEW

2.3.1 FORWARD AND BACKWARD PASS COMPUTATION

Forward pass (earliest event time) computation gives the earliest expected start and finish times for each activity. The computations starts from the initial node and move to the end node. Forward pass notations starts with, an assumed earliest occurrence time of the initial event. Earliest start time Es is the earliest event time of the tail end event. For example:

$Es_{ij} = E_i$ ....-.2.1

Where Es_{ij} =earliest starting time for an activity (i,j)

Ei = earliest event occurrence time of event (i) similarly, earliest finish time of an activity Ef is the earliest starting time plus activity duration

$Efij = ESij + t_{ij}$.. 2.2

Where t_{ij} = time estimate of activity

Also, the earliest event time (Ej) for event j is the maximum of the earliest finish times of all activities ending into that event. Ej = maximum of

$(ES_{ij} + t_{ij})$= Maximum $E_i + t_{ij}$.................................. 2.3

In the same vein, Telsang (2004) illustrates the computation of backward pass (latest allowable time).

The latest event times specify the time by which all activities entering into that event must be completed without delaying the total project. Latest finish time for an activity (i,j)equals the latest event of event j. i.e.

$LF_{ij} = L_{ij}$……………………………………………………………2.4

Latest starting time for an activity (i,j) equals the latest completion of (i,j) minus the activity time.ie ij = LF_{ij} - t_{ij}…………………………………2.5

Latest event time for event i is the minimum of the latest start time of all the activities originating from that event.

Li = Maxj (LSij).= Minimum LFjj-tij=Minj (L_j t_{ij})…………………… 2.6

The slack of an event is the difference between the latest and earliest event times. Slack (i) = L_iEL……………………………………………………2.7

The events with zero slack are the critical events. There are also similar computations for different types of float. Total float is concerned with the overall project duration. It is defined as the amount of time by which completion of an activity can be delayed beyond earliest expected completion time. Total float for an activity (ij) is the difference between the latest start time and earliest start time for that activity.

Tf ($_{ij}$), = LS_{ij} -Es_{ij}=(L_j-E_i)…………………………………………………2.8

Where Ej = earliest expected completion time of tail event = earliest starting time for an activity (i,j).

L_i= latest allowable completion time of head event = latest finish time for activity (i,j)

In a similar manner, free float could be described as the time by which the start of an activity can be delayed without affecting earliest start time of a subsequent activity.

Ff = (E_j-E_i) -E_{ij}……………………2.9 free float.

Where Ff = free float.

Independent float (If) is the amount of time by which the start of activity can be delayed without affecting the earliest start time of any immediately following activities assuming that proceeding activity has finished at its latest finish time If = $(E_i L_i)\ E_{IJ}$……………………………… 2.10

Lu and Lam (2008) point toward increasing project complexity as a driver for CPM adoption in the construction industry.

Galloway (2006a) surveyed construction industry practitioners on the use of CPM. Respondents made a number of common observations, such as CPM has become a standard tool; the growing complexity of CPM often requires the assistance of specialists or experts; establishing standards and certification in use of CPM may be helpful, as would be best practices; and when CPM is taught in universities instructors should adopt a more standardized curriculum. Galloway (2006b) also surveyed universities regarding how CPM is taught. This survey suggested that 1) universities privileged theory to the detriment of applying teaching students how to apply CPM; 2) U.S. universities have more comprehensive curricula than universities in Europe and Asia; 3) curricula and textbooks are inconsistent, leading to varying levels of knowledge; and 4) the need exists for global standards.

Wallwork (2002) discusses standards for a CPM schedule. An acceptable standard for a [CPM] schedule is a schedule that includes activity items for all contract work items, including all contract milestones, contract stipulated work sequences, procurements, submittals and approvals, delivery, installation, testing, and, where applicable, training, submission of operations, and maintenance manuals.

To be useful, the CPM must contain a baseline schedule that indicates the scope of work and the plan for performing the work. It should be updated at least once per month, record start and finish dates as they occur, and document the percentage of work completed for each ongoing task (Wallwork 2002). Korman and Daniels (2003) list some problems that have arisen with CPM, particularly with software packages enabling less experienced individuals to develop flawed schedules. Challenges include adding excessive leads and lags to tasks, the use of multiple calendars on projects, and overriding resource constraints. Ammar & Elbeltagi (2001) introduced an algorithm for determining the controlling path considering resource continuity. In this algorithm, the production rate of each activity is compared with that of its successors in order to specify the start-to-start or finish-to-finish relationships between two consecutive units. However, Ammar & Elbeltagi's (2001) method assumes constant production rates and only finish-to-start relationship types between the activities within a unit.

2.4. LITERATURE GAP

2.4.1 MANAGEMENT PROCESSES

According to K. Nagaranjan (2010). The following are seven steps involved in management processes. This includes: Forecasting, planning, organizing, motivating, controlling, co-ordination and communication. These process are further grouped into administrative and executive function.

2.4.2 Administrative functions includes forecasting, planning and organizing while executive function entails motivating, controlling and co-

coordinating. The six processes revolves the seventh one which is communication and may be described as the life wire of project management the project manager spends approximately 90% of his time communication. Fig 2.6 refers

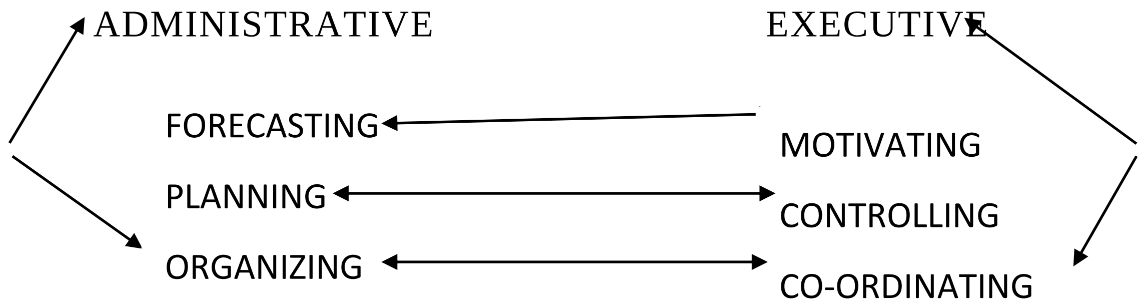


Figure 2.6 -process of management
Principles of construction management

2.4.3 Pilchcer (2004) views forecasting as the process whereby the broad aims and objectives of the organization are resolved by looking ahead and by attempting to predict the possible future course of events through predicting the current situation into the future. Planning is a process which endeavors to translate these broad aims into a method of reaching that objectives, that is planning is concerned with deciding future actions on the basic of available forecast. Both forecasting and planning involves recognition of all available factors in a given situation and understanding what each factors has in contribution to it and how far each is likely to affect the future. The former is concerned with probable events while the later relates to planned events and is a statement of the policy to be carried out. Going by the views expressed by Pilcher above, one considers forecasting a veritable tool in the management process. In the construction industry for instance, forecasting has the following applications:

1. It determines the work to be carried out.
2. The decision as to whether activities should be expanded-or reduced.
3. The determination of the various proportions of work to be carried out.
4. Decisions in respect of sales policy and mechanical plant procurement
5. Forecasting likely shortage of materials.

This is the process which succeeds forecasting. It is the most important of all the processes of management.

Pilcher (2004) held the view that it is within the planning process that instructions are issued for actions to taken as a result of policy determination. Planning is the administrative process which translates the policy into a method of reaching the objectives.

CHAPTER THREE

MATERIAL AND METHODS

3.1 Research Design

The study adopted an ex post facto research design. Ex post means after the fact. The use of this design is predicated on the fact that the variable of study had already occurred and that the variable involved is not manipulatable. According to Ndiyo (2005), an ex post facto research design is a systematic empirical inquiry in which the researcher has no direct control of the independent variables. The suitability of the design to this study is informed by the fact that, though the study is an empirical study, an aspect of it requires survey so as to observe the effects of what has already occurred. In addition, opinion of relevant stakeholders in the project were sought in order to arrive at valid conclusion.

3.2 Area of Study

This project (Rehabilitation of Aba-Owerri Road in Abia/Imo States, Contract No. 6021) was awarded to Messrs Niger Construction Limited (Niger Cat) with a completion period of fifteen (15) months. The need for the project arose as the result of dilapidating nature of the road. Like other rehabilitation projects before it, the project involved large number of activities, awareness and knowledge acquired in network scheduling and problems the construction company encountered during the preliminary Stage of contract was also the source of inspiration to develop the work programme-Chart to network scheduling to determine if it can address the complex nature of the project. The project was delayed due to some security breach in the area of the project

3.3 Population of the Study

The stakeholders who actively participated in the project formed the population base for this study. Three key stakeholders are identified to have participated in the Aba-Owerri road rehabilitation project and they are;

The Client	-	Federal Ministry of Works
The Contractor	-	Niger Construction Limited
The Host Communities	-	Along the entire project route

It was gathered from the client's staff register that at any point in time on the project 92 workers made up their manpower base. Also from the client, The Federal Ministry of Works, it was gathered from their staff register that at any point in time 15 workers were available to aid the oversight function of the ministry. Different host communities from time to time sent delegates comprising of a minimum of 20 people to liaise with the construction workers in ensuring all challenges were collectively ironed- out.

3.4 Data Collection and Tool

Primary and secondary sources of data were utilized for this study. This was to ensure that adequate historical background was set for the study by way of comprehensive literature search, while the practical implication/realities of the subject matter was assessed by way of field survey and face-to-face interview for the collection of firsthand information from the key construction stakeholders who prominently participated in the rehabilitation project of the once deteriorated Aba-Owerri Road.

3.4.1 Primary Data

The primary data used in this study was obtained from the client, the contractor and the host community by way of extraction from works scheduling document from the contractor and interview from the client and the host communities. This process marked a framework for the study, after which some of the inefficiencies associated with other scheduling techniques peculiar to road construction project execution highlighted by different authors guided the researcher.

