INLAND WATER PORT HEADQUARTERS LOKOJA

(Exploring alternative circulation pattern in ports)

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DECLARATION

I hereby make the formal declaration that this thesis is my own composition and reports my personal research work. It has not been accepted for any award of higher degree before now. All references are duly acknowledged and all quotations represented as such.

_____

OKPE Odumu Samuel

CERTIFICATION

This thesis entitled Inland Water Port Headquarters Lokoja (Exploring alternative circulation pattern in port) meets the regulation governing the award of the degree of Master of Science in Architecture of Ahmadu Bello University and is approved for its contribution to knowledge and literary presentation.

_____	_____
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Member supervisory committee.	Date
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Member supervisory committee.	Date.
_____	_____
Head of department.	Date.
_____	_____
Dean of postgraduate school.	Date.

DEDICATION

There are too numerous personalities I intend to dedicate this work to; most profoundly I dedicate this work of my hands to the Blessed Virgin Mary (Mater ecclesiae). To my late father Mr. Robert Ode Okpe, my own mother Mrs. Justina Okpe, my sister Linda, Eche my brother, Ene my heart throb, Ehi, Erdoo, and my beloved son John-Paul and to all people of peace and goodwill.

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Abstract.

Conscious of the importance of inland waterways navigation and transport, the federal government of Nigeria has continually made efforts to ensure navigability along the Niger and Benue rivers since 1954. Conversant with the importance of traffic in ports and the general circulation problems that arise in facilities with multiple and complex circulation systems the research shall focus on exploration of circulation styles in ports. In the light of this task, the research work aims at finding out the problem of traffic flow pattern in ports through constructive assessment of the various planning configuration in ports thus proffering a resultant planning system or configuration if prompted by the research findings. To achieve this research goal, various studies are intended ranging from studies on primary sources of data to secondary sources of data and shall be further reinforced by conditional surveys of existing ports.

The proposed inland waterways port lokoja shall constitute the forum for the architectural representation of the research which aspires to differ from the pristine styles of planning in a bid to establish better efficiency in planning not only for ports but for all facilities that integrate a complex traffic system. At the end of the research, this work shall establish various planning forms and redefine a new course in port planning, through a decentralized facility that segregates the various activity zones and traffic types.

Knowledge that port facilities are principally engineering tasks is not new, thus the research shall only be limited to the architectural content of ports of which planning forms a substantial part.

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CHAPTER ONE: INTRODUCTION.

1.1 PREAMBLE.

The action or process of conveying things or persons from one place to another explains in simple terms, "transportation" (Longman dictionary). This activity has always been a part of man from time immemorial. Various modes of transportation served as a means of economic transaction between peoples and cultures. These modes include land, water and air. Among these modes of transportation the most abundant resource used for transport is water and has manifested itself in history as the cheapest, safest, and the most common means of transportation. Not only as a means of transport; Rivers and large water bodies have often attracted settlements owing to the numerous advantages lying therein, some of which are; agriculture, commerce, exploration, to mention a few. Large water bodies have never lost their relevance in facilitating the activities of man all over the world. More than before, large water bodies have lent themselves to more resourcefulness which is being explored on an increasing basis as time passes based on mans' scientific and technological innovativeness.

Nigeria shares in this natural resource, being spined by major waterways in the hinterlands, and bordered by the Atlantic Ocean in the south. These major rivers are rivers Niger and Benue and their respective tributaries.

Nigeria's earliest involvement in importation and exportation of goods depended largely on marine transport especially in the riverine areas and by these rivers, it is therefore no gainsaying the importance of the development of the natural waterways through the development of ports and others along the two rivers that spine the country especially as a means of boosting economic activities in this contemporary age of science, technology

and diversification, thus ensuring safe and efficient cargo handling and transportation for maximum economic output.

1.2 PHILOSOPHY.

The desire to achieve a four-fold architecture which is comfortable, desirable, representative and functional with high user efficiency is the core of research. Architectural manifestations; if carefully planned represent a form of communication and like any language, they possess vocabulary and syntax. Making an architectural statement that meets with the task of eliminating circulation difficulties through constructive integration of spatial patterns is the pivotal point of reflection in this work. Chan –Heflin (2003: 2) asserts that "to meet with the consistent vision to offer modern, efficient and safe facilities to tenants, improved circulation patterns, storage areas, as well as upgraded berths should be a task in mind for port authorities and all stakeholders". Maersk (1998:2), states that "water ports will face pressure of expansion to meet the growing volume of shipments and therefore should cater for these facilities beforehand in the initial stages of design". Thus the initial stages of port development hold a great deal in the entire success of a port complex. It is of paramount importance therefore to adopt in the initial stages of port development patterns that will offer an utmost and satisfactory eventual facility. This thesis seeks to arrive at this.

1.3 DEFINITIONS

Ports are towns which possess harbors to which vessels resort to load or unload, from which they start or at which they finish their voyages.(Longman) Albert (1978) defines a port as a haven, synonymous with an interface for the entry and exit of vessels in a country, while Bookman (1996:1) in a publication titled "the future of marine activities "sees the port as a point of trans - shipment of goods and services.

In the light of all these, ports have yet been categorized not only on the basis of being towns or function but also on the basis of the nature of the transit medium and are of categories namely;

1. Inland water ports
2. Sea ports

To differentiate between these two, it is necessary to know what forms the transit medium, be it sea or river /canals. Taylor (1949: 57) defines an inland port accommodation as a facility that acts as an exchange point along a navigable river or canal and serves as a point of trans-shipment to manufacturing areas .Inland port accommodation in another definition "is one that is remote from the sea and located in the interior of a country" Mohammed (1999:3).

Sea ports on the other hand are located along the coastal fringes of the sea .Adeeko reports that "a sea port is a ship /shore interface where there are facilities for berthing or anchoring ships and also where there are equipments for the transfer or delivery of goods from ship to shore, ship to ship and ship to vehicles".

As a larger body of water, the sea takes larger vessels with higher draughts. Owing to the nature of the sea, the sea acts as a medium for transportation between various countries through connecting lands that share the same transit medium.

Port accommodation usually has a set of facilities that enable it's functionality ,these include; quays and wharves for berthing of ships, with ancillary equipments such as administration building, transit sheds, warehouses, passenger and customs accommodation, road, rail and water interfaces (terminal facilities), the control tower, check offices, fire stations, mechanical workshops etc.

Port accommodation are generally known to be focal points for social and administrative interaction based on the type of activities that go on within and without; such activities include preparation for efficient trans - shipment of goods and services to their appropriate destination both locally and internationally ,etc and should therefore have in its integral character the representation of this task.

1.4 STATEMENT OF PROBLEM:

The task undertaken in this work is to address the problems of circulation and thus optimally make provision for easy and uninterrupted flow of cargo as well as other traffic forms on the port facility. This is reinforced by Hillings (1969:41) approach to the subject as he asserts that "the nature of the basic port problem is the same everywhere; the quick, efficient dispatch of vessels and the rapid, safe and economical flow of cargo". He states further that "the port capacity and the degree of sophistication of the facilities provided will clearly be a critical factor in determining the economic development of the hinterland. A high percentage of the total national investment in secondary and tertiary activities is likely to be focused at the ports so that the decisions regarding the location, layout, and facilities, becomes fundamental questions of national physical and economic planning. In the course of port development, the future is looked into in the present, this helps in the choice of planning to be employed. Until now the case of port development is

not very clear and general problems have arisen due to rigid planning principles as well as lack of foresight on the part of planners. This is manifest in congestion of traffic as well as interrupted flow of movements of the various traffic types in ports. To a large extent this may be attributed to rigidity in planning with gross concentration of facilities and functions which creates chaos and negates the vision of modern multimodality as described by Kendall; (1986: 203); "modern port transportation facilities ought to envision the uninhibited movement of cargo at least between two transport modes with adequate separation of facilities to reduce the possibility of congestion".

The concept of "destination inspection" is quite a recent one for instance in most ports around the world. In the past, the task was pre-shipment inspection which is a singular task. Such tasks require that an already prepared ground be established in the early stages to prevent huge capital loss. The new concept of destination inspection has led to huge reconstructions in many ports in a bid to create an ideal environment for the said task to be carried out. Inadequate segregation of facilities in the initial stages of development may eventually lead to impossibilities in attainment of the goals required at any point in time. The results are manifested in waste due to massive reconstructions which may be uncoordinated adversely affecting the functional relationship between parts in the port facility.

Certain factors throw light on the study area and have a direct bearing on these technological concepts in port development these include;

1. Adequate space for stacking and examination of container through proper forecasting;
2. Appropriate space for adequate plants and equipments in terms of circulation and function;

3. Coordinated expansion systems in the traffic flow and operation patterns in the initial design stages and subsequently;
4. Functional modal transfer points in the resultant facility.

Lokoja port is a river port that shall cater for, and accommodate shipments for the dry inland ports in the northern parts of Nigeria. It is this facility that shall provide the front for the development and exploration of the entirely new planning system that shall avoid the reoccurrence of some of the major problems identified earlier on. This planning system shall integrate a simple, clear, organic and combined pattern of port design that will to a large extent provide an optimal coordination of the existing planning systems thus setting an example for ports in Nigeria and elsewhere.

Furthermore, in the sea ports of Nigeria, the heavy human and vehicular traffic has been a problem leading to congestion and consequently to obstructed operations, vandalization and pilferage of goods as well as general environmental degradation. Decentralizing the sea ports as a way of segregation shall auger well in the task of decongestion. (Dabo; 2002:5). This in itself is a secondary response in the assessment of the problems of ports; it becomes even more necessary to provide a port facility whose performance reflects higher efficiency within its limits as a unit. Regina Maersk (1998: 2) comments that cargo shipment and storage will undergo enormous growth by the year 2020.According to Moody (1998), lesser category ports will be engaged in bulk and break bulk and integration of a number of conveyance systems. It becomes paramount to have a clear foresight of the future in the development of ports.

1.5 AIM AND OBJECTIVES:

This research aims at finding out those factors that are responsible for the inefficient traffic flow in ports and also to proffer solutions to these problems through adapting the findings of the research to the port facility at Lokoja.

The objectives are as follows:

1. To create a conducive environment for cargo trans-shipment.
2. To incorporate into port architecture a well integrated, growing, dynamic, circulation/flow design.
3. To document port architecture in Nigeria by studying existing ports.
4. To integrate within the ports a flexible storage facility that shall meet the fluctuating cargo capacities and at the same time make for proper and easy cargo inspection.
5. Create a good working environment with improved port efficiency as an architectural contribution to inland water transport.
6. To create a wider opportunity for employment in Lokoja and its environs.
7. To exalt waterfront designs in the hinterlands as a means of creating the awareness among people.

1.6 MOTIVATION AND JUSTIFICATION:

In 1997, the National Inland Waterways Authority was established by decree 13 of the same year to undertake and develop the inter-regional waterways and also monitor the operational activities and maintenance of essential services on the nation's coastal and inland waterways. Among its functions, it was to ensure the development of infrastructural facilities for the national inland waterways network connecting the creeks

and rivers with the economic centers using the river ports as nodal points for intermodal exchange (MITI; 2003: 133).

More recently, the master plan for integrated transport infrastructure further proposes the revitalization of the inland waterways system through capital and recurrent dredging and provision of navigational aids. This constitutes a great motivation.

Prior to these, federal governments' commitment to the implementation of the dredging of the river Niger as proposed by the Netherlands Engineering Consultants (NEDECO) has also been a base point in the researchers mind.

Most of the nation's imports and exports (approximately 85%) are conveyed by ships.Trans-shipment of goods and services from the coastline to the hinterland are usually done either by rail or road or vice versa. This means of transport besides being more expensive have little efficiency as most roads and rail have being damaged owing to the heavy goods that are usually conveyed by them. The need for an inland water port terminal becomes paramount for efficient cargo handling. The Federal government in 1997 proposed the location at Lokoja for the said task based on its proximity to the Federal capital territory which is quite reasonable as a way of linking Abuja with the seaports through the river canals. To complimentarily fulfill this task, the provision of ancillary facilities as well as an architectural design that caters for a functional flow of goods and persons as well as the storage of goods without interference shall contribute to this field of knowledge as existing facilities indicate the absence of this consciousness.

1.7 SCOPE AND LIMITATION:

This thesis entitled "inland water port Lokoja" shall lay special emphasis on the architectural component of ports. These shall include; an administration building,

terminal facility, jetties, storage facilities, circulation infrastructural plan, site arrangement, staff and passenger facility, lettable spaces and recreation facilities

The limitation in this work lie in the undoubted fact that port construction is to a great degree engineering ; also, the non availability of existing river port facilities in Nigeria, has compelled our study to be carried out on the seaports most of which are of a larger scale though not in all cases. Other limitations are financial limitations.

1.8 METHODOLOGY

Conditional surveys will be carried out in the existing seaports which shall constitute the primary data. Other data to be utilized shall be drawn from secondary sources such as journals, magazines, books, related documents and newspapers as well as case studies drawn from visits to existing facilities, sites, and internet resources. This research shall be a scientific research.

1.9 CLIENTS, SPONSORS AND USERS:

"the national importance of harbors and docks is of the first order, and if it be conceded that the state should build anything, then surely harbors should come in the category of those structures to be built and owned by the state" (Taylor; 1949: 84). In line with this statement, the activities of the seaports are run by the Nigerian Ports Authority (NPA), in the case of inland water ports, the National Inland Waterways Authority (NIWA) shall shoulder the responsibility of running these ports.

The Lokoja port has been proposed to take off by the year 2010 according to the transport master plan 2003.The clients are the federal ministry of transport. The users shall be companies /industries and firms involved in the transport sector.

REFERENCES

1. Adeeko.A. (1998). Introducing Tincan Island Port*: tincan island port handbook.p.5.* Lagos. Nigeria Ports Authority.
2. Albert (1978). In R.T.Mohammed. *River port terminal for baro*; unpublished MSc. Thesis.p.2. Zaria: Department of Architecture.
3. Bookman (1996) The Future of Marine Activities; www.ports in usa.com.
4. Chan.H. (2003). Modernization of Ports: "*the future of marine activities*". p.2. www.ports in usa.com.
5. Dabo. (2002). Decongesting the ports: Nigerian ports authority news. *Journal of the Nigerian ports authority; volume 3 # 15; pg 5.*
6. Hilling. D. (1969).problems of port development in West Africa.: *Transport in Africa*. Proceeding of a seminar held in the centre of African studies. p.41. Scotland. University of Edinburgh .
7. Kendall (1986). Multimodality. In Y. Hayuth. Multimodal freight transport. In Hoyle et al *Modern Transport Geography*. London: Belhaven press.
8. *Longman Dictionary of Contemporary English*.
9. MITI (2003). Analysis of transport infrastructure: *Master plan for Integrated Transport Infrastructure*; Abuja: federal ministry of transport.
10. Moody (1998). *The future of marine activities*. www.ports in usa.com.
11. Snyder. J. (1979) Introduction to Architecture; Mc Graw hill; New York.
12. Taylor. D. (1949). *Docks, wharves and piers*. New York: Stoughton press. p.84

CHAPTER TWO: LITERATURE REVIEW

2.1 PREAMBLE-GENERAL HISTORY OF PORTS

Water transportation is the cheapest and safest among the other modes and can be relied upon for pleasurable and relaxing journeys when good quality services are provided. (Okuofu and Nnama, 1998:24) Water covers about 75% of the earth's surface whether as ocean, lakes, rivers, or other forms (Ofoedu, 1990) and as such provides a ready means of conveyance from one geographical area to another.

Water has proven to be a resource that is largely invaluable in the sustenance of life. As a means of transport, it has manifestly been the cheapest and easiest means of conveyance of goods and services from one area to the other. In history water transport dates back almost to the earliest period of mans known existence. Among the various means of transportation available to man, water has proven to be the most beneficial not only in terms of transportation but also in other respects. This assertion is reflected in the establishment of settlements along major waterways the world over from time immemorial. In Mesopotamia, the Tigris and the Euphrates provides for us a clear example 'in Egypt settlements along the Nile are another example among many.

Transport is an industry involved in the conveyance of goods, people, and services from one location to another. Transportation requires a medium for conveyance to take place; these are air, water, land, pipelines etc.Water as a medium for transportation requires harbors or a place of shelter for ships.

Harbors have a dual history;

1. Harbors of the ancient from 3500 BC –AD 500;
2. Harbors commencing in the 18th century

In the thousand years which separated these periods, i.e. from the extinction of the roman empire to the beginning of the 18th century, no development took place and most of the early art of harbor building was lost.(Taylor 1949 :35).

Practically all the ancient harbors of importance were in the Mediterranean, which as far as is known remains the home of the earliest seafaring nations. The Cretans appear to have been the earliest navigators, and there is evidence that the conducted sea traffic with Spain and England as early as1600 BC. Other vestiges of the Egyptian ports in history has left knowledge that commerce was carried out between Crete and A-Ur on the canopic branch of the Nile in about 3000 BC which most likely is the earliest of all Egyptian ports. Many other ports which existed in history these are: port of Pharos, port of Sidon, port of Tyre, port of Carthage, port of Alexandria, port of Piraeus, port of Cnidus, Claudius port of Ostia in ancient Rome, the Roman pierced moles etc. Taylor (1949) remarks that "after the Roman era no harbour of importance was carried out for centuries. Ships embarked and disembarked cargo and passengers in estuaries or open road steads. It may be said that the revival of harbour construction was fostered by military reasons in the 18th century. Examples of these are; the ports and fortress of Dunquerque, port of London etc the 19th century picked up this art and it went on and on.

2.2 HISTORY OF PORTS IN AFRICA:

Ports in Africa can be traced back to harbours around already established settlements since rivers were a major means of transportation from place to place and for other activities such as fishing etc.

In the 15th century the European colonialist began their exploits establishing slave ports along the coast of West Africa. As centres of cultural contact Hoyle (1967) remarked that

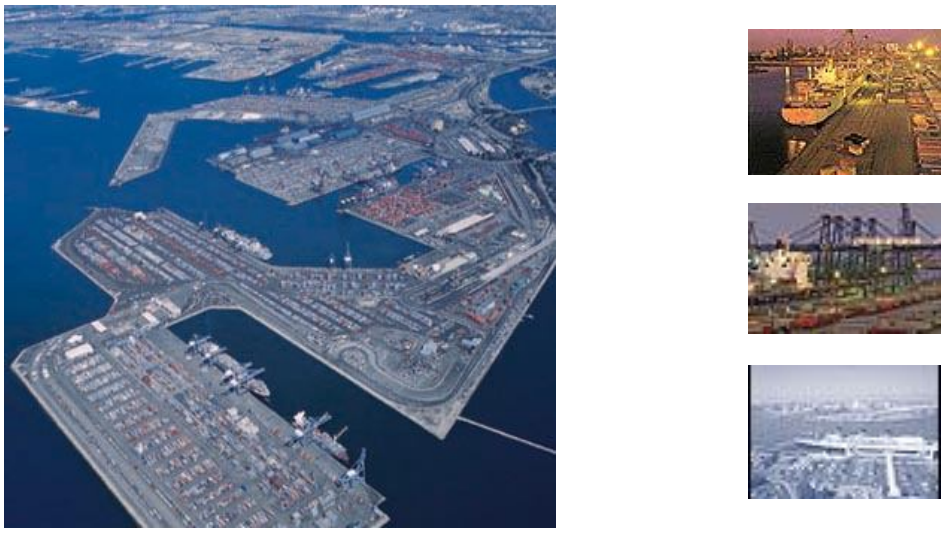
ports acted as a means of reaching the inner parts of Africa (hinterlands) which was until the time of European contacts not known to the other parts of the world. These ports were also points/centres of economic contact. This basically formed the ingress of development in Africa. This development generated into economic ports for the importation of finished goods as well as for the exportation of raw materials in colonial and post colonial Africa.

2.3 HISTORY OF PORTS IN NIGERIA:

Nigeria's earliest importation and exportation of goods depended largely on maritime transport because other modes of transport– air, rail, pipeline, and roads were non existent, underdeveloped or very expensive (Nnama; 1988:24). Along the waterways in Nigeria fishing ports existed even in the pre-colonial era even though no specific date exists in document. Ogundana; in his assertion agrees with the evolution of ports in the 15th century as given by mohammed (1999), he further breaks down the period of alternating concentration and diffusion into six periods which emerged from an empirical study of changing port significance in Nigeria. During the first period European activity along the Nigerian seaboard was limited. Benin through its port of Gwato was the leading port of trade, the Warri kingdom, probably through Ode Itsekiri, also engaged in trade. Bonny was a significant port, while the Europeans had only feeble contacts with the other rivers such as Brass and Calabar. Lagos probably did not exist until towards the end of the period.

2.4 RIVER AS A MEANS OF TRANSPORTATION:

A river is a large, natural stream usually fed by converging tributaries along its course and discharging into a larger body of water, such as an ocean, lake, or another stream. Chorley (1969) remarked that many hundreds of rivers discharge into the sea, but most of



(Plate 2a showing the Port of long beach, California; source: www.polb.com/.)

the flow occurs in a few larger streams. This indicates that not all rivers can flow directly into oceans or that some flow into larger streams which in turn flow into oceans or lakes. Not all nations have the fortune of being on the coastline of the sea or ocean but nearly all nations are traversed by rivers.

Rivers have served as means of transport, communication and trade from place to place in different parts of the world. In Africa economic problems have hindered the construction of roads; people in the riverine areas are left with no alternative than to utilize canoes on rivers and streams to convey their goods, services and passengers to have a link with other parts. Ferries have always been used in Nigeria on the river Niger and Benue to carry goods and passengers etc, to link the people in the riverine areas with the other parts of the country. Ezetulugu (1974) commented that "the use of rivers to transport is importance to any useful economy especially as a means of contact with the

hinterland. In Nigeria these rivers form a good network and traverse through almost all the states and can be used in improved conditions in improved conditions for local and distributive trade." River port terminals will go a long way to improving domestic trade and distribution of goods. The will also serve to facilitate equitable distribution of goods.

2.5 IMPORTANCE OF WATERWAYS AND PORTS:

Besides the provision of food, mineral and energy resources, waterways serve as a source of security and national defense, source of space, leisure, waste disposal, and for trade transport and communication Mohammed; (1999). Shipping is one of the uses of the sea and waterways. It is most important to the society as most of the world's foreign trade travel by sea. This is possible because about 72% of the earth's surface is covered by water serving as a bond for many countries. Sea transport is the cheapest of all forms of large scale transport; this is the reason why foreign trade is associated with maritime transport.

Waterways played vital roles in the civilization of many parts of the world. They have always influenced commercial and industrial activities which are tools for economic development. The Mediterranean was the cradle of civilization largely because it was a nursery of maritime trade. Seafaring means ports; and most of the early cities of the Mediterranean lands were ports as well as major cities examples are Tyre, Sidon etc. The multifunctional character of the seaport extends to the industry as well as the commercial activities associated with the transfer of goods. The functional structure of a port in commercial, industrial, and military terms is determined partly by the nature of the hinterland and partly by the water of the port in relation to the overseas maritime links;

moreover, different port functions relate to different areas of the hinterlands on an international, national and local scale.

2.6 DESCRIPTION OF RIVER NIGER:

The river Niger flows (third largest river in Africa) from the west to the east of West Africa through Guinea, Mali, Niger, Benin, and Nigeria to the gulf of Guinea. It has a length of 4180km which is interrupted by so many rapids and has two deltas –an inland delta in central Mali and a coastal delta along the gulf of Guinea. The coastal delta is the largest in Africa, spanning nearly 190km.

The Niger originates in the highland of southern Guinea near its border with Sierra Leone. Several tributaries contribute to the size and flow of the Niger from the upstream with a resultant flood plain downstream from Bamako near Segou .There, the waters of the Niger spread over an inland delta that covers 20,000sqkm. In the process of replenishing



(plate 2b showing inland delta along the Niger)

several lakes, as well as through ground absorption and evaporation, the Niger loses a large part of its water leaving the river much diminished beyond the inland delta. As the river flows into Nigeria, heavier rainfall as well as the inflow of the river Sokoto and

Mekrou adds to its flow and volume. Southwards, its volume is greatly increased by its major tributary –the river Benue as well as other tributaries –rivers Kaduna and Anambra. As it moves south from its junction with the Benue at Lokoja, past Onitsha and toward its mouth, it is a broad, deep river that flows within a confined channel .Before the gulf of Guinea it forms a trellised fan-like entry with a lot of sedimentary deposits.

Southward the river flows through a lush savanna down to the tropical forests. The Niger contains almost 200 species of fish and many wild animals. (Microsoft Encarta 2002)

2.7 ECONOMIC IMPORTANCE OF RIVER NIGER:

About 5000km of the Niger and its tributaries are navigable. Commercial navigation begins close to its source in the town of Kouroussa in Guinea. Several rapids between Koulikoro in Mali and Jebba in Nigeria interrupt through traffic save for the lock in Kainji dam which permits boat passage.

Along the upper middle Niger passenger travel holds a chief place. Owing to the poor network between road and rail, six river ports were upgraded in the 1980s in Nigeria to encourage passenger and goods conveyance and to encourage greater use of the inland waterways.

Furthermore river Niger serves the purpose of agriculture even far beyond the Niger valley. Among these benefits is fishing even though in the post 1970 period there has been a substantial drop in terms of catch by about half its value. The drop is mainly attributed to drought, increased water diversion for irrigation, dam construction and over-fishing.

Local livestock farming is also greatly supported by the river Niger except along its lower course where tsetse fly is prevalent. Herdsmen (primarily Fulani tribe) depend on the

river for water and on its flood plain for dry season pastures for their cattle, sheep, and goats.

Irrigation schemes on the river Niger has helped immensely in the expansion of agricultural development in the Niger basin with a resultant increase in agricultural output. Since 1932, when the French colonialists held in control a good part of West Africa, attempts at developing about one million hectares of the inland delta area of Mali for irrigated cotton and rice production commenced, of which only 55,000 hectares was cultivated as at the 90's. Other irrigation schemes that were developed were principally in Nigeria; the downstream of the kainji dam and along the tributaries of the Niger. Crops such as millet, sorghum are the leading crops in the drier savanna area of the basin, while tuber crops and maize are grown in the moister regions (Microsoft Encarta; 2002).

In 1968, the largest hydro electric plant on the Niger was completed at kainji dam providing Nigeria with about one sixth of its electricity demand. Energy supplies however were unreliable due mainly to the frequent drop in water level in the river, poor maintenance of infrastructure, and growing demand. The use of the river Niger's water is presently not regulated, and new dams are being constructed on its tributaries. These developments in themselves pose a threat to the river's discharge and the deposition of fertile soil on the flood plain. Its results are numerous and can be an impediment to further developments in agriculture particularly livestock farming.

The river Niger is of great economic benefit to the entire region of West Africa. In terms of transportation it provides an easy means of travel from place to place along its course.

2.8 NAVIGABILITY OF THE NIGER:

Nigeria has almost 3000km of navigable waterways, centred on the Niger–Benue river system .The potential of this means of transportation among others is considerable due to its relative cheapness .In addition, this transport mode has a relatively low impact on the environment compared with other modes its energy demand is low and it can efficiently handle bulk cargo. (MITI; 2003:123)

The term navigability means the movement of vessels in a given water body. About 5000km of the Niger and its tributaries are navigable even though some impediments to navigation exist alongside. These are factors like the presence of rapids, and other unwanted interruptions.

The potential for navigability was harnessed in the pre-colonial era which saw the use of the Niger as a means of transporting agricultural goods to the international ports from the interior of the country. Inspite of this, physical / operational constraints to navigability have led to a great reduction in navigation (MITI; 2003:123).

Within Nigeria's territory the river is 2600km and does not connect any major economic centre. Also, the water level in the Niger River varies considerably during the course of the year. During the rainy seasons the depth of the river allows even large barges to navigate up to Lokoja and up to Baro. In the period between May / June and the end of October tug barge convoys (2*1000tons) can navigate safely (MITI; 2003:123). At present navigation is impossible or at least very difficult for larger barges outside the rainy season and only shallow draught vessels can operate.

The Kainji and Jebba dams were constructed for the purposes of generating electricity, and to store the discharge of the river thus increasing the minimum flows and reducing the maximum flow of the river to support downstream navigation.

Between lokoja and the bifurcation, the Niger splits into several channels carrying insufficient water to provide sufficient navigational depths. Additionally these channels change their discharges from year to year, so that a channel may provide enough water for navigation for one year, and be reduced to a rivulet the following year.

Sedimentary action is particularly problematic at river crossings with deposition taking place during the high water and is scoured again during the low water levels. Since the year 1983, the least available depth has not been



(plate 2c showing high sedimentary action of the river Niger)



(Plate 2d map of the Niger)

updated thus there is no yield in data about the least available depth. Again the current velocity on the river Niger at maximum is about 2m/s which do not have a negative effect on inland navigation. Rock outcrops near the navigation channel of the Niger, south of Lokoja along the sacrifice channel are direct impediments to navigation. In the past, some

of these were removed; others were indicated by markers, while others are still unmarked.