3.4.2 SECONDARY DATA

The secondary data used in this study were obtained from various Nigerian and international sources; inter alia, journal and conference papers, articles, books, theses and the internet. The search for information were made at libraries in Imo State covering F.U.T.O. library, FEDPOLYNEK Library, the federal library Owerri, and IMSU library. Other documents used for this purpose were:-

(1) Progress reports from the contractor and the federal ministry of works,

(2) The main work-program (Gantt Chart) utilized for execution of the project,

(3) The staff registers and the stakeholders register.

NIGER CONSTRUCTION LTD. (NIGERCAT)

BUILDERS OF ROADS AND CIVIL ENGINEERING WORKS

DIRECTORS:
Chief Mike Omeru (JP) (Chairman)
Mr. F. Najjar (Managing)
Dr. A. Bassoul
Mr. Emami Ayiri
Mr. G. Ghorayeb
Mr. F. Horkos
Mr. M. Hajjar
Col. L. O. Iheanacho (Rtd.)

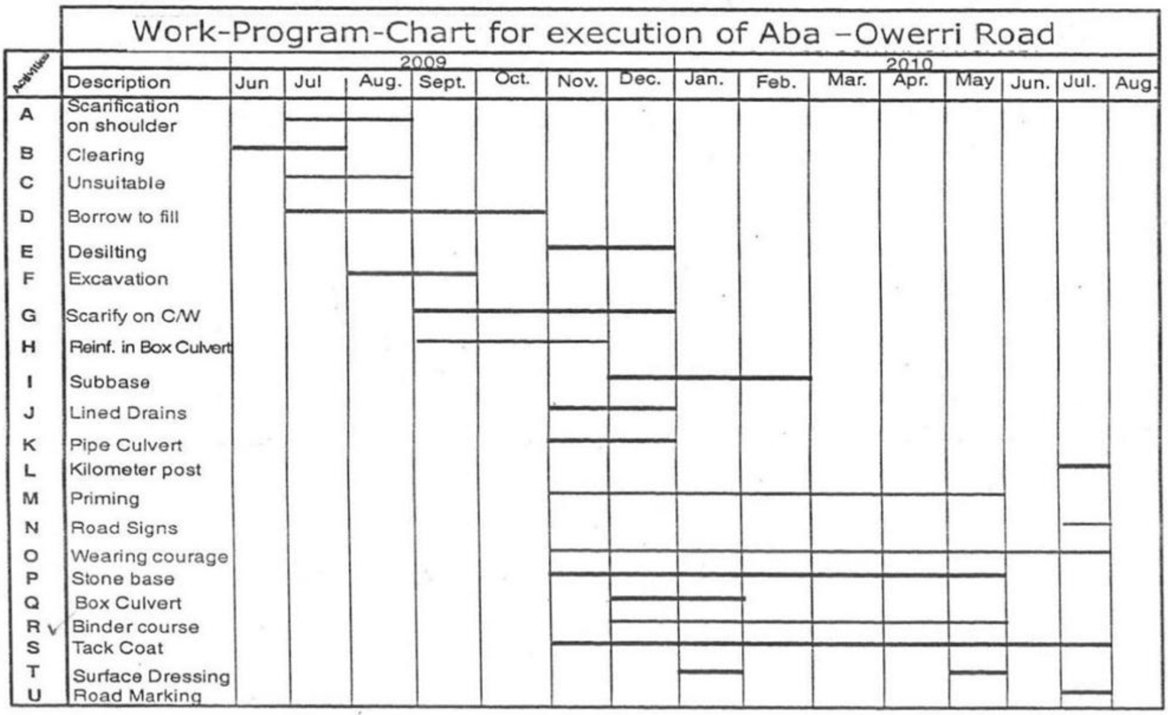
HEAD OFFICE:
63, Enerhen Road,
P. O. Box 402,
Warri, Delta State.
Tel: 053 - 251313
Fax: 053 - 252235

DATE: 22nd August, 2009

The Engineer's Representative,
Federal Ministry of Works,
Housing and Urban Development.

Attention: Engr. Anizoba .E.I.

REHABILITATION OF ABA-OWERRI ROAD C/NO. 6021 IN ABIA/ IMO STATES.
SUBMISSION OF PROGRAMME OF WORKS FOR THE ABOVE PROJECT



Thanks for your usual Co-operation.

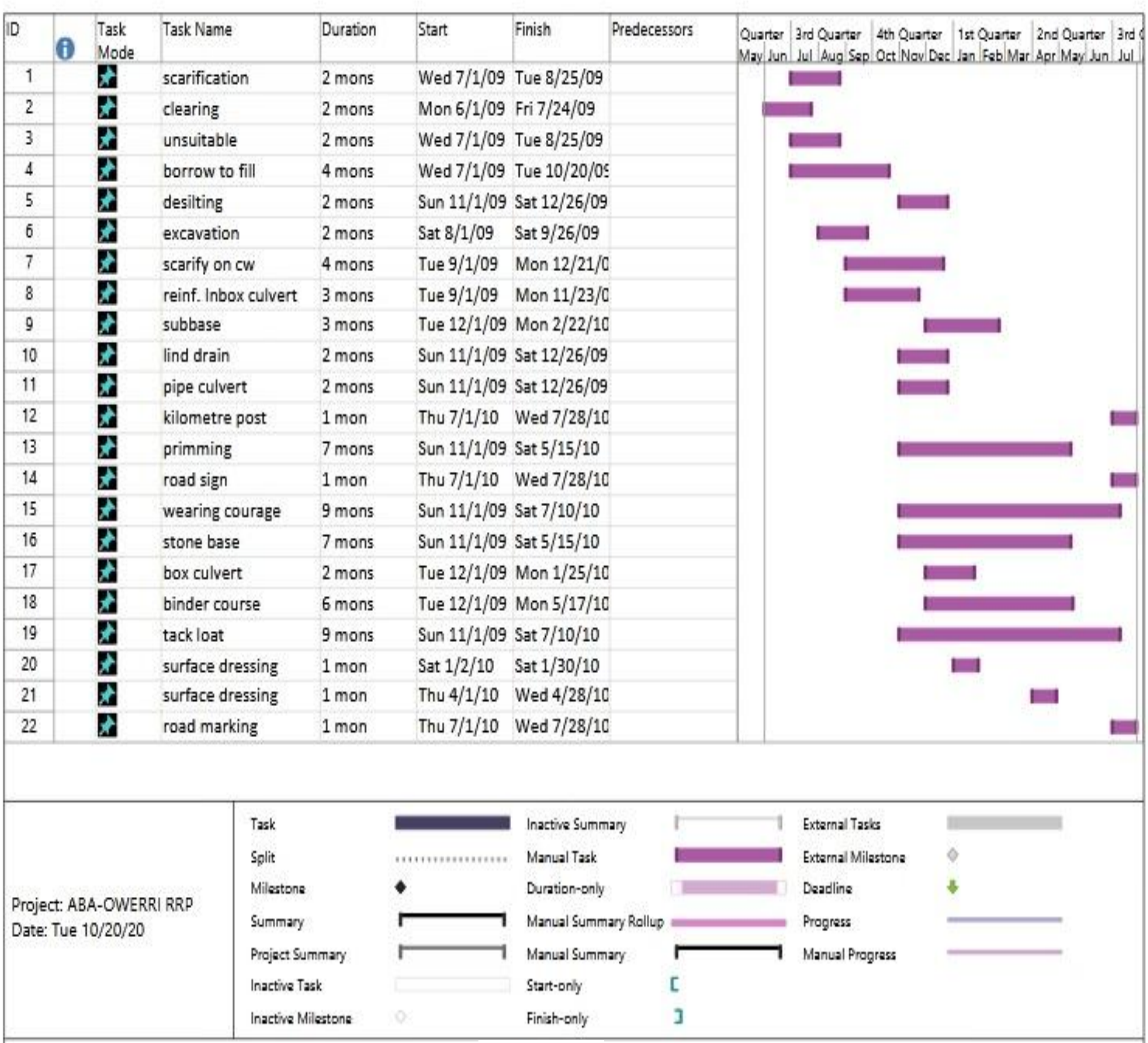
Yours faithfully,
For and behalf of:
NIGER CONSTRUCTION LIMITED (NIGERCAT)

For:

EL. KHOURY MALHAB
(PROJECT MANAGER)

BRANCHES: ABUJA: Plot 1065, Adetokunbo Ademola Crescent, Wuse II, P.M.B. 475, Tel:09-5231339, Fax:09-5231280
PORT HARCOURT: Trans-Amadi Industrial Layout, P.O. Box 617, Tel:084-234300, 232585, Fax:084-232053
BENIN CITY: 16, Ugbomanta Street, G.R.A. P.M.B. 1214. Tel: 052-252091, 253933
AUCHI: Iyuku Road, Iyuku, P.M.B. 0008. Tel:057-200398, 200330
ONDO: Elegbeka - Ifon, Ose Local Govt., Area.

Fig. 3.1



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		scarification	2 mons	Wed 7/1/09	Tue 8/25/09	
2		clearing	2 mons	Mon 6/1/09	Fri 7/24/09	
3		unsuitable	2 mons	Wed 7/1/09	Tue 8/25/09	
4		borrow to fill	4 mons	Wed 7/1/09	Tue 10/20/0	
5		desilting	2 mons	Sun 11/1/09	Sat 12/26/09	
6		excavation	2 mons	Sat 8/1/09	Sat 9/26/09	
7		scarify on cw	4 mons	Tue 9/1/09	Mon 12/21/0	
8		reinf. Inbox culvert	3 mons	Tue 9/1/09	Mon 11/23/0	
9		subbase	3 mons	Tue 12/1/09	Mon 2/22/10	
10		lind drain	2 mons	Sun 11/1/09	Sat 12/26/09	
11		pipe culvert	2 mons	Sun 11/1/09	Sat 12/26/09	
12		kilometre post	1 mon	Thu 7/1/10	Wed 7/28/10	
13		primming	7 mons	Sun 11/1/09	Sat 5/15/10	
14		road sign	1 mon	Thu 7/1/10	Wed 7/28/10	
15		wearing courage	9 mons	Sun 11/1/09	Sat 7/10/10	
16		stone base	7 mons	Sun 11/1/09	Sat 5/15/10	
17		box culvert	2 mons	Tue 12/1/09	Mon 1/25/10	
18		binder course	6 mons	Tue 12/1/09	Mon 5/17/10	
19		tack loat	9 mons	Sun 11/1/09	Sat 7/10/10	
20		surface dressing	1 mon	Sat 1/2/10	Sat 1/30/10	
21		surface dressing	1 mon	Thu 4/1/10	Wed 4/28/10	
22		road marking	1 mon	Thu 7/1/10	Wed 7/28/10	

Fig. 3.2

Fig 3.2: The reproduced Gantt chart work schedule using MP 2016 software

3.5 Data Analysis

The method of data analysis employed in this study comprised mainly of descriptive statistics.