2.9 NAVIGATION CONDITIONS:

The tasks on navigation are twofold namely**:**

1. Physical constraints;
2. Operational constraints.

2.9.1 Physical constraints:

This is best explained in terms of basic channel characteristics and dimensions, current velocity and physical obstructions in the navigation channel.

2.9.2 Operational constraints:

These include standards like adequate access to port facilities along the river throughout the year, fleet and port operations, communication and reliable navigation aids around the clock.

2.10 INLAND WATERWAYS IN NIGERIA:

Nigeria has over 3000km of navigable waterways(MITI;2003:123). These include; rivers Niger and Benue, and their tributaries as well as coastal creeks and lagoons. This natural endowment constitutes a great economic resource to Nigeria. The potentials are quite much even though obstacles stand in its course of development and use. Fluctuations in

their physical characteristics are however discouraging. The presence of rapids, shifting channels, fluctuating depth are all obstacles to easy navigation. At the bifurcation large silt deposits make it difficult for large power crafts to sail seaward. Consequently only limited distances allow for uninterrupted navigation.

The river Niger from Baro downstream was the main source of importation and exportation of goods in the pre colonial era. Again, the development of the road network has greatly reduced the use of the river Niger except along the coastal fringes, in the Niger delta region where petroleum related activities have continued to generate high traffic in the creeks and lagoons. In the colonial era no major works were carried out on the rivers save the elementary improvements of cutting the inside of bends, light dredging, weeding, and the creation of channel walls by piling where banks were weak.

The kainji project of 1968 contributed immensely to the revival of navigation on the river Niger by controlling the water levels through either reduction or addition as the season demands.

Barbour et al (1982) states that "the Niger below Baro to Lokoja has the largest traffic". "In the best of years however about 300,000 tons of cargo were transported along the Niger and Benue with about one–third of this tonnage moving upstream and two–third moving downstream" (Okuofu and Nnama;1988:24). This is an indication of the possibility for great improvement of the resource for better results.

2.11 DREDGING OF THE RIVER NIGER:

In all navigation routes all over the world dredging is a continuous exercise. In some sense, dredging simply means a dragnet exercise to remove sediments and other obstructions in the course of a river.

Dredging the river Niger from Port Harcourt upstream to Baro will make the river navigable all year round (NIWA 2001; NITT2002:188). The required least available depth for all year round navigation is approximately 1.7m-2.0m which can be achieved by capital dredging works combined with recurrent dredging works. With this, the inland waterways can take 10,000 tons flat bottom ships and barges and in the high water season up to 20,000 tons of flat bottom ships (Malizu et al; 1988:27).

On the 10th of February 1999, the contract for the dredging of the river Niger as proposed by NEDECO was awarded. This activity shall in no little way enhance navigation and commercial activities in the riverine areas with a resultant manifestation in the national economy. Dredging shall enhance smooth sailing on the river Niger. According to Abubakar (1999:44) "this will be a catalyst for economic upliftment and development of the hinterland". On 11th February 1999 the new Nigerian newspaper reported that "when ships carrying 2000 or more tons of cargo are able to navigate upstream of the Niger, Abuja will only be about 100km from the sea".

The necessity for a river port at lokoja becomes more glaring after a consummate reflection on the potentials.

2.12 MAJOR RIVER PORTS IN NIGERIA:

Principally, the major river ports in Nigeria are those on the river Niger and Benue.

Those on the river Niger are: Onitsha, Idah, Lokoja, Baro, Jebba, and Yelwa.Those on the river Benue are: Makurdi, Ibi, Lau, Numan, Yola, and Garua.

2.13 PORT AT LOKOJA:

Lokoja port is quite an old and popular port being a confluence of two major rivers. Besides this it was a transit point for slaves and served the capacity of evacuating food

and cash crops, it is also known as one of the major fishing ports of olden times. These goods are often taken out of Nigeria to Europe via the Atlantic Ocean in which the river opens into, at the Bight of Benin.

The Lokoja port was mainly a fishing port before the colonial era and gradually translated to an administrative centre for the colonialists. As a fishing and transitional port, Lokoja has always remained itself in the processing of goods from the hinterland to the sea. No port facility was constructed in Lokoja even though the current NIWA jetty stands as a vestige of the old port facility.Lokoja is also a dockyard for ships in the post colonial era.

a. 

b 

a. (Plates2e: tug boats at berth along Lokoja jetty; source: field survey)

b.(Plate2f: Ship at berth in Lagos port; source: field research.)



(Plate 2g: Occupation of the lokoja people; source: field research)

Today the port at lokoja if fully operational shall stand to meet the need of the FCT Abuja thus shall be a link between the sea and Abuja, and shall be an agricultural collection and distribution centre (MITI 2003:188). In 1960, the projection for the improvement of the Escravos bar should have been a boost for the Lokoja port and other ports if it only was implemented.

To meet these contemporary demands, adequate facilities that meet the needs of a standard port is necessary since it shall serve the purpose of the FCT Abuja. These facilities shall include; port administrative offices, quays, and berths which shall auger well in line with the proposal of NEDECO (1959).

2.14 ECONOMIC BENEFITS OF RIVER PORTS:

A well organized transport sector is the bedrock for economic developments (Shem; et al; 1988). Water transport is the most economic of all modes of transport especially for low value (bulk) commodities whenever time and quality of transport holds no place of importance. River ports are thus a necessary compliment for effective river transport. River ports shall serve the purpose of connecting economic centers as nodal points for inter-modal exchange therefore ensuring even economic development in all parts of the country. River ports are also intermediaries between producing areas and consuming areas. The serve as points for distributing local and foreign goods across the country. The river Niger and Benue are the most assured link between the east and west of Nigeria since rail and road transport only offers north/south movement. Employment shall also be provided through the activities of the river ports in their respective locality.

2.15 CONCLUSION:

From the conditional surveys above the port in Lokoja is highly deficient in terms of facilities needed for a fully operational and functional river port even though its pristine engagement still holds with respect to trade cargo and administration. Mohammed (1999) states that ‘‘there are many ports which however, do not contain ship quays and these primitive ports carry on an appreciable aggregate of world trade.” Lokoja port is one among many examples. Providing a modern port facility that meets optimal functionality and contemporary expressions shall boost activities in the port of Lokoja. Architectural expressions are to be explored considerably to foster maritime interest in the interior of Nigeria. In this particular case, the facility shall express the influence of its being near Abuja since it is expected to serve its purpose as a stimulant.

B.S Hoyle (1973) gave two phases of transport development namely ‘‘initial transport provision and transport elaboration”. Initial transport development involves the construction of major rail arteries, modern roads and port facilities. Its main character is that it permits economic growth to a certain extent and impedes development if not followed by a well integrated and efficient transport system (transport elaboration).The port of Lokoja intends to meet these two conditions, first by providing a port facility, and secondly with an integrated approach to the various modes of transportation. This shall be a strong stimulant for growth and development.

REFERENCES:

1. Barbour et al (1982). In R. T. Mohammed. *River Port Terminal for Baro- Integrating Forms and Space with Immediate Port Environment*; unpublished MSc. thesis. Zaria: Department of Architecture. p.16
2. Chorley (1969). In R. T. Mohammed. *River Port Terminal for Baro- Integrating Forms and Space with Immediate Port Environment*; unpublished MSc. thesis. Zaria: Department of Architecture. p.13
3. Ezetulugo (1974). *River port marine terminal*; Onitsha. Unpublished MSc. Thesis. Zaria: Department of Architecture.
4. Hoyle.B.S. (1973). *Transport and development*. London: Macmillan press.p.
5. Malizu et al (1988); Unpublished Report; Nigerian Institute of Transport Technology; *Transport Planning and Management Course on Inland Waterways*.
6. *Microsoft Encarta* (2002); description of the River Niger.
7. MITI (2003); - navigation conditions of inland waterways. In: *Master Plan for Integrated Transport Infrastructure.* Abuja: Federal ministry of transport.
8. New Nigerian newspaper. Navigating the Niger upstream. 11th February 1999. p.
9. NIWA (2001); NITT (2002). In*: introducing inland waterways. Master plan for integrated transport infrastructure*. Abuja: federal ministry of transport. p.188
10. Nnama (1988). In: Malizu et al*: unpublished project report on Inland Waterway Development*. Zaria: Nigerian Institute of Transport Technology. p.24.
11. Ofoedu (1990). In R. T. Mohammed. *River Port Terminal for Baro- Integrating Forms and Space with Immediate Port Environment*; unpublished MSc. thesis. Zaria: Department of Architecture. p.9

12. Okuofu and Nnama (1988). In Malizu at al: project report on inland waterways development in Nigeria: problems and prospects. *Transport planning and management course on inland water ways*. Zaria: Nigerian institute of transport technology. p. 24.
13. Shem et al (1998). In Malizu at al: project report on inland waterways development in Nigeria: problems and prospects. *Transport planning and management course on inland water ways*. Zaria: Nigerian institute of transport technology. p.
14. Taylor.D. (1949). *Docks, Wharves and Piers*; Stoughton Press New York.

CHAPTER THREE: PORT FACILITIES AND OPERATION.

3.1 INTRODUCTION TO PORT FACILITIES

According to the transport and communication report federal republic of Germany, “not even a highly modern inland shipping fleet would be really productive without efficient inland ports. A quick turn round of vessels would be neutralized through the time spent berthed in ports.” For this reason, the main concern is to speed up trans-shipment of goods and to discharge inland vessels more rapidly.

To this extent port facilities are necessary as a compliment to inland shipping proper. It suffices to say that these facilities are installations which aid port operations in maximizing efficiency in port performance.

The primary task in any port is the transfer of goods and commodities from one transport system to another e.g. from ship to truck, train etc it suffices to say that quays, wharves, transit sheds, warehouses and piers with a properly integrated non-conflicting transport network are the most essential requirements of any port facility. Some other necessary ancillary facilities that aid port operations are, fire fighting facilities, rescue facilities, port security facilities, medical facilities, port engineering facilities, quarantine facilities, communication facilities, devices (water, light and sewage), pollution control, waste disposal and environmental protection (green areas, landscaping, beach areas and outdoor environment), recreational facilities for ship and port crew, port administration and control offices and passenger facilities. Others are fuel bunkering facilities, dangerous material areas, canteen and rest rooms.

Particular attention shall be given to the architectural components of the port facilities id est all architectural inputs in port development.

PORT FACILITIES:

The concern is about all facilities that have a relationship with architecture either in planning or in expression.

3.1.1 TRANSIT SHEDS:

This facility plays the primary role of an intermediary between permanent storage and ship-shore cargo flow i.e. it harmonizes the faster ship- shore flow with the slower inland shore movement of cargo. This facility houses sensitive cargo against weather elements, also it acts in the full capacity of a cargo waiting area\zone. They are provided for the role of temporary storage for goods discharged from vessels awaiting clearance and distribution to warehouses or railways. Export cargo is also stored temporarily in transit sheds. Cargo inspection is carried out in the transit shed with the aim of ascertaining the contents of the shipping manifest as given by the recording clerk. This activity is usually carried out by the customs. It is at the transit sheds that all customs proceedings are carried out. Transit sheds are usually not meant for long storage of goods; usually it is limited to a period of three months.

For the reason of its function given above they are usually located adjacent to the ship side i.e. to the water front. Transit sheds span about the same length with the berths owing to its location and usually has an average length of 160-180m. The width of the sheds does not follow any specified guidelines though its minimum range from 50-60m.the aisle apace between one transit shed and another is considerably large to allow for manipulation during operations.

Jones (1990) asserts that containers in a transit shed should be stored in a manner which maximizes security without causing any unnecessary delay in operations." by this he throws light on the risk and difficulty of multi-storey stacking whether in transit sheds or otherwise. Even though this is an agreeable point, others view it as inconsequential. These divergent views leave it to every port designer to assess. Ramatu (1999) states that "cargo handling is greatly simplified in single storey sheds and the need for expensive foundations and cargo lifts are obviated. Exceptions in multi storey are in situations where the second storey is used for a passenger terminal."

Cargo flow in transit sheds and warehouses should as much as possible be devoid of interruptions of any sort. Free space for free flow of cargo and operations is essential. As such interior columns should be avoided, insufficient width of sheds should be avoided, and ventilation and lighting should be given priority. Good quality floors that are smooth and resistant to deterioration should be provided.

Transit sheds should be flexible or demountable so that the can meet the changing needs of the port. Offices in transit sheds should be clear of the perambulating space and should not be an interference. Other needs are that loading platforms be provided at the rear ends for break-bulk cargo as trucks may need to load without the use of forklifts.

3.1.2 WAREHOUSES:

A warehouse is a long term storage facility either for imported or exported goods. Imported goods are only taken to the warehouse after three months which is a period of taxed storage. Warehouses are mainly for impounded goods storage.

Other uses of the warehouse lie in a ports engagement in commercial business of long term cargo storage.

Minimal dimensions are normally applied so long as the satisfy operations. The warehouses are principally run by the customs since impounded goods are the primary stored goods there. Warehouses are not normally located by the shipside; the results are often seen in a breach of its functions were they are taken to be transit sheds. They should rather be located in the rear of a transit shed or in areas agreeable by logical design.

The size of a warehouse can be determined by the extent of land available and by the use. Adequate space should be provided for truck circulation and railways; as much as possible clear spans of interior space should be attained to prevent interference. In the case of non mechanical loading of mobile carriers, loading bays provide ease of loading thus should have adequate width for easy maneuvering of equipment.

Materials used for constructing warehouses range from plastics to steel, timber, concrete, glass etc

3.1.3 PORT ADMINISTRATION BUILDING:

These facilities vary depending on the system of administration. Jones (1990) reiterates that “the port is a restricted zone as much as it is public; hence public facilities should be designed in ports to allow for easy access without breaching port control regulations on restricted zones”. This facility comprises all port offices and is usually under a head

called a port manager who oversees the affairs of the entire port. Port administration comprises various departments namely:

1. General administration department
2. Traffic department
3. Accounts department
4. Audit department
5. Harbor masters department
6. Port estates department
7. Industrial relations department
8. Legal department
9. Medical department
10. Marketing department
11. Procurement department
12. Public relations department
13. PMS Outfit
14. Personnel department
15. Statistics department
16. Security department
17. Stores
18. Communications department
19. Agents offices
20. Engineering department
21. Maintenance department
22. Customs department

All these departments save communications, security, maintenance workshops, engineering and traffic departments should as much as possible be in the public area of the port.

3.1.4 WORKSHOPS:

They are usually multi functional in nature and are usually located close to service areas within the port premises. The maintenance and repair of equipments are usually carried out here. It runs under a workshop manager as its administrative head.