Data were analysed in two phases. First, the Gantt chart obtained from the contractor scheduled the project to last for fifteen (15) months. Microsoft project (MP 2016) software was used to ascertain the actual completion time for the project and to establish that Gantt Chart scheduling for the rehabilitation of Aba-Owerri Road in Fig. 3.1 as submitted by the contractor did not reflect the actual completion time for the execution of the project.

The steps involved were;

The work scheduled Gantt chart with duration for each activity was obtained from the contractor. This was used to create and work with the plan's data in views. Project includes many types of views. Examples of views include tables with graphics, tables with timescales, tables alone, charts and diagrams, and forms. In this study, Gantt chart with timeline view was used. After creating the chart, each task and its duration was entered in the task and duration column. The length of the chart based on duration imputed will display automatically on the timeline part of the table. The length of the chart is a function of time frame used. In project, the Calendar list contains the three base calendars that are included with Project:

- 24 Hours; Has no nonworking time
- Night Shift; Covers a late-night "graveyard" shift schedule of Monday night through

  Saturday morning, 11:00 P.M. to 8:00 A.M., with a one-hour break each day
- Standard; The traditional working day and week, Monday through Friday from 8:00

A.M. to 5:00 P.M., with a one-hour break each day.

The study adopted project time of 24 hrs.

3.5.1 DESCRIPTIVE STATISTICS

The work-programme utilized in the construction project of the rehabilitation of Aba-Owerri Road was critically analysed and compared to a critical path Diagram which was developed subsequently for the same purpose to see how each method suits the purpose of project in terms of time requirement. All the deficiencies associated with the work programme (Gantt chart) were highlighted.

The response and recommendation from all the stakeholders also guided the researcher in his analysis so as to come up with robust analysis.

CHAPTER FOUR

RESULTS AND DISCUSSION

In this chapter, the result of the interview with the project stakeholders is presented. In addition, the critical path analysis of the project using the work scheduled Gantt chart is discussed. This is to established the actual completion time of the project.

From the interview conducted, the following responses were obtained from different stakeholders.

The Client – The Federal Ministry of Works

Table 4.1: Why was the award of contract for the rehabilitation of Aba-Owerri Road necessary?

Responses	Frequency	%
The road was in a poor state and constitute a death track	3	30
There were many potholes and cracks along the road	2	20
The Ministry is entrusted with responsibility to maintaining Federal roads	2	20
The Federal government approved the project	3	30
Total	**10**	**100**

Source: Field work

Table 4.1 above shows the responses of supervisory staff of The Federal Ministry of works on why it was necessary for the rehabilitation project to be carried out in the first place. Out of the ten (10) staff randomly selected for the exercise, three (3) representing 30% of the total admitted that the rehabilitation was necessary because the road was in a very poor state and was fast becoming a dead track. On the other hand, 2(20%) of them said the rehabilitation was necessary because there were so many potholes and cracks on the road which caused damage to vehicles using the road. Apart from that, armed robbers attacked easily along the road and there were frequent accidents as well. Consequently, 2(20%), said it is the responsibility of The Federal Ministry of works to maintain and rehabilitate federal roads wherever and whenever it is bad. However, the maintenance of federal roads is contingent upon approval by the federal government. This response was supported by 3(30%) of the respondents. It should be admitted that irrespective of how bad federal roads may appear, if the government does not give approval for its construction, it cannot be constructed or rehabilitated.

Question 2: How long did it take for the contract to be appraised and awarded?

It was gathered from this question that because of bureaucracy in the execution of government business, it took some time between inspection, appraisal and award of the contract which represents due process. After inspection, report was made by the inspecting team to the minister who then set up a tender board who called for tender for bidding from registered contractors with the ministry. At the completion of successful tender and bidding exercise, it was then considered whether there was need to award the contract or not. Though no specific number of years was mentioned, it was gathered however, that some time had passed before the contract was finally signed.

Table 4.2: After approval, what was the expected completion time for the project?

Responses	Frequency	%
12 months	1	10
15 months	2	20
18 months	2	20
20 months	1	10
24 months	2	20
30 months	2	20
Total	**10**	**100**

Source: Field work

The responses on the expected completion time of the project after approval varied by the assessment of each staff. While 1(10%) said it will take 12 months for the project to be completed, 2(20%) said 15 months. On the other hand, 2(20%) of the total admitted 18 months while 1(10%) suggested 20 months. Two (2) representing 20% of the respondents suggested 24 months and another 2(20%) suggested 30 months. From the responses, it is obvious that there was no uniformity among client's staff on the actual completion time of the project.

Question 3: Was any of the aforementioned period of project completion tenable?

It was observed that none of the periods mentioned by the respondents above actually reflected the completion period of the project. Each respondent may have taken certain factors into consideration, yet, they were short of the exact completion time for the project. This is because none of them was able to predict the *force majore* in the project which could delay the project beyond the expected project completion time.

Question 4: What factors that affected timely completion of the project?

It was gathered from the respondents that both man- made and natural disaster worked for and against the timely completion of the project. Though the project was scheduled based on standard 24-hrs working time, it was not possible to complete the project within the stipulated scheduled time. For one, at the commencement of the project, some project staff were kidnapped and there was terrorist activities in the area which sparked violent outburst among the benefiting communities. This caused the project site to be shot down for almost six months. At resumption, of activities, new arrangement had to be made between the company, the communities and the ministry. At another time, flood along the project root caused delay in execution of some activities as some materials were washed away. More so, bureaucracy at the ministry delayed approval of certain request for speedy execution of the project. All these factors collectively hindered the timely completion of the project.

In view of the aforesaid, there was in actuality extension in project duration, this resulted in adjustment in the contract sum. This was to ensure that the project is not abandoned by the contractor besides ensuring that no one party suffers excessive loss.

The Contractor

Question 1: What was the basis of your scheduling?

The basis of scheduling in any project is to; map out the expected completion time for a project. This is expected to ease management of resources. Secondly, scheduling is used to douse the curiosity of stakeholders in a project about the time require for each deliverable. Third, scheduling help in identifying critical activities along critical path of the project and the time required to complete each activity along the critical path. It also helps in determining and identifying inter-related activities with the critical activities.

Question 2: Was the scheduling period tenable and achievable?

Scheduling is one thing, achieving the schedule is another? Scheduling as said earlier could be done to douse curiosity of stakeholders. In actuality, not every scheduling is tenable at the scheduled time frame. In view of this, it can be said that the project was not completed as scheduled due to some factors. Among which were; untimely release of fund by the client, environmental crises, insecurity in the project area and natural phenomena that were beyond human control.

From the aforesaid, the actual completion time for the projected shifted from the scheduled completion period of 15 months to 32 months. Due to this variation in scheduled date, there was need for re-validation of the contract between the client and the contractor.

The Host Communities

Question 1: What is the impact of road rehabilitation project to your community?

The rehabilitation project was welcomed by the community. The project has many impact. For one, accident will be reduced along the road. Activities of armed banditry will be checked as the completed project will allow for easy patrol of security personnel along the road. Petty trading will as well resume along the road.

Question 2: What were your response towards the rehabilitation project?

We had meetings among the benefiting communities to ascertain the readiness and cooperation of each community towards the project. Each community was asked to nominate people to work with the contracting firm as workers and as liaison officers respectively. The communities were happy that at last the long awaited rehabilitation has finally come to be.

Question 3: What were your expectations of the project with regards to the government and the contractor?

The expectation was that since government had finally approved the project, it will be executed and completed as promised and that the contracting firm is the proper fit for the job.

Question 4: Were you informed of the completion time for the project?

The communities were told at different meetings with government and the contractors that the project will be completed in less than one and half year (less than 18months).

Question 5: If your answer to 4 above is yes, how realistic did you consider the time frame?

Our believe was that though the project may not be completed in exactly 18 months as we were made to belief, that it could be completed sometime earlier or later than envisaged.

Question 6: In your opinion, what was the actual completion time for the project?

The project took more time than expected, probably close to three years if not more.

Question 7: What in your opinion did you consider the strength and or weakness of the project?

What we considered as the strength of the project was its approval by the government and subsequent mobilization to site. Another strength was the completion of the project. The weakness however, was the non-coordination of the completion time of the project. The project completion took longer than we were told at the onset.

Question 8: What were your contributions towards successful and timely completion of the project?

Though the contracting firm had problem of instability and insecurity initially which caused them to close down the site, we realized we need to work with them if the project must succeed. Subsequently, we raised a team of local vigilante to complement their security team.