3.1.5 COLD STORAGE BUILDINGS:

Cold storage buildings are facilities that preserve perishable cargo by providing the required temperature for their preservation. These cargos are mostly food items that are shipped in refrigerators inn the form of tanks enclosed in a square casing in some cases while in others, they are shipped by refrigerated boats and distributed for use. Cold storage buildings are situated in a way that enhances these items to be off loaded and stored in them with minimal temperature changes as in the case f refrigerated boats.

Items that fall into this category are; fish, meat, dairy products, vegetables, fruits, drugs and chemicals.



(Plate 3a showing cold storage tanks in containers; source: field work)

The water content in these items keep some of them chilled and others frozen due to their critical temperature generated via the water content in them. Cold storage deals mainly with a controlled environment in terms of humidity, temperature, and air velocity.

The size of this facility is not based on any specific standard, in this facility insulation should be given proper attention in detailing; openings must meet mechanical operation standards to prevent freezing. A vestibule or fore space should be provided before the refrigerator doors to prevent temperature gains.

3.2 SHIPPING OPERATIONS:

Shipping operations refer to all activities carried out in the process of shipping and the handling of cargo in ports. It involves all actions that regard ships and everything that it takes to arrive at an output in the function of ports. All ports have an internal control department that controls traffic/pilotage i.e. incoming ship and outgoing ship through the communications department of the control tower which operates at a frequency. This activity is carried out specifically to prevent conflict and to direct ships safely to berth.

Shipping operations may be local or international depending on the route the ships ply. Local shipping refers to operations carried out within the territorial boundaries of a country while on the other hand international operations refer to those carried out ex-national territories. Local operations require little customs procedures. The capacity of the vessels that travel local waters often differ from those that travel international waters. Those that travel local waters are of a smaller capacity than those that travel international waters though not in all cases especially where the local travels involve large shipping. Customs operation/ checks are usually carried out at points of entry or exit into ships for

passengers and for cargo depending on the planning procedure, the are most often done in the sheds. Porters are employed to carry luggages of passengers via conveyor belts as they board the ship. Passenger travel on ships is not too common owing to the duration of travel as well as loneliness.

3.2.1 Cargo handling:

Cargo is usually handled in ports in two ways which are;

Manual handling

Mechanical handling

3.2.1.1 Manual handling:

Manual cargo handling deals with men working with the cargo directly. In Africa this system is very common due to low technological development and availability of cheap labour. It involves the transfer of cargo to and from ships by men through loading them upon their shoulders or heads as the case may demand. Agricultural commodities are the give the most opportunity for cargo handling. In Nigeria, the groundnut pyramids were loaded into ships manually.

3.2.1.2 Mechanical handling:

Mechanical handling of cargo involves the use of machines to convey cargo to and from ships. This system of cargo handling has the advantage of speed and is not tedious compared to manual handling; and it eliminates to a large extent the cost of manual labour. This system involves also high technology in which case the initial cost of

installation is quite high. This factor makes it difficult for many ports to meet up with these technologies.

To understand cargo handling properly, it is apt to differentiate between cargo types in a bid to classify the handling equipments. general cargo are those that are shipped as units or packages e.g. barrels, boxes, bags etc.bulk cargo refers to loose, unpacked materials e.g. grains, flour, petroleum products, cement etc.

3.3 Handling equipments:

As earlier stated cargo handling requires equipments to load and unload them into vessels. These equipments include; forklifts, mobile cranes, ship gears, and transverse forklift trucks (unloading equipment). Other equipments are truck, trailer, and cranes mounted on Lorries, conveyors.

3.3.1 Forklift:

These are equipments which can pick unit cargo and palletized cargo off the apron and run them into the shed as well as stock them up to a height of 6m. Horizontally, they store cargo within spans reaching any given limit. They are known to be very effective and efficient even though their efficiency diminishes as its travel reaches up to 70m owing to their slow speed.



(Plate 3b showing forklift amidst containers; source: field work)

3.3.2 Mobile cranes:

Mobile cranes perform similar functions with the forklifts. The difference being in the horizontal travel which in this case is a limitation. These cranes are able to handle objects that cargo that are stacked in considerable heights. They are pneumatic tyred mile cranes meant for operation in close quarters.

3.3.3 Conveyors:

Conveyors are used in maintaining the flow of bulk cargo in the cargo transfer line. The different types of conveyors used in ports are slats, pressure pipes, overhead chain or monorail and inclined plane conveyors.

3.3.4 Ship gears:

A cargo vessel has each of its hatch equipped with a pair of cargo booms. This facility is called a ship gear and is useful for loading and unloading vessels. One of the hatches is stretched over the offshore edge of the hatch, the other over hanging the hatch. Each possesses cargo hooks used to anchor the cargo to be hoisted. These hatches rotate and are able to turn in any given direction.

1.  **2.** 

(Plate 3c 1&2 showing the ship gear loading and unloading vessels; source1: field work, 2: www.polb.com)

3.4 Containerization:

Containerization involves the process of packing various cargo types into steel, wooden or aluminum cans meant specifically for that purpose. Containers have doors that can be sealed and locked and are versatile means of conveying goods as well as ensuring security of goods.

Containers are of different types and they in turn serve different purposes and are usually in standard modular sizes, they also aid handling of cargo. Containers are compatible with virtually all means of transportation and are standardized internationally. They carry different cargo types from liquid cargo to dry bulk cargo, live animals, fresh fruits and vegetables etc. In all these the containers are specially fitted with the requirement in each case.

Containers play important roles in shipping and its advantages are numerous and these are; in terms of cargo security the have proven to be very helpful, they provide protection against weather elements, they prevent breakage of cargo, they aid loading and unloading of ships in ports and reduce the time ships berth in ports thus reducing cost by increasing turn around of ships. They are easily loaded and unloaded into other conveying systems for inland transport. Their disadvantages lie in the weight, additional loading volume, and low flexibility.

It has been a generally acceptable fact that containers are among the best innovations of the shipping world. (World freight technology)

1. 

(Plate3d 1,2&3 showing containerization of cargo source:1-field work, 2&3-www.polb.com)

2. 

3. 

3e. 

(Plate 3e showing a ship at berth; source: www.polb.com)

3f. 

(Plate 3f showing a modern forklift; source: field work)

3.5 Palletization:

Palletization means stacking of goods on wooden platforms for easy carriage as a unit. The have attached bases designed for carrying substantial loads and to be easily and efficiently handled by mechanical handling equipment. The side walls and base of this container may be either tight or open construction and may or may not have tops of tight or open constructions. This type of packing has grown remarkably since the second world war' simultaneously with the development of mechanical handling equipment and the design of high ceiling warehouses to accommodate heavy floor loading. Its advantages are in the reduction of tare weight and thus transport cost; reduction of the cube size thus permitting the loading of more containers in a given conveyance thus reducing transportation cost; permits maximum cube utilization in warehouses at origin as well as at destination and in transportation vehicles. When required for extreme stacking, pallet containers with corner posts can be designed.



1.



2.

(Plates 3g, 1&2 showing non-containerized cargo; source: field work)

3.6 CONCLUSION:

Based upon the perusal of port facilities and operations, good planning as well as a combined service of all necessary facilities shall constitute a good port. On the contrary, port facilities without the necessary support facilities may hardly meet the test of good performance. All stakeholders in the design and engineering of ports therefore have a role to play by providing effective and efficient facilities that shall enable the port perform to the required standard.

REFERENCES:

1. *Architecture and transportation*; volume 64 #5\6; academy editions London.

2. Freight transport demand of industry in Nigeria; *dock and harbo*ur; volume 4.

3. Jones (1990) *Cargo Security* – A Nuts and Bolts Approach; Boston printing; USA

4. Mohammed T.R (1999) *River Port Terminal, Ba*ro unpublished MSc (arch) thesis.

5. (2004) Nigeria Ports Authority ;(information for website).

6. *World Freight Technology*; Volume 24; #13; London.

CHAPTER FOUR: CASE STUDIES

4.1 INTRODUCTION:

In the course of this work existing case studies have been taken within and outside this country to serve as a guide in the given task. Local case studies have been taken in Nigeria as a study guide while two foreign case studies are taken as well.

The criteria for choosing case studies are:

1. Considerations with respect to their links with the subject i.e. the exploration of alternative circulation patterns for ports. Therefore a broad array was chosen to throw light on the various approaches to circulation.
2. The non-availability of case studies of existing river port facilities had to be compensated for with the study of sea ports which in any case reflects the same expectation. It has also been noted that certain river ports are larger in scope or capacity than sea ports in themselves and may need more circulation facilities e.g. the port of Duisburg in Germany.
3. In an attempt to reach at a local study of river ports, a proposed design of a river port in Lokoja was taken and analyzed.

4.2 CASE STUDY ONE: PROPOSED INLAND PORT AT LOKOJA

4.2.1 History: The port of Lokoja is located at the confluence of rivers Niger and Benue. It is a pre colonial transit port. Its major activities at that time were its being a linkage port and a fishing port. Lokoja in colonial times was also an administrative port for the colonial government. Before 1960, Lokoja jetty was used by John Holt ventures and UAC. Lokoja later became the headquarters of the Inland Waterway Department (IWD).

In 1997, National Inland Waterways Authority was established to replace the IWD with its headquarters at Lokoja.

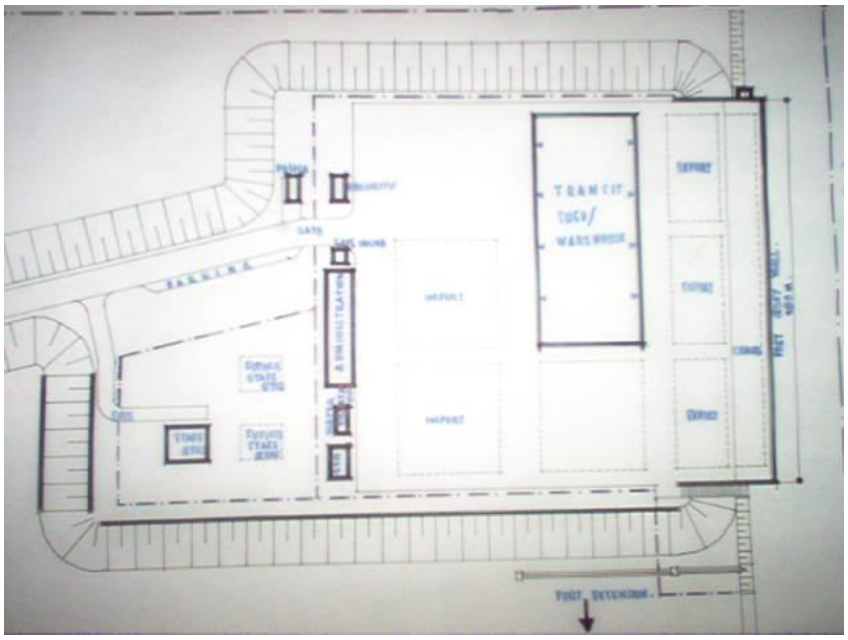
Consultant designers: Haskoning Engineering Consults.

Date: February 2004

Client: Federal Republic of Nigeria; Federal Ministry of Transport; National Inland Waterways Authority.

4.2.2 Facilities and description:

In this design proposal, facilities were provided to aid the smooth running of the Lokoja port in the capacity of a full scale river port. These facilities include: an administration building, water treatment plant, gate house, transit shed, warehouse, shipside, quay, staff housing, police station, generator house, and parking.



(Plate 4a Site plan of the proposed lokoja port; source: haskoning Nigeria.)

Storage data:

Area for storage =40m * 86m

Storage expansion =40m* 40m

Export space =20m* 40m (3 numbers)

Import space =40m * 40m (2 numbers)

4.2.3 Criteria for choice of site:

1. A new site was chosen based on the following criteria:
2. Its proximity to the proposed Lokoja – Abuja dual carriageway;
3. The need to boycott circulation conflicts especially with respect to the existing NIWA facility;
4. The depth of the river at the new site;
5. Possibility for clear expansion.

4.2.4 Merits of design:

1. Design is cost effective;
2. The design has a simple network of services.

4.2.5 Demerits of design:

1. Poorly integrated circulation system with the absence of some important circulation modes namely rail system.
2. Vehicular system not given a clear cut circulation route which shall result in conflicts as operations intensifies.
3. Design did not provide certain important facilities such as control tower, communications outfit, fire service station, customs unit, health care facility.

4. Aisle widths between transit shed not up to the required consideration. Only 6m was provided.
5. Admin building poorly designed and does not reflect a port as given by UNCTAD1983 – "ideally, the facilities which a port provides should be designed jointly with the ships which will use them, the land transport and the port facilities at the other end of the route i.e.; as part of the integrated transport system." this standard is wholly contravened in the architectural expression given.
6. Consideration is not given to aid expansion in circulation. In the long run, this shall result in conflicts.
7. Storage space not up to the specified cargo tonnage projection.
8. Design not in conformity with technological advancements in cargo inspection.
9. Cargo security poorly designed for.

4.2.6 Findings:

The findings are:

1. Due to antiquated design approach, as well as cost considerations many design functions were left out of the design. This is manifestly the absence of facilities that are a sine qua non to the existence of any port. One of such assertions was given by Jones (1990) that "the principal activity in any port is the transfer of cargo from one mode of transport to the other and indeed the port is an interconnectivity of transport mode networks." In this, only vehicular and pedestrian routes were provided.
2. The port at Lokoja is meant to serve the FCT, and should reflect in an expressive manner the dignity of the city it reflects. This is absent from the elevation.

3. Cost played an effective role in this design which is good.

4.3 CASE STUDY TWO: LAGOS PORT COMPLEX APAPA

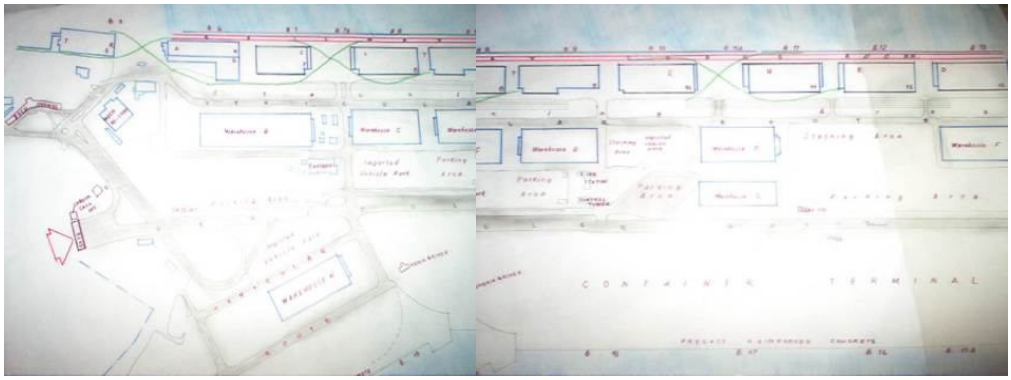
4.3.1 History:

Lagos port complex began port operations in 1914 as the defunct customs wharf in Apapa. It grew to be the busiest and biggest port in West Africa covering an area of about 200ha of land with 27 berths.

4.3.2 Facilities description:

The site of Lagos port is properly serviced by a complex network of roads, rail, and water transportation. It has a silo capacity of 76,600 tonnes; it has a weekly transport of 9-10 vessels per week.

The maximum vessel dimension in the Lagos port is 210m length, a maximum draught of 10m.



(Plate 4b Site plan of the Lagos port complex; source: Julius Berger Nigeria).

4.3.3 Cargo types:

The import cargos are basically dry bulk general cargo; the export cargos are cocoa, animal feeds, battery dust, gum Arabic, and columbite.

Circulation: Railway gauge – 400mm gauge (not functional)

Container Crane Tracks – 457mm gauge

Mechanical Handling Equipment: 9.2 plants and equipment.

Cargo Worked: General Cargo, Dry Bulk, Liquid Bulk

Agents: 10 numbers

Others: Clinic, infrastructural development and modernization to meet international standards.

Existing facilities: Old administrative building, New administrative building, Transit sheds, warehouses, Gate house, Control Tower, Canteen, Imported vehicle park, Car park, Mechanical workshop, Dock offices, Quay stacking areas, Weigh bridge, Police station, Fire station, Water tower, Workshop.

4.3.4 Merits:

1. Have all the circulation modes in place.
2. Separation of port functions between Apapa port and container terminal aids circulation and inspection of cargo.
3. Modernization of port facilities stands to boost operation especially with the projected interconnectivity with the various modes of transportation.

4.3.5 Demerits:

1. Administrative facility not homogenous i.e. administrative functions are scattered and this results in poor traffic control in terms of access.
2. Unlimited movement of persons within the port is a threat to security of cargo. The design did not segregate its functions actively.

3. Irregular and undefined route for cargo movements results in careless placement of cargo. It becomes difficult to identify cargo either for inspection or otherwise. This may also culminate into a security threat.
4. Conflicts of circulation and lack of clear cut routes for vehicular traffic.
5. Congestion at port entrance is most likely due to poor forecast.
6. Expression of the entire complex devoid of a water front character.
7. Design shows the absence of a genuine design concept which has given rise to discordant functional character.

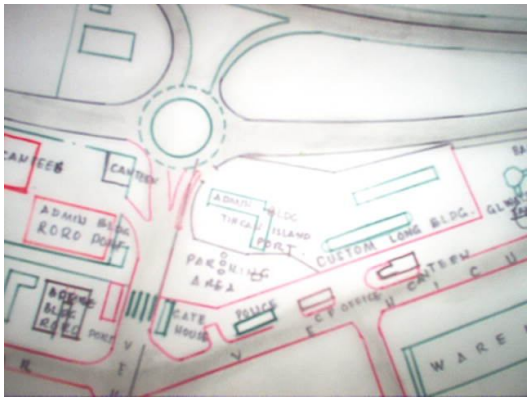
4.4 CASE STUDY THREE: RORO

4.4.1 History:

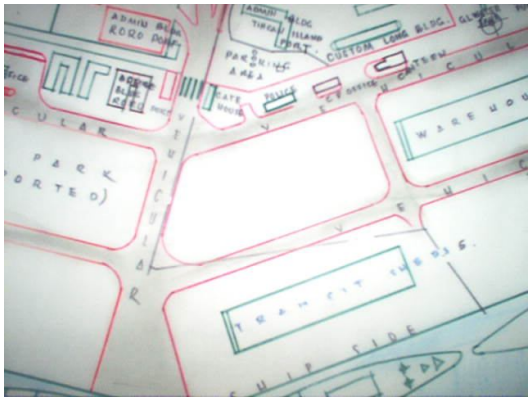
These ports were both commissioned in 1977. RoRo port was commissioned as part of the Tincan island port facility. Roll on roll of facility known in shipping parlance as RoRo is one of the most modern and efficient systems of cargo handling in shipping the world over.

4.4.2 Facilities and description:

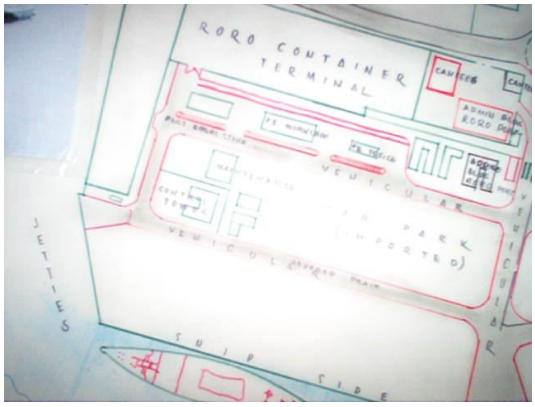
The port is uniquely equipped to handle a large number of vehicles container and general cargo. The port consists of berths 9 and 10. it also has 7 car parks in the Tincan island port. The total capacity of the car parks is 7987 car. The quay length is 435m, and has a maximum draught of 9.5. There are two warehouses of 6800sqm each and an administration facility. 50 plants are employed in the day to day activities of the port. The major cargo handled in this port is those that run on wheels.



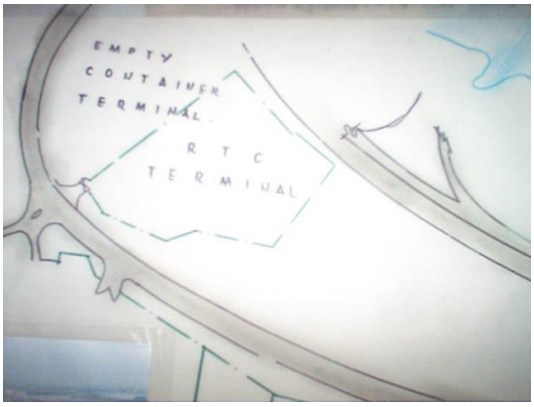
a.



b.



c.



d.

(Plates 4c a-d plates showing various aspects of the RORO port complex; source: Julius Berger Nigeria.)

4.4.3 Merits:

1. Proper segregation of storage facilities.

4.4.4 Demerits:

1. Heterogeneous administration facility, i.e. admin facility functions in a scattered and poorly coordinated form.
2. Traffic route not clearly defined.

3. The absence of the railway and other modern conveying systems makes it an incomplete port facility.
4. Unlimited pedestrian access in his pot is a threat to security owing mainly to poor segregation of facilities.
5. Architectural expression devoid of waterfront character.

4.5 CASE STUDY THREE B: TINCAN ISLAND PORT

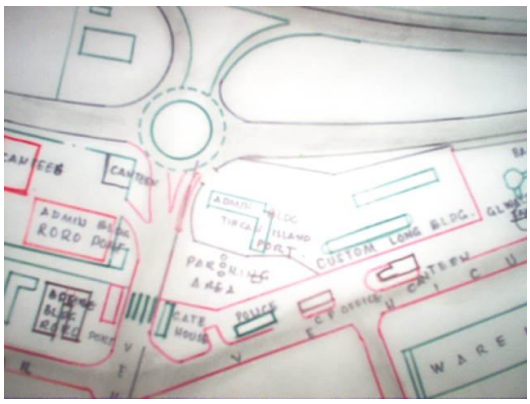
4.5.1 History:

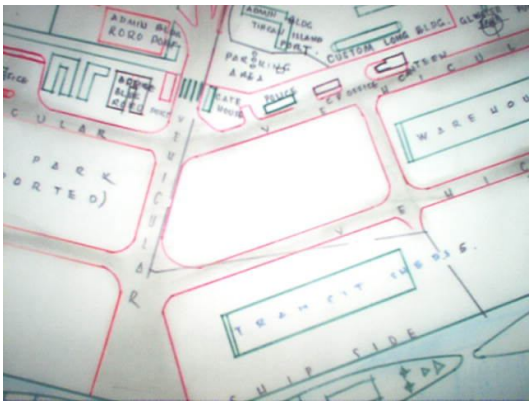
Tincan island port was built during the oil boom era of the 1970's which witnessed a tremendous rise in importation activities. This resulted in the congestion of ports and in great disorderliness within and around the port complexes. It was built with the main of decongesting the Apapa port facility and was thus located on the nearby area used for dumping containers known as the tin can island. It was commissioned on the 17th of October 1977. It is located on the northwest of Apapa port and covers an area of 73ha.

4.5.2 Facilities and description:

Its facilities are; an administration facility, control tower ,5 transit sheds, 3 warehouses, workshops, customs clearance, clinic, police station, and fire service station.

The major cargo type handled in this port is metal related products, electronics and general bulk cargo.





(plates4d, 1&2 showing the Site plan of the Tincan Island port expressive linearity with functions being parallel to quays).

4.5.3 Merits:

1. Services are straightforward.
2. Facility has relative cost advantage.

4.5.4 Demerits:

1. Heterogeneous administration facility, i.e. admin facility functions in a scattered and poorly coordinated form.
2. Traffic route not clearly defined.
3. The absence of the railway and other modern conveying systems makes it an incomplete port facility.
4. Unlimited pedestrian access in his pot is a threat to security owing mainly to poor segregation of facilities.
5. Architectural expression devoid of waterfront character.

4.6 CASE STUDY FOUR: RANGOON PORT YANGON RIVER.

4.6.1 History:

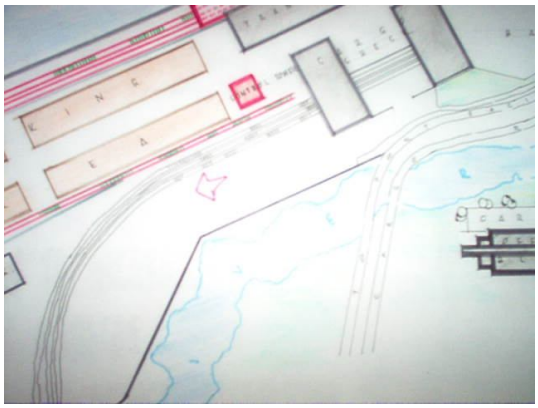
The Rangoon port is an old river port in Burma and later became an industrial port. This port is one of the great ports of Asia which was sent to hibernation in 1962 after the coup. It is now a source of trade between the Burmese people and the outside world.

Facilities and description:

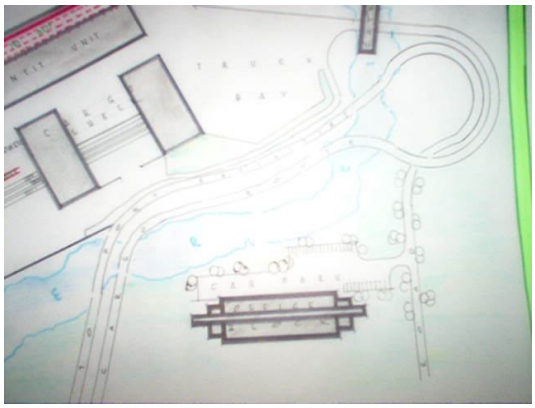
Its facilities include terminal facilities, industrial, storage, administration facilities, control tower, engineering facilities, and service and circulation facilities.



1.



2.



3.

(Plates 4e 1 showing the vessels at berth along the quays of the segregated port of Rangoon; and 4e 2&3 showing the site plan and the facility placement in a dispersed manner).

4.6.2 Merits:

1. Adequate segregation of port functions enhances circulation by reducing inter-modal and intra modal transport conflict.
2. Proper security consideration attained by regulating facility zoning.
3. Cargo flow given an effective functional consideration, cargo security enhanced.

4.6.3 Demerits:

1. Inadequate parking facilities.
2. Location of some facilities interferes with the general port functionality.
3. Storage space is inadequate.

4.7 CASE STUDY FIVE: SANTIAGO CALATRAVA.

ss4.7.1 Facilities and description:

This port has three major means of transportation ports. These are: river port, railway, and airport.

The port has a major terminal served by cruise ships, it has a passive cargo facility, and it has an open light cargo stacking area. The port is linked with the two arms of the entire complex by a network of roads.

4.7.2 CONCEPT:

There is no such thing as a straight line in nature says the designer, with a monumental magnification of the earlier roofs and pavilion forms. The station hall has a huge bird wrestling with its prey with outstretched wings.

4.7.3 Merits:

1. Quite a modern approach to inter modal circulation design in a congregated port facility.
2. The architecture eases the transfer of goods intermodally due to the clear network of connecting circulation axis.

4.7.4 Demerits:

1. Circulation network is complex and does not aid easy movement.
2. Port not provided with support and operation facilities.

4.7.5 GENERAL FINDINGS FROM CASE STUDIES:

From the local case studies, the following were found:

1. In most of them there is a clear evidence of the absence of a well defined and articulate concept as seen in the uncoordinated erection of structures as the port expands.
2. Most ports are designed in phases thus the concept of ports should encompass subsequent phases.
3. Poor segregation of facilities and undefined\ unlimited access in ports may lead to security risks which is often the case in ports.
4. The different circulation modes interfere with each other thus shows the absence of a good traffic concept.
5. the conceptual expression is devoid of an expressive waterfront character.(reference to the UNCTAD 1983 terms for waterfront designs)
6. Administration facility is heterogeneous with the absence of soft landscape.
7. Space design in the admin facility does not meet the modern trends. The double banking system is predominant.
8. Finishes are durable.
9. From the foreign case studies, the following findings were made;
10. The facilities are properly segregated. Security problems and circulation conflict are considerably reduced.
11. Appears that facility location in the ports may be due to the landform.

REFERENCES.

1. Haskoning (2004); Proposed Port Facility for Lokoja–*Tender Document*; Haskoning Engineering Consult; Lokoja.
2. Jones.L. (1992); *Cargo Security*- A Nuts and Bolts Approach; Boston Printing; USA.
3. Maggie.T. (1993); *Visions for the Future-Architectural Design*; New York.
4. N.P.A (2004); *Port and Terminal Facilities*; Marina, Lagos.
5. N.P.A (2004); *RORO Port Handbook*; Corporate Affairs Department; RORO Port Lagos.
6. N.P.A (2004); *Introducing Tin Can Island port*; Tin Can Island Corporate Affairs Department; Lagos.
7. Rangoon port- *Yangon River* (2004); www.ports in asia. com.
8. Schnell et al (1974); *Transport and Communication*- Federal Republic of Germany; Press and Information Office of the Government of the Federal Republic of Germany.

CHAPTER FIVE: PROBLEM SYNTHESIS.

5.1 INTRODUCTION:

The effective as well as the efficient performance of ports holds a great deal in establishing any given economy since it is a point of contact for trade with many parts of the world either through intra or inter country, or continent. All nations depend, one on another for their development in terms of resources, as no nation is an island in itself.