This project has 21 activities (a, b, c, ….u) The time required for each of the twenty one (21) activities and the precedence relationships between the activates arc as under

S/N	ACTIVITY	PRECEDING	SUCCEEDING	DURATI
1	A- Scarification on		E	2
2	B- Clearing		D, C&G	2
3	C- Unsuitable	B	H,I	2
4	D-Borrow to fill	B	F,Q	4
5	E- Desilting	A	F,Q	3
6	F- Excavation	D,E	H,I	2
7	G-Scarification on	B	J/K	4
8	H-Reinf. in box	C,F	J,K	0
9	I- Subbase	C,F	M,P	3
10	J- Lined drain	G,H	M,P	2
11	K-Pile culvert	G,H	L	2
12	L- Kilometer post	K	N,0	1

13	M- Priming	J I	N,0	7
14	N Road signs	L,M	U	1
15	0-Wearing	L,M	T	9
16	P- Stone-base	I,J	T	7
17	O-Box culvert	D,E	R	2
18	R- Binder course	Q	S	6
19	S-Tack coat	R	T	9
20	T- Surface dressing	P,0, & s	U	2
21	U-Road markings	N,T	-	1

The 21 activities (a, b,c, …u)(see page 23) are processed and analyse in the table below using MP 2016 software

Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
Auto Scheduled	**Rehabilitation of Aba- Owerri Road, contract No.6021**	**630 days?**	**Mon 6/1/09**	**Mon 12/28/09**		
Auto Scheduled	**<New Summary Task>**	**1 day**	**Mon 6/1/09**	**Mon 6/1/09**		
Manually Scheduled	<New Task>					
Manually Scheduled	scarification shoulder	2 mons	Wed 7/1/09	Tue 7/14/09		
Manually Scheduled	clearing	2 mons	Mon 6/1/09	Sun 6/14/09		
Manually Scheduled	unsuitable	2 mons	Sun 6/14/09	Sun 6/28/09	5	
Manually Scheduled	borrow to fill	4 mons	Sun 6/14/09	Sat 7/11/09	5	
Manually Scheduled	desilting	2 mons	Tue 7/14/09	Tue 7/28/09	4	
Manually Scheduled	excavation	2 mons	Tue 7/28/09	Mon 8/10/09	7,8	
Manually Scheduled	scarify on c/w	4 mons	Sun 6/14/09	Sat 7/11/09	5	
Manually	reinforce	3 mons	Tue	Mon	6,8	

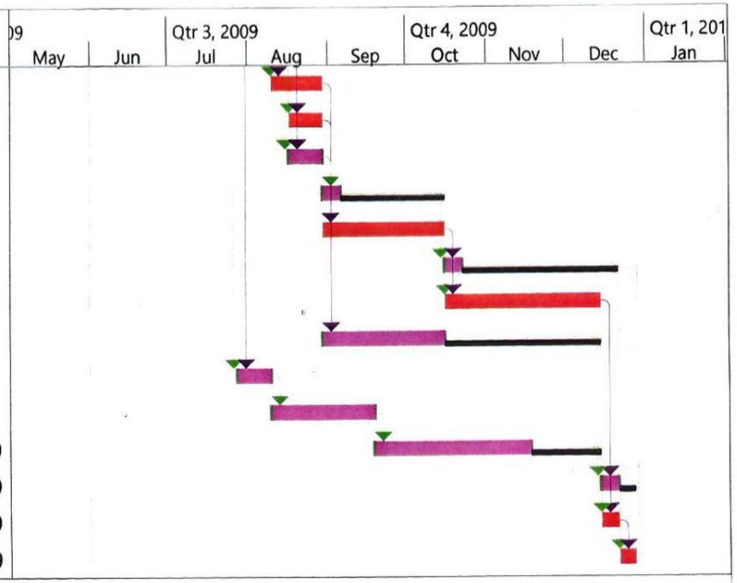
Scheduled	inbox culvert		7/28/09	8/17/09		
Manually Scheduled	subbase	3 mons	Mon 8/10/09	Sun 8/30/09	6,9	
Manually Scheduled	lined drains	2 mons	Mon 8/17/09	Sun 8/30/09	10,11	
Manually Scheduled	pipe culvert	2 mons	Mon 8/17/09	Sun 8/30/09	10,11	
Manually Scheduled	kilometre post	1 mon	Sun 8/30/09	Sun 9/6/09	14	
Manually Scheduled	primming	7 mons	Sun 8/30/09	Fri 10/16/09	13,12	
Manually Scheduled	road signs	1 mon	Fri 10/16/09	Thu 10/22/09	15,16	
Manually Scheduled	wearing courage	9 mons	Fri 10/16/09	Tue 12/15/09	15,16	
Manually Scheduled	stone base	7 mons	Sun 8/30/09	Fri 10/16/09	12,13	
Manually Scheduled	box culvert	2 mons	Tue 7/28/09	Mon 8/10/09	7,8	
Manually Scheduled	binder course	6 mons	Mon 8/10/09	Sat 9/19/09	20	
Manually Scheduled	tack coat	9 mons	Sat 9/19/09	Wed 11/18/09	21	
Manually Scheduled	surface dressing	1 mon	Tue 12/15/09	Mon 12/21/09	18,19,22	
Manually Scheduled	surface dressing	1 mon	Tue 12/15/09	Mon 12/21/09	18,19,22	
Manually Scheduled	road marking	1 mon	Mon 12/21/09	Mon 12/28/09	17,24	

Sun 8/30/09


ID
Task Mode
Task Name
Duration
Start
Finish
09
Qtr 3, 2009
Qtr 4, 2009
Qtr 1, 201
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
0 Rehabilitation of Ab 630 days? Mon 6/1/09 Mon 12/28/0
1 <New Summary Ta 1 day Mon 6/1/09 Mon 6/1/09
2 <New Task>
3
4 scarification shoulder 2 mons Wed 7/1/09 Tue 7/14/09
5 clearing 2 mons Mon 6/1/09 Sun 6/14/09
6 unsuitable 2 mons Sun 6/14/09 Sun 6/28/09
7 borrow to fill 4 mons Sun 6/14/09 Sat 7/11/09
8 desilting 2 mons Tue 7/14/09 Tue 7/28/09
9 excavation 2 mons Tue 7/28/09 Mon 8/10/09
10 scarify on c/w 4 mons Sun 6/14/09 Sat 7/11/09
11 reinforce inbox culvert 3 mons Tue 7/28/09 Mon 8/17/09
Project: Rehabilitation of Aba- O
Date: Tue 10/13/20
Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Path Predecessor Milestone Task
Path Predecessor Summary Task
Path Predecessor Normal Task
Path Successor Milestone Task
Path Successor Summary Task
Path Successor Normal Task
Path Driving Predecessor Milestone Task
Path Driving Predecessor Summary Task
Path Driving Predecessor Normal Task
Critical
Critical Split
Progress
Manual Progress
Slack
Page 1

Fig. 4.1

ID	Task Mode	Task Name	Duration	Start	Finish
12		subbase	3 mons	Mon 8/10/09	Sun 8/30/09
13		lined drains	2 mons	Mon 8/17/09	Sun 8/30/09
14		pipe culvert	2 mons	Mon 8/17/09	Sun 8/30/09
15		kilometre post	1 mon	Sun 8/30/09	Sun 9/6/09
16		primming	7 mons	Sun 8/30/09	Fri 10/16/09
17		road signs	1 mon	Fri 10/16/09	Thu 10/22/09
18		wearing courage	9 mons	Fri 10/16/09	Tue 12/15/09
19		stone base	7 mons	Sun 8/30/09	Fri 10/16/09
20		box culvert	2 mons	Tue 7/28/09	Mon 8/10/09
21		binder course	6 mons	Mon 8/10/09	Sat 9/19/09
22		tack coat	9 mons	Sat 9/19/09	Wed 11/18/09
23		surface dressing	1 mon	Tue 12/15/0	Mon 12/21/09
24		surface dressing	1 mon	Tue 12/15/0	Mon 12/21/09
25		road marking	1 mon	Mon 12/21/0	Mon 12/28/09



Project: Rehabilitation of Aba- O
Date: Sat 10/10/20

Task	Deadline
Split	Path Predecessor Milestone Task
Milestone	Path Predecessor Summary Task
Summary	Path Predecessor Normal Task
Project Summary	Path Successor Milestone Task
Inactive Task	Path Successor Summary Task
Inactive Milestone	Path Successor Normal Task
Inactive Summary	Path Driving Predecessor Milestone Task
Manual Task	Path Driving Predecessor Summary Task
Duration-only	Path Driving Predecessor Normal Task
Manual Summary Rollup	Critical
Manual Summary	Critical Split
Start-only	Progress
Finish-only	Manual Progress
External Tasks	Slack
External Milestone	

Fig 4.1 contd.

Using Inter- Dependency Relationship of activities along the paths through Gantt chart to determine the network diagram to established the critical paths, critical activities and the project duration

The project based on the schedule submitted by the contractor was scheduled to last for 15 months. The Gantt chart schedule however, put the duration of the project at 630 days about 21 months. However, the critical path analysis of the project put the actual completion time for the project at 32 months (see fig. above). In view of the objectives of the study and following the research questions, the following were noticed; the project was originally scheduled to end in 15 months, but the completion of the project took longer time than scheduled to be completed. This means the project took longer time than scheduled to be completed. It goes to show that there was about 13% variation in completion time (113% (17/15* 100)

The likely variation in the project completion time could be attributable to both man-made and natural phenomena. Man- made phenomena include late mobilization to site, no release of fund by the government for early take-off and instability in the security system of the project area. Other could be poor forecasting on the part of the managers. Natural phenomenon likely could be rainstorm which washed away the surfaces and required recasting and flood.

However, the critical path analysis showed that the actual completion time for the project was 32 months. This is indicated by the orange coloration on the chart. On the other hand, the slacks are represented by the black lines.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION

This study examined deeply the development of Network scheduling Techniques for large projects involving a large number of activities and the conventional methods of scheduling like the work programme-Chart.

This project (Rehabilitation of Aba-Owerri Road in Abia/Imo States, Contract No. 6021) was awarded to Messrs Niger Construction Limited (Niger Cat) with a completion period of fifteen (15) months.