Within a country river ports may be built to perform the same functions the seaports perform to ease the burden on the other transport modes. The capacity may be smaller or larger than the sea ports as found in the port of Duisburg in Germany (Schnell; 1974:26) Ports are very huge capital projects that demand a lot of justification in terms of the quality, planning, and expression. River ports are to possess these same qualities and if necessary to a greater degree, in order to reflect their importance and significance within a given geographical region.

Ports are intrinsically to be made of a composition of different interfaces of transfer of goods and therefore require qualitative planning of the relational traffic modes. Circulation in the port of Lokoja has been taken as one of the key points in this work in a quest to reach an optimal degree of functional expression in general port design. This shall enhance quick transfer of goods as well as eliminate conflicts in between modes of transport which remains one of the basic functions of ports. In this variant, concise discussions on circulation shall be taken up as they relate to documented and established facilities. General circulation planning that reflect a true picture of the what a port should be is fitting for a growing economy like Nigeria especially as the government intends to

expand the economic base of its citizens and as a matter of fact to ease transfer within the area of the Federal Capital Territory which this port stands to represent.

5.2 THEORY OF CIRCULATION:

Circulation deals with movement in defined routes and repeated circles. An intercourse of different modes brought together may likely impede the functional activity aimed at in the flow of traffic. In traffic circulation, different modes must be given appropriate consideration as they affect each other in a bid to deter the development of conflict in operation.

From early time man has always sought a means of conveyance from place to place via different media be it land or sea since air transport was at that time non existent. As time elapsed, mans ability to articulate his environment grew with the emergence of towns and cities in different parts of the world.

In modern times, the development of technology has given rise to more sophisticated approach to developments in virtually all fields; transport inclusive. This development in technology has given birth to the many transport modes we have today in their sophisticated form. These are the railway, air transport, ships in water transport which has always existed but in a more queer form, land transport through the development of automobiles of different categories. Concomitantly, there is a continuous need for development in the general arrangement of these modes especially at points in which they come in contact one with another. It is this aspect that is the focal point of our discussions on circulation.

Various assertions have been made in this regard with the hope of reaching a clear definition. One of these was given by Snyder (1979:263) as “simply synonymous with

functional grouping of facilities". This definition is closest to the required definition needed to through light on our study. The functional grouping of these modes in a manner that eliminates or nearly eliminates conflicts has been the base of many attempts and yet there is still a lot left to be done.

5.3 PORTS AND CIRCULATION:

According to B.S. Hoyle (1992), "a port is a water-land interface of various modes of transportation and cannot be completely called a port with the absence of any major mode". Therefore a port is a point of contact for these different transport systems and requires a coherent functional grouping or relationship. Being a port, it automatically plays the role of transfer of cargo from one transport system or type to another.Hayuth (1980:213) wrote that "the deep penetration of maritime containers into the interior of countries and continents, the intensification of this trend through the growing volume of intermodal movements and the extended size of ports hinterland has had a far reaching implications for the organization of traffic flow, logistics and physical distribution". In order to facilitate the long distance overland route and to rationalize the rapidly developing inland transport schemes, networks of inland transfer points have sprung up. Indeed these transfer points are duly the river ports and similar infrastructures.

Being a centre for integrated transport, organization and coordination of multi modal systems, the development of concepts that veer off the conventional styles is imperative.

This leads us to conclusively say that ports and circulation are inseparable.



5a.



5b.



5c.



5d.



5e.

1. ***Kitaq port birds view; source: www.kitaqport.or.jp.(plate 5a)***
2. ***Rail system at port of Kitakyushu; source: www.kitaqport.or.jp.(plate 5b)***
3. ***Vehicular and rail routes leading to the port of Kitakyushu; source: www.kitaqport.or.jp.(plate 5c)***
4. ***J.R kokura station and the city monorail, kitakyushu; source: www.kitaqport.or.jp(plate5d)***
5. ***The shinkansen (bullet train) at kokura station; source: www.kitaqport.or.jp.(plate 5e)***

All plates show a coordinated transport infrastructure set up.

5.4 GENERAL PORT PLANNING PATTERNS:

Transportation has traditionally been viewed and analyzed as a segmented system, comprised of individual transport modes (Ullman; 1956:199). It requires therefore a conceptual plan which in effect integrates these segments in a wholistic manner. In a way, this is similar to town planning in its formation; the only restriction being in the scope of work and in its detail. These planning patterns generally revolve around concepts that integrate one of the following as its basic approach. The patterns that form the functional entity for the concepts are:

1. Linear planning
2. Dispersed planning
3. Radial planning

Some of these patterns indeed depend on the geomancy presented though not entirely. These patterns establish an overall relationship between the various aspects of a given physical environment within a general concept.

5.4.1 Linear planning pattern:

Linear spines usually define this planning system. This system relies on a straight geomancy and usually circulation systems may have to go along the spine though variations may arise due to concepts. Its advantages are:

1. Lower cost;
2. Ease of servicing.

Its disadvantages are:

1. Rigidity;
2. Conflicts at nodes.

5.4.2 Dispersed planning pattern:

This system deals with various settlements within the whole. The form islets that are linked with unifying circulation systems. Its advantages are:

1. High flexibility;
2. Easy segregation of the parts.

Its disadvantages are:

1. High cost of servicing and circulation.

5.4.3 Radial planning pattern:

This pattern revolves around a focal point and radiates along lines from the focus to the outer axis. Its disadvantages are:

1. Expensive services due to extensive outer link.

5.5 SYSTEMS OF CIRCULATION:

A system of circulation simply means the modes of transfer in terms of traffic from one place to another. These systems include:

1. Water borne circulation systems;
2. Railway systems;
3. Vehicular circulation systems;
4. Cargo circulation systems;
5. Pedestrian circulation systems.

5.5.1 Water borne circulation:

This circulation system deals with the vessels or barges that carry and transfer cargo by water either on the sea or on inland waterways. For this circulation to be successful, the facilities and conditions necessary must be provided to cater for easy transfer. Infact this is the most basic requirement for a port. The facilities needed are; effective depth that shall enable the vessels sail without any impediment, quays should be provided as well to serve as berths along the course of the water body and are usually built as concrete piles and beams projected into the water to reach to points of sufficient depth. It is upon these beams that platforms are laid which eventually is called the shipside. The water must possess sufficient width to enable easy maneuvering of the vessels before and after loading or unloading.

The river Niger at lokoja upon dredging is quite wide (250m) enough to provide the required width and depth necessary for vessel circulation. The vessel types that shall be expected to ply this river are of capacity; range from 2000tons to 20000tons (MITI 2003:123).

5.5.2 Railway systems:

Railway systems comprise all the facilities necessary for the effective and efficient conveyance of cargo and people from place to place. The railway proper is made of steel being the only known material that can withstand that level of vibration produced by trains. Rails are essentially secondary conveyors in ports and act in the capacity of augmenting ships where the limitations abound. These limitations are in terms of reaching the destinations proper which in most cases the interior of countries which are not linked by waterways; thus the need for railways.

Rail track installations:

Curved radii to the centre line of the track, R:

For direct mainline fast track ≥300m

For sidings in stations ≥180m

For branch lines with main line rolling stock ≥180m

Without mainline rolling stock ≥ 100m

For sidings used by mainline engines ≥ 140m

For sidings not used by mainline engines possibly ≥ 100m

Minimum ≥ 35m.

If 100m is greater than R and R in turn is greater than or equal to 35m carriages should only be pulled. If R is greater than 130m it might not be suitable for a rolling stock.

Radii for narrow gauge railways:

For 1.00m gauge track ≥50m

For 0.75m gauge track ≥40m

For 0.60m track ≥ 25m

For tracks that will be used at speed greater than shunting speed, a transitional section of curve must be laid between the straight section and the circular arc itself, giving a continuous curvature change from 1:∞ to 1: R. under certain circumstances, the curves must be canted in order to keep the centrifugal force that arises during travel through the curve within reasonable limits. Canted curves and transitional curves should be blended together.

Sets of points are designated in accordance with the rail shape, the branch lines radius and the pitch of the frog. Lengths of sets of points are given together with switch rails below.

49-190-1:7.5 = 25.222m/12.611m

49-190-1:9 = 27.138m/10.523m

49-300-1:9 = 33.230/16.615m

Carriages must not stand beyond the marker sign, to prevent obstructing the set of points. The distance between the track centre lines at the marker sign should be ≥ 3.5m.

The diameters for normal turntables are: for axles, 2-3m; for wagons, 3-10m; and for engines, 12.5-23.0m. The size for transfer tables should be calculated as minimum axle base of the carriage to be transferred plus 0.5m.

Standard clearance profiles:

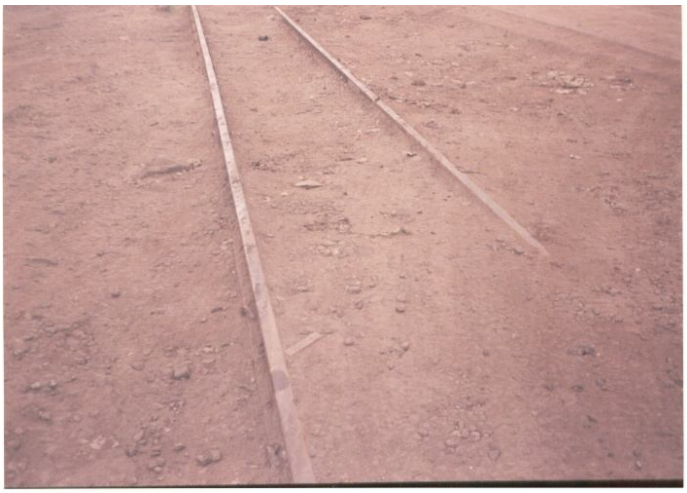
a ≥ 150mm for immovable objects which are not firmly connected to the rail

a≥135mm for immovable objects which are firmly connected to the rail.

b= 41mm for devices guiding the wheel on the inside of the front surface.

b≥ 70mm for all other cases.

Z = corners which have to be radiused.



(plate5f: Rail track covered by debris at the Lagos port complex; source: field work)

In the general arrangement of railways, it is important to link them to the main service points of the port and yet avoid all obstacles in its way. The zoning necessarily has to consider this as a vital point for its effective and efficient functionality. Usually noise is generated in high decibels from rails and thus should be kept away from the administration facility. In cases where modern trains are used, it becomes less of a problem owing to the low noise engines. Buffers may also be created within the service area in an attempt to demarcate this mode from the others. Effective zoning suffices to be the only way out. Another point to consider in the design of rails in ports is the separation of incoming from outgoing trains.

5.5.3 Vehicular circulation systems:

Vehicular circulation within ports deal with routes for cars, lorries, trucks, forklifts, mobile cranes, and other conveyors that require roads for their movement.

Each of these vehicles in themselves serves different purposes and requires different routing as well as different space configuration. Conflicts arise mostly in vehicular transportation due to poor routing, parking facility, and poor separation of the individual service units. In ports, the major or principal vehicular mode is the truck. Trucks should be given adequate considerations in terms of space allotment in road designs. Proper parking spaces should be provided in order that movement routes are not converted into parking spaces as in most ports in Nigeria. Bull (2004:54) states that "in vehicular movement, parking is obviously an indispensable element since vehicles are not designed for perpetual motion. Parking relieves congestion by freeing up space on roads thus expanding the effective capacity of the roads, cuts down the time vehicles use in looking for parking space, and encourages the use of other modes via taxation at peak periods".

Parking spaces for large vehicles are of necessity to be provided in ports to prevent the problems that may arise from insufficient space. Vehicular routes should be clear one from another according to the function and role they play in the entire facility. Road economy may also be ensured through proper vehicular size requirements. In areas where the roads meet and play the role of a collector, the larger dimensions are to be adopted.

5.5.4 Cargo circulation system:

Cargo circulation refers to the movement of goods within the port facility. It usually includes all the modes as well as special conveyors. Cargo routes in ports are either from the ship to the shipside, from the shipside to the warehouse or from the ship to the other modes of transportation and vice versa. Cargo movement is a major factor in the zoning of the entire facility being that it determines the location of the importation reception points which plays a vital role in distribution between modes during modal splits as well as the location of the export reception zone and its subsequent flow.

Cargo varies in type ranging from containerized cargo to bulk cargo, liquids, and agricultural goods. Facilities thus have to be placed in a manner that shall help the functional flow of cargo to their respective destinations. These facilities include railways, crane routes, motorable routes, conveyor belts, etc. In the course of cargo movement another important factor to be considered is security. Certain routing of cargo may ease pilferage and theft of goods especially loose goods. The designer must take note of this in his circulation computation. Jones (1990:139) suggests that “the flow of cargo should be broken into understandable items as it is transported through the port. Cargo movement should fit every given pre-planned operation”. Cargo routes must be designed in a manner that is not accessible to everyone with the exception of those directly involved in

operation of cargo. Security in ports is one of the main roles in which cargo circulation must play through an adequate security flow chart of the entire cargo yard. Operational facilities should be placed in such a way that will facilitate the sequential flow of cargo in conformity with the cargo route directives. It thus becomes increasingly difficult for cargo to be misdirected.

5.5.5 Pedestrian circulation:

Pedestrian circulation refers simply to human traffic. This is an essential consideration in ports as this holds a great deal for port security as well as clarity of operation. Pedestrian circulation deals with the provision of adequate facilities for human movement within the port premises. Such facilities shall include; walkways clear from interfering with operations, bicycle routes and parking also clear of operation. Restriction zones have to be given due attention to curb theft and pilferage of goods. Cargo routes must be designed in a manner that is not accessible to everyone with the exception of those directly involved in operation of cargo. Infact the entire public facility should be kept away from the operational facility. In this way, access to restricted points can be easily monitored. This measures are taken more especially with respect to pedestrians as accounts of the past has shown that most cases of pilferage and theft are done by pedestrians who trespass restricted areas due to porosity in planning.

5.6 CIRCULATION PLANNING IN PORTS:

Architecture plays the essential role of providing three basic components in any given design. These components are;

1. Function or use;

2. Stability;
3. Beauty.

These three components were given by Vitruvius as the essentials of architecture. The component of "function" has indeed remained the focal point from which every other role generates. The use of any given facility determines what initiatives would be incorporated in the course of its development. The architect refers first to function as a basic criterion and must negotiate optimal relations between one part and another in a task. In carrying out this responsibility the architect seeks to establish a clear flow between spaces and within spaces either interiorly or exteriorly. In doing this, the architect may devise strategies to express a given philosophy in whatever manner he deems, intuitively. These expressions may be generated from intuitive concepts or from experience of one kind or another. In the design of flow diagrams, precision is an important factor in terms of relationship of spaces within an environment.

In ports, circulation is an inseparable function that plays a vital role being that ports are a transfer point between one mode of transport and another. In circulation as well, a point that cannot be divorced in this contemporary age is technology and should be woven one to another. The basic function of circulation is to overcome the spatial gap between points of demand and supply and thus requires efficient planning, not only of the components of circulation, but of integrating these modes to speak one language that possesses syntax. Kendall (1986:203) refers to this as "intermodality" which he describes as "a system that envisions the uninhibited movement of traffic in at least two different modes". Intermodality focuses on the synchronization and organization of transport systems to form an entire functional unit. Included in such a total system are producer, shipper, ocean, land and air carriers, ports, freight forwarding organizations, and

warehousing services. Coordination of these units should thus provide the basic concept in ports (Hayuth; 1987:203). In this total concept each mode serves as a link to the entire transport chain even though individual modes do not lose their identity.

The achievement of this requires a careful architecture that harnesses all the units in a simple concept of circulation. This assertion is contained in the term transport geography which counts its importance in two folds namely: that transport industries, facilities infrastructure and networks occupy substantial areas of geographical space, constitute complex spatial systems and provides substantial numbers of widely spread jobs. Secondly, it is concerned with the interrelationship between phenomena in a spatial setting and with the explanation of spatial patterns, and transport is one of the most potent explanatory factors (Gauthier; 1970:2, Gillingwater; 1983:2). In a nutshell, it requires a careful interaction between areas. This as synonymous with basic town or city circulation planning since all of these generate along spatial interaction and spatial definition; its difference being in the scope and services. In city planning, patterns are integrated into concepts with limited adjustments. In the same way, port planning requires that concepts be evolved and distinct planning styles be integrated based on the entire functional system not only of circulation now but of the entire components of the port to fit into the circulation system. Only by this approach can a wholistic result be obtained and the goal of efficiency be reached.

In certain cases, port planning patterns and eventually concepts may arise from the given landform; which yet does not consistently allow for a flexible planning decision and thus should be discarded as the demand arises. In reaching towards the goal of a stabilized circulation system in ports, planning patterns should be duly harnessed to give desired

results. In reality optimal results can be attained through various ways in planning especially by seeking alternatives that will augment already existing methods of planning.

5.7 ALTERNATIVE CIRCULATION PLANNING PATTERN IN PORTS:

In ports, the entire circulation plan form relies on the approach adopted. This approach may be borne out of the geomancy of the area or the designers' ability to attain a rich planning form. For the purpose of this work, the target is to arrive at an optimal circulation through clearly sieving the advantages of each planning system and lumping them together to give a new alternative to approaching the planning of ports. These advantages include:

1. Cost effective planning;
2. Straightforward servicing;
3. Elimination of rigidity and traffic conflicts through flexible planning;
4. Creating aesthetic balance through incorporating a non-dominant focal point and representing uniformity in each aspect of the focal point.

By creating a pattern that meets these advantages, accommodating concepts must be allowed in the development process that allows for an organic harmony with the existing landscape. These concepts aim at achieving these outlined advantages as well as meet basic traffic design principles as prescribed by Bull (2004:55) through:

1. Creating preference for principal movements;
2. Reduction of conflict areas by channeling movements;
3. Through controlled parking and station areas thus eliminating to a great degree, congestion through freeing up space on streets for circulation, and cutting the time vehicles spend looking for parking space.

In the inland water port of Lokoja, these outlined advantages will to a reasonable extent be imputed into the planning concept in the different stages and aspects of the entire port complex. On another hand, ports have to be representative in character through the expressional use of forms that agree with its function. The port of Lokoja will as much as is attainable allow the forms to be adequately incorporated into the planscape.

5.8 CONCLUSION:

The advance of technology has brought about a general growth in virtually every aspect of development including transport which has given birth to the vertical integration of the larger portions of the total distribution of cargo in ports (Cassons; 1986:203). In the light of these developments, architecture is bound to respond in the same direction complimentarily; in the fulfillment of the targets of technology through providing adequate facilities both in capacity and function as well as expression. The port at lokoja aims at achieving just this.

REFERENCES:

1. Bull. A. (2004); *Traffic Congestion*-The Problem and How to deal with it; United Nations publication ECLAC-MIDEPLAN 1998a
2. Cassons (1986). The Role of Vertical Integration in the Shipping Industry. In: Y. Hayuth: Multimodal Freight Transport. In: B.S.Hoyle et al: *Modern Transport Geography*. London: Belhaven press. p.203.
3. Gauthier et al (1992). Why is Transport Geography Important? In B.S. Hoyle et al. *Modern Transport Geography*. London: Belhaven press. p.2
4. Hayuth.Y. (1980); Inland Container Terminal: function and rationale; maritime policy and management. In: Y. Hayuth: Multimodal Freight Transport. In: B.S.Hoyle et al: *Modern Transport Geography*. London: Belhaven press. p.213.
5. Hayuth.Y. (1987); Intermodality: Concept and Practice; structural changes in the freight transport industry. In B.S.Hoyle et al: *Modern Transport Geography*. London: Belhaven press. p.203.
6. Jones.L. (1990); *Cargo Security*-a nuts and bolts approach; Boston printing; USA.
7. MITI (2003). Traffic volumes analysis and projection. In: *Master plan for Integrated Transport Infrastructure*. p.188.
8. Schnell et al; (1974); *Transport and Communication*-Federal Republic of Germany; press and information office.
9. Snyder. J. (1979). *Introduction to Architecture.* New York: Mc Graw Hill.
10. Ullman.E.L. (1956) In: Y. Hayuth: Multimodal Freight Transport. In: B.S.Hoyle et al: *Modern Transport Geography*. London: Belhaven press. p.199.

CHAPTER SIX: SITE CHARACTERISTICS AND DESIGN CONSIDERATIONS.

6.1 INTRODUCTION:

Lokoja was founded in 1860 by a Briton William Braike. It derived its name from a Hausa word meaning "red iroko tree" since the first settlers were the Hausa people from the Katsina emirate.

From field opinions, it was revealed that Lokoja is a no mans land because it comprised various ethnic groups namely; Nupe, Yoruba, Igala, Igbirra, and Bassa komo.

Until 1966, Lokoja was the administrative capital of the Kabba province. On 27th august 1991, it became the capital of Kogi state when Nigeria was restructured to thirty states by the administration of General Ibrahim Babangida.

Lokoja is a commercial as well as an administrative town. Its inhabitants are mainly civil servants, traders and fishermen. The confluence of the rivers Niger and Benue has limited the land mass available for agriculture. Its population is about three hundred and fifty thousand. Fishing is the predominant occupation of the inhabitants after the civil service.

6.2 GEOGRAPHY OF THE SITE:

Lokoja town is located at the confluence of the rivers Niger and Benue, on the west bank of the Niger River on the altitude 45-125metres. On the North West of the town lies the Pati ridge with a lot of vegetation and reaches an altitude of 1346metre. Many streams penetrate the town flowing into the Niger or river Mimi. Lokoja is accessible to parts of Nigeria through motorable roads and lies on the paved federal trunk road A2 which links

on the North to Abuja, on the South-West to Okene and on the West to Kabba. On the south is the paved state trunk road which leads to Ajaokuta.

6.3 CLIMATIC CHARACTERISTICS:

Lokoja is located on the tropical belt of Nigeria and has two major seasons owing to the prevailing winds at different periods of the year. From May to October, the southern westerly wind brings in the rainy season even though this may be earlier in the year. On the other hand the winds from the North- Eastern region of Nigeria which prevails from the month of November to April ushers in the harmattan season which is dry and dusty.

6.3.1 Temperature:

The mean monthly temperatures are from 33.7°C maximum and 22.7ºC minimum. The hottest period comes around the month of February to April with maximum mean daily temperatures being about 38.3ºC and the mean daily minimum being 25.8ºC. This holds true for most parts of Nigeria. Variations in the diurnal temperature depend on the state of the sky. On clear days a large amount of in coming air and outgoing radiation produce a wide daily temperature range. Seasonally, the same holds true. (Olgyay; 1973)

Temperature and human comfort has a deep relationship and so the design has to take proper cognizance of the orientation of buildings as well as of choice of materials and building behavior.

Temperature °C :mean monthly

Month	**maximum**	**minimum**
January	34.91	19.1
February	36.6	22.5
March	37.6	25.1
April	36.6	25.8
May	33.9	24.4

June	31.9	23.5
July	30.6	22.3
August	30.4	22.9
September	30.7	22.9
October	32.3	22.9
November	34.8	21.1
December	34.8	20.1

TABLE 6.1

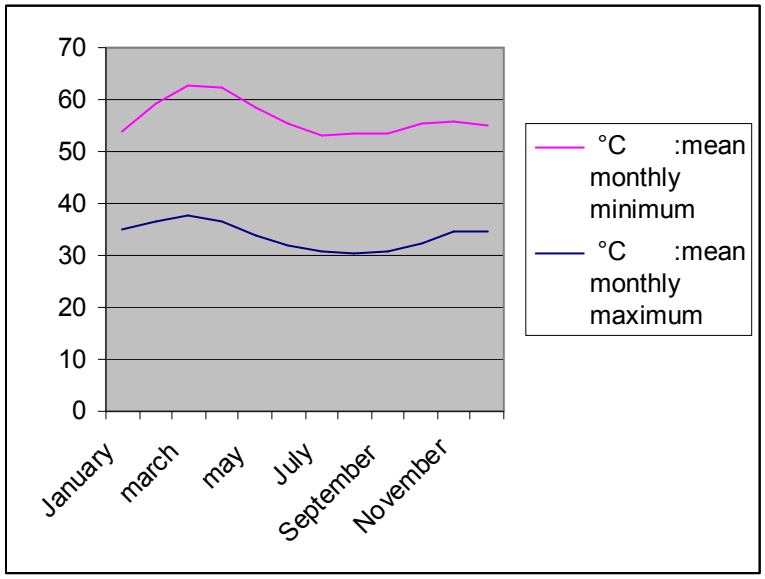


CHART 6.1

temperature °C mean daily maximum and minimum

Month	**Maximum**	**minimum**
January	35.2	21.6
February	36.2	21.9
March	38.5	23.5
April	36.2	25.7
May	38.2	24.2
June	31.7	23.8
July	30.1	23
August	30.5	23
September	30.8	23.1
October	31.9	23.3
November	34.3	22.6
December	34.3	23.4

TABLE 6.2

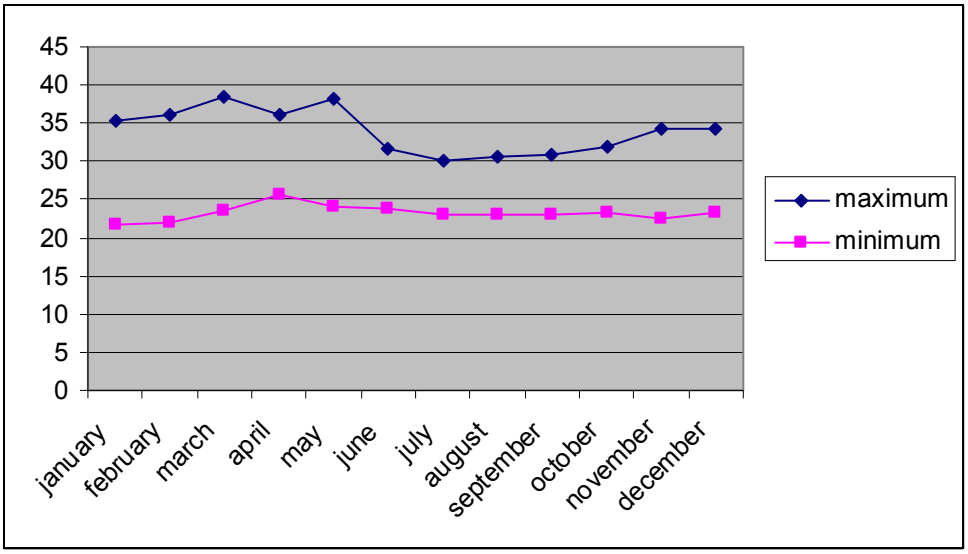


CHART 6.2

6.3.2 Rainfall:

Rainfall normally begins to fall at the end of March and reaches its peak at the periods of double- maxima namely; June- July and September- October. Design choices must thus take cognizance of this and create room for higher ranges of rainfall than the measured 1300mm (approximately).

Mean monthly rainfall

Month	**Rainfall**	**(mm)**
January	2.2	
February	29.3	
March	22.5	
April	54.5	
May	152.9	
June	174.5	
July	272.9	
August	254.1	
September	182.15	
October	128.8	
November	1	
December	4.3	

TABLE 6.3

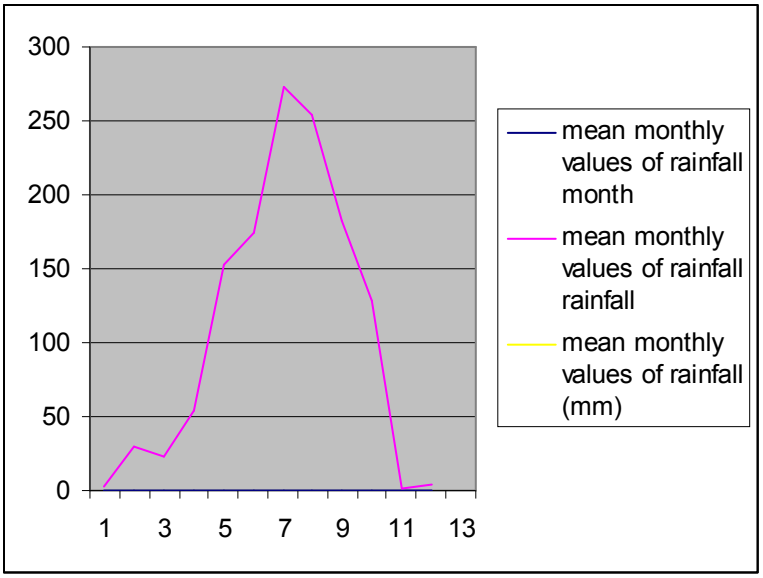


CHART 6.3

6.3.3 Relative humidity:

In Lokoja, relative humidity in the wet season exceeds 80% in the mornings and could be as low as 21% in the afternoons of the dry season. As the wind blowing inland losses moisture, the humidity decreases with increase in altitude. The humidity level is subject to the influence of the seasonal winds. In the dry season relative humidity level drops owing to the high harmattan winds. The relationship between relative humidity and temperature is quite a constant one as relative humidity rises, temperature rises; a situation that is often influenced by the equatorial mass. The extremes of relative humidity are in the months of August and February. The microclimate of the port site in Lokoja varies because of its environmental variation in terms of elevational change and the physical features of the site such as the water surface, character of land cover etc.