The quest to venture into development of Network scheduling Techniques for road rehabilitation of the above project came into being after considering the large number of activities involved, awareness and knowledge acquired in network scheduling and problems the construction company encountered during the preliminary Stage of contract was also the source of inspiration to develop the work programme-Chart to network scheduling to determine if it can address the complex nature of the project. The project was delayed due to some security breach in the area of the project

It is therefore the primary responsibility of project manager in the areas of insecurity and community disturbance to make adequate arrangement for a peaceful working environment and formulate corporate policies with technical capability for proper project execution.

It could be noted that project completed on schedule, within budget and quality standard are the major criteria for determining project success.

It is for this reason that the study tend to analyse the project activities through logical sequence and network analysis for timely completion of the project. Also, there was an in-dept survey on environmental issues to ascertain the major environmental factors militating against project success and decide on a mitigation measures in order to ensure scheduled project completion. The major aim being to provide an improved strategy for dealing with road construction project sited in an environmentally constrainedlocations, and also to advocate for the introduction of network scheduling techniques to such projects during planning stage.

This study reviewed many literature in the areas of project management/network analysis and environmental management. The literature reviewed helped in developing conceptual framework for the study.

Both primary and secondary sources of data were adopted in the study. The primary data used in this study was acquired by surveying existing literature and related literature on network scheduling techniques applicable to road construction projects, the primary data was also adopted through questionnaire, the questionnaire was issued to major construction stakeholders who participated prominently in Aba-Owerri road rehabilitation project in order to collect the necessary information which will guide the findings to be made in this study.

The Secondary Data were obtained from various Nigerian and international sources, international journals and conference papers, articles, theses and the internet. Information were gotten from Imo State Libraries. Others include progress reports from the main work programme- Chart used for the execution of the project, the staff register and the stakeholders register.

In order to validate the study, the data were subjected to analysis. The secondary data was used in developing a network scheduling diagram from the work programme-Chart that was used by the contractor.

The analysis isolated and determined critical path, Critical activities and activities on floats, earliest starting time and latest finish time through backward pass and forward pass computation methods. It is from this analysis that critical activities in the road rehabilitation project were established and appropriate control measures put in place during the project implementation.

5.2 RECOMMENDATIONS

Based on the findings from the study on development of network scheduling techniques for road rehabilitation project, the following recommendations are made;

1. Since project scheduling is the process of laying out all the actual activities of the project in the time order in which they are to be performed, it is therefore necessary to keep in view the logical sequence of the activities so that the project completion time is not delayed.
2. It is reasonable to choose the best suited network based scheduling for individual project.
3. Good project scheduling or planning without monitoring and control

mechanism during implementation will lead to project failure or abandonment.

4. The management is therefore required to devise antidote and strategies to forestall road construction projects failures, especially when sited in environmentally constrained locations.
5. High level managerial skills equipped with modern project management tool should be provided from project initiation/conception, planning, execution, monitoring and control to completion.

The CPM ascertain the realistic project duration as against the programme of work of Gantt chart.

The scheduling for this Project Aba-Owerri Road which was used as a case study for this research was based on Gantt or bar chart. It is in record that most federal road projects ended up in contractors applying for variations to review the contract upwards as a result of applying wrong scheduling.

It is also pertinent to know that from statistics, over fifty percent of roads construction in this country was based on Gantt or bar chart. Reference is here being made to some of the few federal road projects which I personally supervised and my observations during the course of supervision as indicated below which necessitated the comparison of Gantt or bar chart with Network Scheduling Techniques

1. Construction of Mbaise Ngwa Road with a bridge at Imo River, Imo/Abia States C/NO. 6157

2. Rehabilitation of Nsukka - Obollo - Ikem - Ehamufu - Nkalagu Road in Enugu and Ebonyi State. C/No. 5962.
3. Rehabilitation of Aba-Owerri Road in Imo/Abia State, C/No. 6021 which is used as my case study.

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APPENDIX

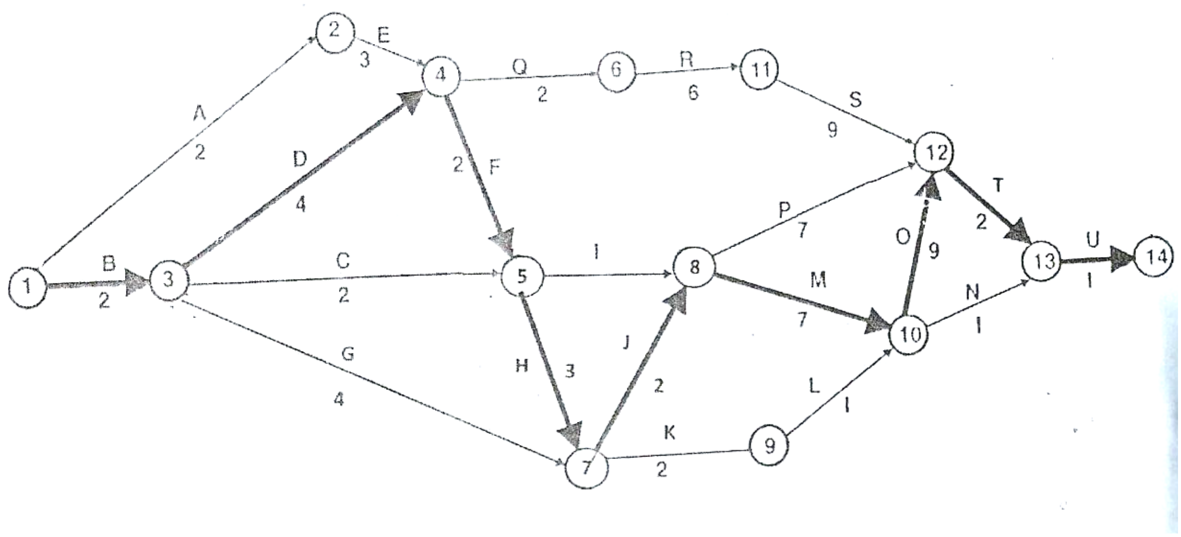


FIG. 4.1

The source of Network diagram, fig 4.1 above was empirically structured out from the programme of works (Gannt Chart) as submitted by the contractor (Niger Construction Limited) who executed the project (see page 16 and 17).

Fig. 4.1 represents the network of Aba- Owerri Road project. The duration of each activity (in number of months) is along the respective activity. This network was developed from work programme-chart as submitted by the contractor (Niger Construction Company Limited) for the execution of rehabilitation of Aba-Owerri Road in Ime end Abie States.

ILLUSTRATION 4.1is to identify all the paths through the network and to determine the critical paths and project duration

A,B,C …….U are the activities

1,2,3 ….. 14 are the events or Nodes

The following are the paths in the network

A → E→ Q→ R → S → T → U

A → E → F → H → J → M → O → T → U

B → D→ Q → R→ S→ T→ U

B → D→F→H→J→M→O→T→U

B→C→I→P→T→U

B→C→I→M→O→T→U

B→G→J→M→O→T→U

B→G→K→L→N→U

ILLUSTRATION 4.2

Activities-A & B have no preceding activities i.e., they do not depend on any other activity for their commencement. Thus, these two activities can be done simultaneously.

Activities -D,C & G can only commence after completion of

activity B, and also activity- E shall commence after completion of

activity -A, activity-F shall commence after completion of

activities-D,E, activity -H shall commence after completion of

activities C & F, activity-I shall commence after completion of

activity -C & F, activity -J shall commence after completion of

activities G & H, activity –K shall commence after completion of

activity-G & H, activity -L shall commence after completion of

activity K, activity -Mshall commence after completion of

activities-I & J, activity -N shall commence after completion of activities –L &M,activity -0 shall commence after completion of

activities –L &M,activity –P shall commence after completion of

activities –I &J, activity –Q shall commence after completion of

activities –D & E, activity – R shall commence after completion of

activity –S, activity -S shall commence of completion of activity –R, activity –T shall commence of completion of activities – PO&S, While activity-U shall commence after completion of activity N&T The duration along thepaths are obtained by adding up the durations of all the activities that lie on the respective paths.

Table Two: Duration along the paths of the network

PATH	DURATION
A→E→Q→R→S→T→U	2+3+2+6+9+2+1 = 25monts
A→E→F→H→J→M→O→T→U	2+3+2+3+2+7+9+2+1 = 31months
B→D→Q→R→S→T→U	2+4+2+6+9+2+1 = 26months
B→D→F→H→J→M→O→T→U	2+4+2+3+2+7+9+2+1 = 32 months
B→C→I→P→T→U	2+2+3+7+2+1 = 17months
B→C→I→M→O→T→U	2+3+7+9+2+1 = 26 months
B→G→J→M→O→T→U	2+4+2+7+9+2+1 = 27 months
B→G→K→L→N→U	2+4+2+1+1+1 = 11months

The source of table two was extracted from the network diagram showing all the paths in the network with their corresponding project duration

Out of the eight paths, the B→D→F→H→J→M→O→T→U has the longest duration and this is the critical path. The project duration is the duration of the critical path, which is equal to 32 months.

Finding out the number of paths available in a given network connecting the initial and end events, the time duration of all the available paths and identifying the critical path is suitable for smaller networks. If the network is relatively larger in size, there will be a larger number of paths available connecting the initial and the end events. In such cases it would be cumbersome to find out all the possible paths. Hence in the case of large networks, a more systematic procedure is followed to identify the critical path. The method uses two series of computations viz: forward pass computation and backward pass computation.

NETWORK SCHEDULING TECHNIQUES DEVELOPED FOR REHABILITATION OF ABA-OWERRI ROAD

FORWARD PASS COMPUTATION

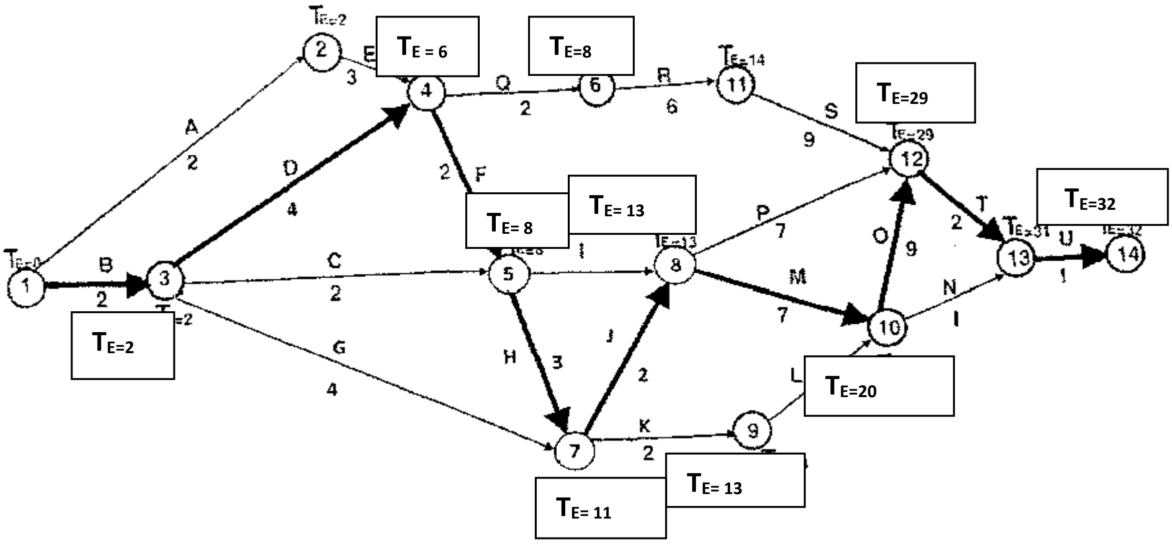


Fig. 4.2 is showing the Earliest Start Time (T_E) of all events

The source of fig 4.2 is a further computation using forward pass and backward pass methods of computation showing the Earliest Start Time (T_E) of events. The computation begins from the initial event and moves towards the final event.

ILLUSTRATION 4.3 (CALCULATION OF T_E)

Illustration 4.3 is o find out the Earliest start Time of events (TE) of events 1 to 14 shown in fig 4.2. The duration of each activity (in number of months) is given along each activity.

Event- 1: This is the start event or initial event. Hence Earlier Start Time is zero

I.e. T_E (of event -1) -0

Event- 2: Represents the end of activity "A" as well as beginning of activity "E". There is no difference between these two moments, i.e., activity "E" can start at the very same moment when activity "A" comes to an end. Hence the Earlier Start Time of event -2 is given by

T_E (of event -2) = T_E (of event -1 + duration of activity -A=0+2=2

Event- 3: activities D, C&G can start at very same moment activity - "B" comes to an end. Therefore, the Earliest Start Time (T_E) of event- 3 is given by: T_E (of event -3) = T_E (of event -1) + duration of activity–B= 0+2=2

Event -4: At event 4, two arrows terminates and two arrows emerges. This means that event-4 represents the completion of two activities (activities D&E) and the start of two activities (activities Q&F).

To calculate the Earliest completion of the two activities D&E. Earlier completion time of activity -E=T_E (of event -2) + duration of activity-E-2+3 -5

Earliest completion of activity - D = TE (of event -3) +duration of activity -D - 2+4= 6

Activities Q&F can only start after both activities D&E are completed. While activity -D can be completed in 6months after the start of event -1, activity - E can be completed only 5months after the start of event -1. Hence activities Q&F can start only after 6months, thus, the Earliest Start Time (T_E) of event -4 is equal to the maximum of the two earliest completion time of the two activities D&E.

Therefore, T_E (of event -4) =6

Event- 5. At event -5 two errors terminate and two arrow energies. This means that event-5 represents the completion of two activities. (activities C&F) and the start of two activity (activities - H & 1)

To calculate the earliest completion time of the two activities C&F Earliest completion time of activity - C = T_E (of event -3) + duration of activity - C = 2+ 2 =4 Earliest Completion time of activity-f =Te (of event -4) + duration of activity -f = 6+2-8

Activity- H can start only after both activities C&F are completed.

While activity-C can be completed 4months after the start of event -1, activity--F can be completed only 8 months after the start of event-1. Hence, the activity -H can start only after 8months. Thus the Earliest Start Time (T_E) of event -5 is equal to the maximum of the two earliest completion time of the two activities C&F)

Therefore,

T_E (of event-5) =8

Event -6: There is only one activity (activity - Q) that enters the event -6 and one activity (activity -R) emerges. This means that event -6 represents the completion of activity - 6 and the start of activity - R. hence,

T_E (of event - 6) = T_E (of event - 4) + duration of activity –Q

- 6+2 =8

Event -7: At event -7 two arrows terminate and two arrows emerges. This means that event - 7 represents the completion of two activities (activities G&H) and the start of two activities (activities J&K)

To calculate the earliest completion time of the activities G&H Earliest completion time of activity -G = T_E (of event-3) + duration of activity -G = 2+4 = 6

Earliest completion time of activity - H = T_E (of event - 5) + duration of activity - H

- 8+ 3 =11

Activities J&K can start only after both activities G&H are completed. While activity - G, can be completed 6 months after the start of event-1 activity - H can be completed only 11 months after the start of event -1. Hence activities J&K can start only after 11months. Thus the Earliest Start Time (T_E) of event - 7 equal to the maximum of the two earliest completion time of the two activities G&H

Therefore, T_E (of event - 7) = 11

Event -8: At event - 8 two arrows terminate and also two arrows emerges. It equally means that event -8 represents the completion of two activities (activities I&J) and the start of two activities (activities M&P)

Earliest completion time of activity - I

T_E (of event - 5) + duration of activity - I= 8 + 3-11

Earliest Completion time of activity -J

T_E (of event -7) +duration of activity-J =6+2=8

Activities M&P can start only after both activities I&J are complete. While activity - I completed 11 months after the start of event -1, activity - J can be completed 8months after the start of event-1. Hence, activities M&P can start after only 13 months. Thus, the Earliest Start Time (T_E) of event -8 is equal to) the maximum of the two earliest completion time of the two activities and.

Therefore, T_E (of event - 8) = 13

Event- 9: there is only one activity (activity -k) that enters the event -9. Hence,

T_E (of event - 9) = (of event - 7) +duration of activity - K = 11 + 2= 13

Event - 10: Also at event - 10 two arrows terminate and two arrow emerges. This means that event - 10 represents the completion of two activities (activities L&M) and the start of another two activities (activities N&O)

Completion time of activity - L=T_E (of event - 9) + duration of activity - L=13+1= 14

Completion time of activity - M = T_E (of event - 8) + duration of activity M=13+7= 20

Activities N&O can only start after activities L&M are completed.

Therefore, T_E (of event -10) = 20 since activity - M is the maximum of the two earliest completion time of the two activities L&M.

Event - 11: There is only one activity (activity- R) that enters the event -9. Hence,

T_E (of event - 11) = TE (of event - 6) + the duration of activity - R=8+ 6 =14

Event - 12: At event - 12 three arrows terminate and one arrow emerges, it means that event - 12 represents the completion of three activities (activities 0,P&S)and the start of one activity (Activity -T)

Completion time of activity - 0= TE (of event - 10) + duration of activity - O =20+9= 29

Completion time of activity -p= T_E (of event - 8) + duration of activity - p=13+7=20

Completion time of activity - 5=T_E (of event -11) + duration of activity 5=14+9=23

Thus the earliest time (T_E) of event 12 is equal to the maximum of the two three earliest completion time of the three activities o, p & s. S

Therefore, T_E (of event -12) =29

Event 13: Two arrows enter event-13 and one arrow emerges. This means that event - 13 represent the completion of two activities (activities N&T) and start of activity - U

Completion time of activity - N

T_E (of event - 10) + duration of activity - N=20+1=21

Completion time of activity - 5=TE (of event -11) + duration of activity 5=14+9=23

Thus the earliest time (TE) of event 12 is equal to the maximum of the two three earliest completion time of the three activities o, p &s. S

Therefore, TE (of event -12) =29

Event 13: Two arrows enter event-13 and one arrow emerges.

This means that event - 13 represent the completion of two activities (activities N&T) and start of activity - U

Completion time of activity - N

T_E (of event - 10) + duration of activity - N=20+1=21

Completion time of activity - T= T_E (of event - 12) + duration of activity - T 29 + 2= 31

Thus the Earliest Start Time of event - 13 is equal to the maximum of the two earliest completion times of the two activities.

Therefore,

T_E (of event - 13) = 31

Event -14: there is only one arrow that enters the event - 14

Hence,

T_E (of event - 14) = TE (of event - 13) + duration of activity - U= 31 + 1= 32

Therefore,

T_E (of event - 14) =32 Therefore, T_E (of event- 14) =32

4.2 BACKWARD PASS COMPUTATION

This is a method of computation of the finishing time of events. Computation is done to arrive at Latest Finish Time (T_L) of the events. Latest Finish Time is also referred to as Latest Allowable completion Time. Latest Finish Time (T_L) is the latest time by which an event should be completed so that the project completion will not be delayed.

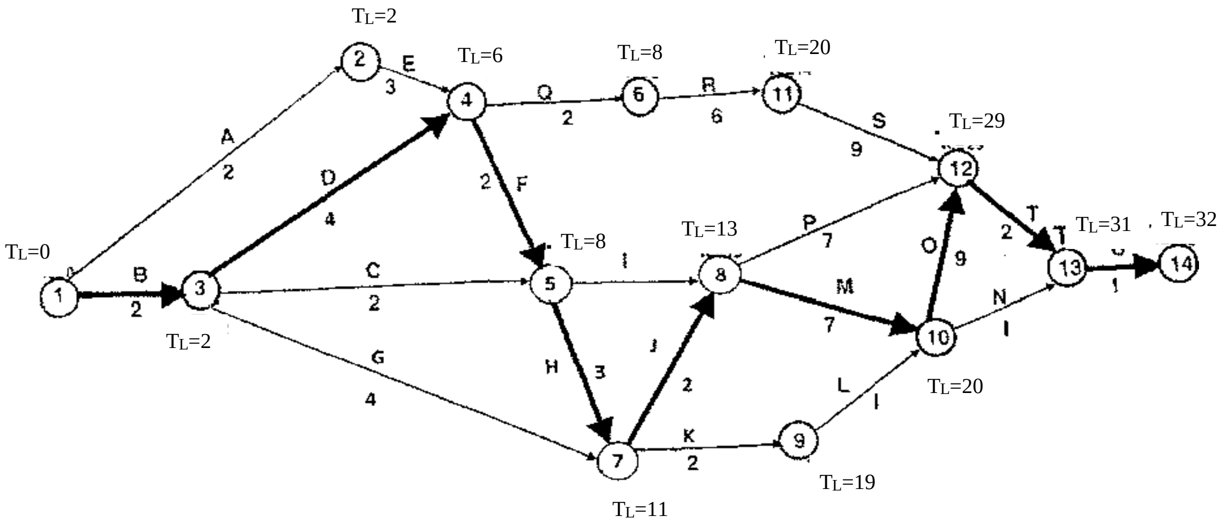


Fig. 4.2 is showing the Latest Finish Time (TL) of all events

The concept and method of arriving at Latest Finish Time (T_L) of events is explained with the help of illustration 4.3 below.

In the network shown in fig 4.3 the Earliest Start Time (T_E) of all the events are given as calculated in illustration 4.2.

Event - 14 Earliest Start Time of event - 14 is 32, since that is the last event, for completing the project without time delay the Latest Finish Time (T_L) for the last event should be equal to the Earliest Start Time (T_E) of that event.

Therefore,

T_L (of event - 32) =TE (of event -14) = 32

Event - 13: There is only one activity emanating from event – 13 (activity -1). Activity - I take one month for completion. Since the Latest Finish Time (T_L) for event - 14 is 32, event - 13 can occur as late as on the 31st month (32-1). If the Latest Finish Time of event - 13 is delayed beyond 31, the project completion time will also extend beyond 32.

Hence, T_L (of event - 13) = T_L (of event - 14) - duration of activity – U= 32-1=31

Event - 12: Again, there is only one activity emanating from event -12 (activity-T), which takes 2 months for completing. The Latest Finish Time of event - 12 is given by:

T_L (of event -12) = T_L (of event - 13) - duration of activity - T= 31 - 2 = 29

Event - 11: only one activity emanating from event - Inactivity - S) which takes

9 months for completion. The Latest Finish Time of event -11 is given by T_L (of event - 11) = T_L (of event - 12) - duration of activity -S= 29 -9 = 20

Event-10: There are two activities emanating from event -10. Hence there will be two time estimates for finish times out of which the maximum of the two time estimates will represent the Latest Finish Time

Activity - N takes one month for completion. Since the Latest Finish Time of event - 13 is 31 months, event - 10 can only start as late as on the 30^{th} month (31- 1).

Activity - 0 takes 9 months for completion. Since the Latest Finish Time of event - 12 is 29, event - 10 can only start as late as on the 2.0th months (29-9)

The Latest Finish Time of event - 10 is given by the minimum of the two time estimates, viz, 20.

T_L (of event -10) = 20

Event - 9: There is only one activity emanating from event - 9 (activity - L), which takes 1 month for completion. The Latest Finish Time of event - 9 is given by:

T_L (of event - 9) = T_L (of event - 10) - duration of activity - L= 20 -1 =19

Event -8: Two activities emanated from event -8. Hence, there will be two time estimates for finish times out of which the minimum of the two time estimates will represent the Latest Finish Time

Activity - M takes 7 months for completion. Since the Latest Finish Time of event - 10 is 20 months, event - 8 can start only as late as on 13th month (20 - 7)

Activity - P takes 7 months for completion. Since the Latest Finish Time of event - 12 is 29months, event - 8 can only start as late as on 22^{nd} month (29 - 7)

The Latest Finish Time of event - 8 is given by the minimum of the two time estimates, viz., 13

TL (of event - 8) = 13

Event - 7: There are two activities emanating from event -7.

Hence there will two time estates for finish times out of which the minimum of the two estimates will represent the latest finish time

Activity - K takes 2 months for completion. Since the Latest Finish

Time of event - 9 is 19 months, event-7 can only start as late as on 17th month (19-2)

Activity-J takes 2 months for completion, and since the Latest Finish

Time of event-8 is 13months, event-7 can only start as late as on 11th month (13-2)

The Latest Finish Time of event-7 is given by: the minimum of the two time estimates viz., 11

Therefore, T_L (of event-7) = 11

Event -6: There is only one activity6 emanating from event-6 (activity-R) Activity-R takes months 1 month for completion. Latest Finish Time for event- 11 is 20, event-6 can only start as late as on 14^{th} months (20-6)

Therefore,

T_L (of event-6) =14

Event-5: Only two activities emanated from event-5. Hence there will be two time estimates for finish times out of which the minimum of the two time estimates will represent the Latest Finish Time.

Activity-H takes 3 months for completion. The Latest Finish Time for event-7 is 11 months; event-5 can only start as late as on 8 months.

Hence TL (off event-5) = T_L (of event-7) - duration of activity- H= 11-3= 8

Activity- I take 3 months for completion. The Latest Finish Time for event-8 is 13, event-5 can start only as late as on 10^{th} months.

Hence T_L (of event-5) = T_L (of event-8) - duration of activity - J

= 13 - 3= 10 T_L (of event-5) = 8

Event - 4: Also two activities emanated from event-5 Activity- F takes 2 months Activity - Q takes 2 months The Latest Finish Time for event - 6 is 14 The Latest Finish Time for event - 5 is 8 Event - 4 can only start as late as on 12th months or Event - 4 can only start as late as on 6^{th} month

Hence there will be two time estimates for finish times out of which the minimum of the two time estimates will represent the Latest Finish Time (T_L)

Therefore, TL (of event-4) = 6

Event-3: There are three activities emanating from event-3 (activities D, C&. Hence three time estimates of finish times are available out of which the Latest Finish Time of event-3

T_L (of event-3) is the minimum of

(a) T_L (of event-4) - duration of activity- D= 6 - 4= 2

(b) T_L (of event - 5) - duration of activity - C=8 - 2= 6

(c) T_L (of event - 7) - duration of activity - G - 11 - 4= 7

Therefore, T_L (of event- 3) = 2 (being the minimum of the three time estimates)

Event - 2: There is only one activity emanating from event - 2,

Therefore,

T_L (off event-2) = T_L (of event-4) - duration of activity -E= 6 - 3= 3

Event - 1: There are two activities emanating from event - 1.

Hence T_L of event - 1 is the minimum of the following two time estimates.

(a) T_L (off event - 3) - duration of activity - B= 2-2 = 0

(b) T_L (of event - 2) - duration of activity - A

Therefore T_L (of event - 1) = 0

From the analysis, it was observed that T_E (of event - 1) = T_L (of event - 1) = 0. If the backward pass computations are done correctly, the Latest Finish Time of the start event (event-1) will be equal to its Earliest Start Time

From fig 4.4, events 1, 3, 4, 5, 7, 8, 10, 12, 13&14 have zero slack. The path connecting these events is the critical path, and is denoted in this network by bold line as shown in fig 4.4 above.

It is also obvious that activities that lie on the critical path are called critical activities since the two time estimates of all the nodes in the critical path are the same, it means that a succeeding activity in a critical path shall commence immediately after its preceding activity is completed.

In the above analysis, activity- U shall start after activity - O is completed and activity - T shall start after activity - O is completed and activity- J is completed. If there is any delay in either starting a critical activity or if the time taken for completing a critical activity exceeds the estimated time, the project implementation period will get extended.

Thus it is obvious, that only the critical activities deserve more attention and control by the management. Any delay in critical activities will lead to time- overrun of the project. Since every time - overrun invariable results in cost- overrun of projects.

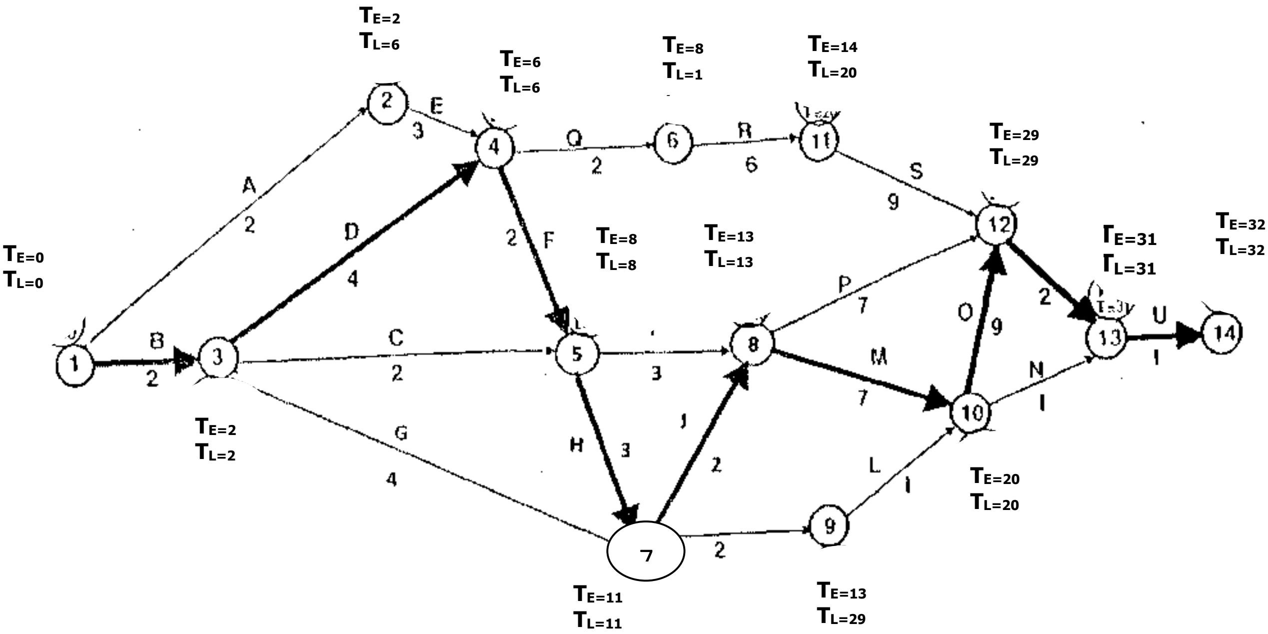


Fig. 4.4 is showing the complete arrangement of the Critical path including analysis of Earliest Start Time (T_E) and Latest Finish Time (T_L) in a large network using Forward pass and backward pass computation Method.

4.3 SLACK TIME AND CRITICAL PATH

TABLE THREE:

The path connecting events with zero slack is the critical path.

Event	T_L	T_E	Slack (T_L-T_E)
1	0	0	0
2	6	3	3
3	2	2	0
4	6	6	0
5	8	8	0
6	14	8	6
7	11	11	0
8	13	13	0
9	19	13	6
10	20	20	0
11	20	14	6
12	29	20	9
13	31	31	0
14	32	32	0

Table Three above is showing how the slack time and critical paths were derived from fig. 4.4. Slack time (or slack) of an event is the differences between the Latest Finish Time (T_L) and the Earliest Start Time (T_E) of that event.

Interview Schedule

The following stakeholders were interviewed in line with Aba-Owerri Road Rehabilitation project

The Client - Federal Ministry of Works representatives

The Contractor - Management staff of Niger Construction Limited

The Host Communities - Communities along the entire project route

The client

1. Why was it considered necessary to award contract for the rehabilitation of the road?

2. How long did it take for the contract to be appraised and awarded?
3. In view of the time frame in 2 above, how long was the project required to last?
4. Was the completion period tenable or realistic?
5. Are there some factors that could hasten or delay the completion time of the project?
6. Granted that the project is completed earlier or later than envisaged, what is the implication of this on the contract sum?

The Contractor

1. What was the basis of your scheduling?
2. Was the scheduling period tenable and achievable?
3. In view of 2 above, was there variation in the scheduling period for the project?
4. What was the actual completion time for the project?
5. In view of your answer to 4 above, what were the likely reasons for variation in scheduled project time?
6. If there was variation in scheduled contract period, how did this impact on the original contract terms?

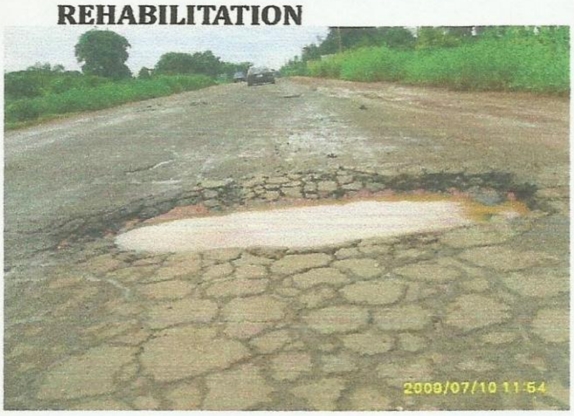
The Host communities

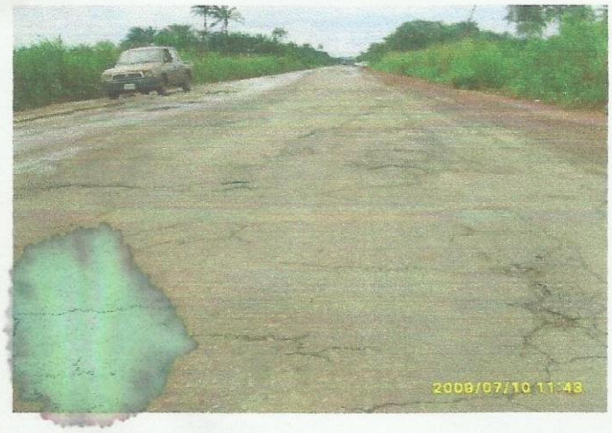
1. What is the impact of road rehabilitation project to your community?
2. What were your response towards the rehabilitation project?

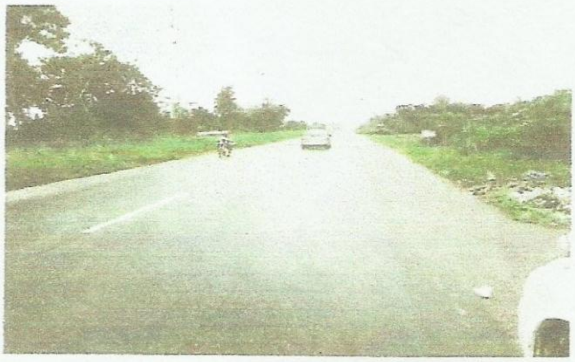
3. What were your expectations of the project with regards to the government and the contractor?
4. Were you informed of the completion time for the project?
5. If your answer to 4 above is yes, how realistic did you consider the time frame?
6. In your opinion, what was the actual completion time for the project?
7. What in your opinion did you consider the strength and or weakness of the project?
8. What were your contributions towards successful and timely completion of the project?

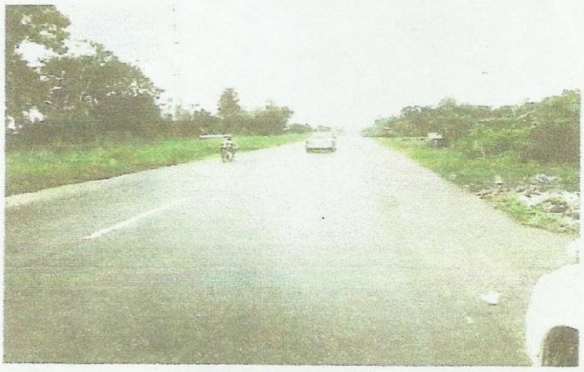
STATE OF THE ROAD BEFORE REHABILITATION

STATE OF THE ROAD AFTER REHABILITATION





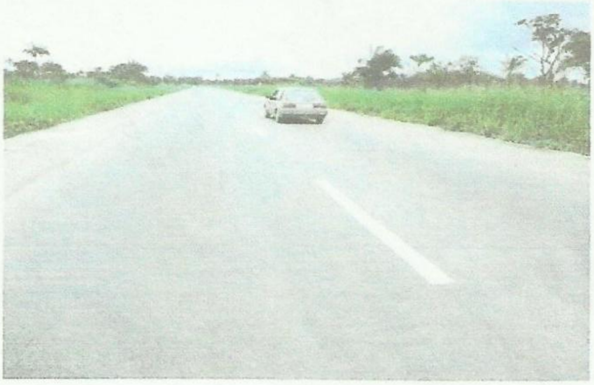




CH.16 + 0000 - CH.18 + 0000

STATE OF THE ROAD BEFORE REHABILITATION

STATE OF THE ROAD AFTER REHABILITATION



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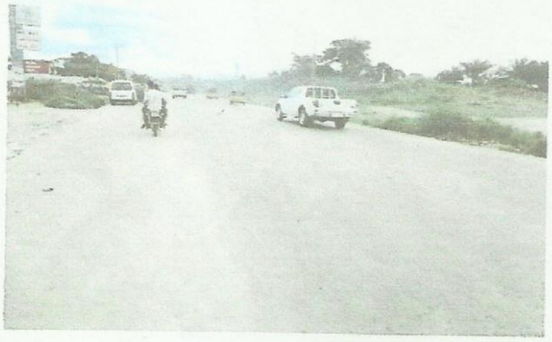
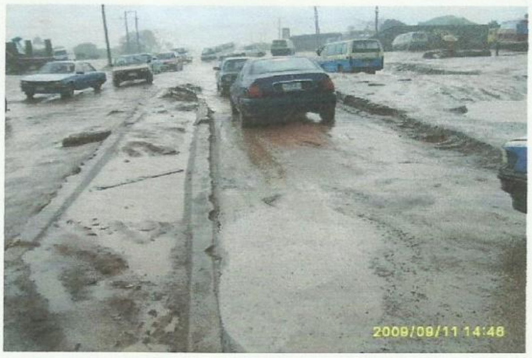
STATE OF THE ROAD BEFORE REHABILITATION

STATE OF THE ROAD AFTER REHABILITATION

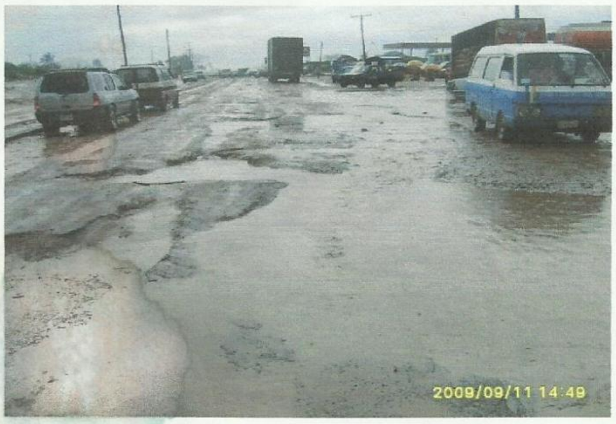


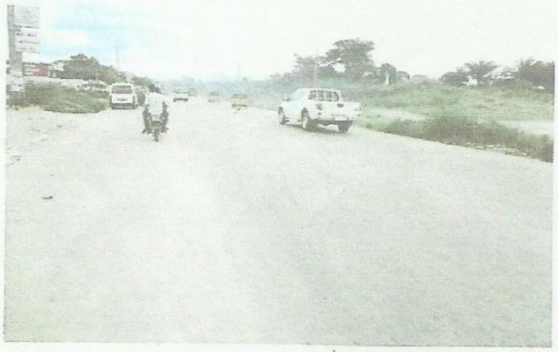


CH.38 + 0000 - CH.39 + 0000

STATE OF THE ROAD BEFORE REHABILITATION

STATE OF THE ROAD AFTER REHABILITATION





CH.38 + 0000 - CH.39 + 0000