Month	**maximum%**	minimum%	**mean values%**

January	41	28	34.5
February	42	21	31.5
March	51.6	28.5	26.3
April	59.8	39	49.4
May	73	52.5	62.75
June	75	54.5	64.75
July	81	61.5	71.25
August	79	65.5	72.25
September	71	68.5	69.75
October	59	54	56.5
November	38	35	36.5
December	44.5	25.5	35

TABLE 6.4

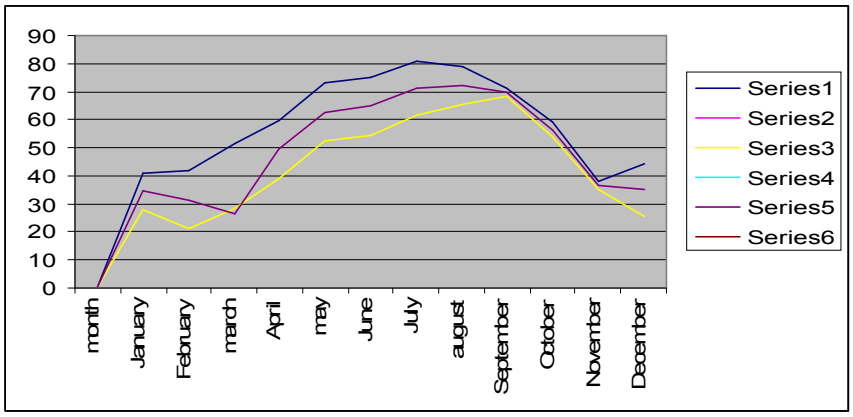


CHART 6.4

6.3.4 Prevailing winds:

The macroclimatic data provides two wind patterns in this geographical region. These are the north east winds (dry tropical continental air) that usher in the harmattan and the south western winds (moisture laden equatorial air) that usher in the rainy season. The harmattan winds prevail from October to March and originate from the Sahara. It is usually accompanied by dust. The other wind is cool and rain bearing and originates from the equatorial maritime environment. It lasts from March to October.

As a consequence of the presence of the water valley as well as the Pati ridge, the wind flow is altered within the microclimate. The effects of wind on buildings have to be considered both on the inside and on the outside of the building. They should be blocked

from penetrating structures during under heated periods, but they should be admitted and utilized at overheated periods. Openings should thus be made to the advantage of the users comfort.

6.3.5 Sunshine:

The effect of sunshine in lokoja is quite high due to its position in the equatorial belt. Its hours are greater in the months of December, February to march but values decrease during the successive months. The intensity of sunshine reduces during the rainy season because of the high cloud cover, its hours reduces as well during the rainy season.

Solar radiation also plays an important role in design with respect to glare which constitutes an aspect to figure out in the wall finishes, roof and wall materials, thermal comfort, and landscape planning.

Sunshine hours:

Month	Sunshine
January	7
February	8
March	8.5
April	6.8
May	5
June	7
July	7
August	6.2
September	4.7
October	5.5
November	7.2
December	8.8

TABLE 6.5

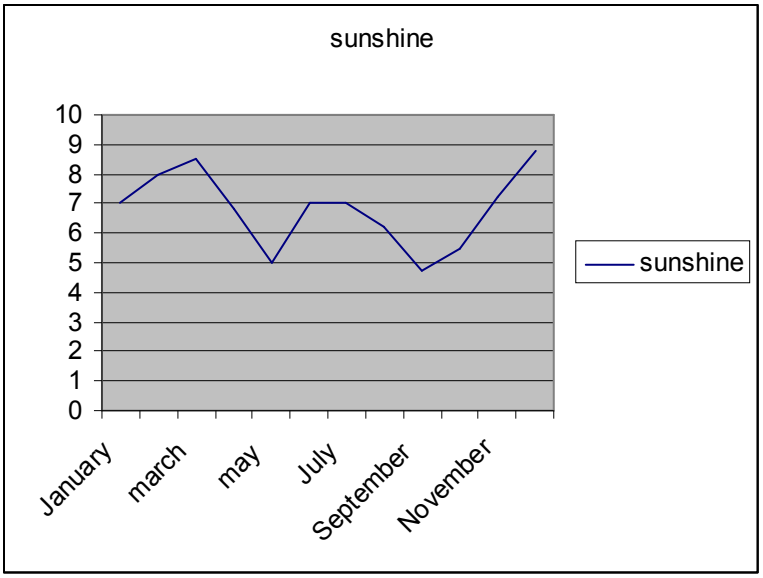


CHART 6.5

6.4 PHYSICAL CHARACTERISTICS OF THE SITE:

The port site is located at Lokoja, the Kogi state capital along the river Niger which is navigable up to the sea. The port site lies in the Niger River basin and is highly swampy in vegetation. Off the site to the western end lie igneous and metamorphic rocks known as the pati ridge.

6.4.1 Site and topography:

The site is relatively flat and slopes gently towards the river Niger on the south western flank of the confluence. Its topography is steep from the datum of the town and portends a sudden fall of about 20m in 5m and from there slopes gradually to the river coast which is swampy and full of weeds. The steep topography from the town owes its form to the existing hills around the town. The site contours are not seen in drawing due to the waterlogged coast of the river.



(*Plate 6a Topography of site on one aspect; source: field research)*



(Plate 6b Topography with vegetation cover; source: field research)

Temperature varies with altitude infact for every 1ºF drop, the altitude rises by approximately 100m. In this light, it is noteworthy to say that cool air is heavier than warm air, and at night the outgoing radiation causes the cold air layer to form near the ground surface. The flood of cold air causes cold islands or cold air puddles. Accordingly, elevations that impede the flow of air affect the distribution of nocturnal temperatures by dam action; the concave terrain formations become cold air lakes at night. The same phenomenon is involved in valleys (Olgyay; 1973).

6.4.2 Site and vegetation:

The vegetation in the area is a result of a combination of factors found in that location. The physical environment which comprises a complete cycle of activities in nature coupled with topographical conditions and climate gives birth to a vegetation that reflects these conditions. The vegetation is a transitional one between the savannah region and the rain forest belt. Though it may still be given the general savanna vegetation, its immediate environment creates something of swampy vegetation with water weeds along the coastal fringes of the river Niger at Lokoja. During the dry season when the water level drops, the swamps become temporary islands or sand beds. The site at graduation toward land is rich in trees and vegetation.



(Plate 6c Vegetation showing water underneath; source: field research)



(Plate 6d Water weeds on surface of the river Niger; source: field research)

6.4.3 Soil characteristics:

The geological constituents of the coastal region of the river Niger at lokoja is a combination of different sediments and soil types owing to the action of the river through flooding. The soils are not often used for agricultural purposes especially in the lokoja region where it is only accessible through canoe due to the weeds on the water surface. In the high water season, the entire coast that is visible during the low water season is completely covered and upon sampling is seen to be predominantly loamy clay. This soil contains a lot of deposits rich for agricultural purposes; on the other hand it is not so suitable for building and thus must involve heavy capital expenditure.

6.4.4 Site and Services:

The potentials of servicing the site hold a lot of substance especially as it is quite reachable on all aspects more especially along the course of the river. Lokoja is connected to the national grid electric supply even though the supply is inadequate. Water supply is poor in lokoja owing to the low capacity water treatment plants available; facilities such as the railway is non existent even though plans are underway to provide the railways of modern standard (MITI; 2003); telecommunication is fairly alright; the federal trunk road A2 makes Lokoja accessible by road and this road is connected to three towns, on the northern flank it links with Abuja, on the western flank it links with Kabba, on the southern flank it links with Okene, Lokoja also links with Ajaokuta.

6.4.5 Site and Sound:

The site is quiet and free of disturbance owing mainly to its location. The presence of water weeds does not allow much accessibility to the site; this probably is the reason for its quietness.

6.4.6 Site and Views:

The views off the site are appealing in virtually all directions. Clear views of the horizon are seen to the extent which the river reaches at sight with a surrounding hilly terrain as well as lush green vegetation.



(Plate 6e View of the horizon; source: field research)

6.4.7 Drainage and Flood zones:

The site is waterlogged and does not allow a precise assessment of the drainage of the river bed though hypothetical indications are given by the basin of the river.

The river Niger flows with an average velocity of 2m\s towards the south with a great basin height which would scarcely reach to the point of flooding beyond its limits. It is

noteworthy to define that the site potentials of being flooded is great since it lies in the basin.

6.5 ECONOMIC ACTIVITIES:

Fishing remains the main economic base for the lokoja people. Along the river Niger, fishing is a major activity of most of the inhabitants of the settlements. Other forms of subsistence agriculture take place along the bed of the Niger in some nearby settlements in the lokoja region. Most of the activities of the people take place on the river which accounts for their being amphibious in nature. The use of nets for fishing is predominant with occasional; use of fishing hooks.



(*Plate 6f Primary occupation of he lokoja people, fishing; source: field research)*

More recently, the people in this area have in a low percentage digressed from the known occupation of fishing to other forms of occupation namely; trading, white collar jobs in government offices. Transportation must be mentioned again across the Niger though in a littler extent. Goods are conveyed from one point to the other through the use of canoes

or in rare cases ferries are employed. This constitutes the main source of transportation in the locality.

Lokoja possesses vestiges of the colonial era and has some tourism potentials. These potentials can be further enhanced through effective exploitation of the natural endowments of the area.

6.6 SITE SELECTION CRITERIA:

The criteria for the selection of the site at lokoja are as follows:

1. Proximity of the site to the federal capital territory Abuja is a major advantage since it is located near the Abuja-lokoja expressway; thus linking Abuja with the sea ports directly.
2. The depth of the river at the Okumi area is another advantage for the location of the port site.
3. Possibility for clear expansion must be taken cognizance of in the choice of sites. Ports are generally known to be growing facilities and should be expandable in the near future without any interference by already existing facilities.
4. Boycotting the metropolitan traffic in the lokoja town is also an important consideration in a bid to reduce conflicts to a barest minimum.
5. The choice of site by the authorities also influenced the site chosen for this work being that it is the only properly studied and documented area with high viability for this task.

6.7 DESIGN PARAMETERS:

The design parameters for water front structures and installations are borne out of an in-depth study of the various influencing factors that play a role in the realization of an effective and efficient facility. For functional solutions to be achieved, the following parameters were considered.

6.7.1 Planning considerations:

Layout and spacing: the layout is to provide the facility with a functional circulation flow between the different facility groupings with the priority being the reduction of conflict in the inter-flow of conveying facilities.

Openings: the openings should be within the range of 20% - 40% of the wall area for proper ventilation as well as maximum view. Design fundamentals require that the openings be protected from the sun and rain.

Structure and materials: the structural elements should be given precise attention in their composition since the environmental influence is very direct. The use of materials should also be done with careful respect to the hygrothermomechanical behavior of the materials to be employed in the facility in view of attaining long term structural stability and durability through impeded environmental influences as a known and desirable property.

Accessibility: the facilities should be zoned in a manner that groups all similar facilities in the same area thus segregating the facility without compromising the general port experience in each zone. The facility should also be free of traffic intersections that may give rise to conflict.

Good services network: a network of services which include circulation facilities as well as others like drainage should be efficiently linked to ensure easy flow of activities within functional groupings as well as in the frame of each unitary group.

6.7.2 Planning concept:

The planning concept is and integration of the different constituents of the entire port facility to form a complete whole.

1. The planning concept is based on the following:
2. Location of facilities in areas of optimal efficiency
3. Functional grouping of facilities with overall port experience.
4. Articulate circulation planning for users, operational services, and maintenance.
5. Integrating the various planning approaches in ports to obtain optimal efficiency in the operation and use of the port facility.

6.7.3 Environmental considerations:

The forces of nature play an important part in factors to consider in any given design more especially in water front facilities. These forces are all inclusive of every thing that exerts pressure on the durability and functionality of the structure and spaces in the facility. They include; temperature, moisture, sunshine, wind, as well as natural light. In water front structures, it is important that a proper integration with the environment is considered in terms of architectural adaptation to the water – land interface. The use of horizontal planning is definitely out of the question due to the nature of the soil. As much as is attainable, natural environment should be maintained to give a relaxed condition during work and after work in a bid to calm the pressure of work.

6.8 CONCLUSION:

These conditions enumerated above are adequately found in the site for the port at lokoja and thus as the centre of the hinterland in Nigeria, it is appropriate destination for a water port on the inland waterways.

REFERENCES

1. MITI (2003); Master Plan for Integrated Transport Infrastructure; Extension of Transportation Networks; Federal Ministry of Transport.

2. Ogbaje.D. (1995); Unpublished Thesis Report; Department of Architecture; Kogi state sport centre Lokoja.

CHAPTER SEVEN: DESIGN BRIEF AND REPORTS.

7.1 Preamble:

The evolution of humanity is scientific, technological as much as it is complex. This evolution has affected every sphere of human life, and indeed architecture. In ports the approach has equally evolved from the ancient sea ports to the modern the modern facilities that are found today as a response to scientific and technological innovativeness. This development and improvement in style requires a facility set up that will enable a functional integration of the chain of activity in the port. This integration requires transition spaces and isolated spaces for interactive as well as specific use at the same time maintain a regular pattern of distribution. This shall be the main constituent of the design brief.

7.2 DESIGN BRIEF:

The design brief to this end shall be for all the following facilities and how the interrelate and shall include:

1. The administration building
2. The traffic control unit
3. The workshop
4. The fire station
5. The storage facilities
6. Quay facilities for cargo handling
7. Clinic
8. Cruise terminal building

9. Security posts.

The integration of these facilities to create a strong relationship that generates into acute functionalism is the task. The brief shall aim at the following:

1. Creating a distinct plan pattern for the entire port facility that reduces circulation conflicts.
2. Integrating the facilities within the environment through organic and associative planning that preserves the natural environment.
3. To explore a new dimension to port circulation within and between facilities.
4. Evolving a distinctively aesthetic waterfront outlook that shall boost tourism.

7.3 FACILITIES:

All the facilities provided are based on the user requirements. These facilities are also the results obtained from case studies of already existing port facilities around the world.

7.31 Administration Building:

This is the core of the activity in the port. It is where all decisions are made to ensure that the port functions well and its objectives are met. Spaces are therefore required for its personnel to discharge their respective duties based on the operational procedures in the port.

7.32 Commercial facilities:

Within the administrative framework lies the issue of profit making. Flexible office spaces are therefore required in anticipation of the tenants whose requirement for office space may vary.

7.33 Welfare Facilities:

These facilities are included to see to the needs of the personnel. Such facilities include the restaurant for managerial staff as well as those knit within the administration building. The restaurant shall be designed to store food within its kitchen and a cozy eatery for relaxation.

7.3.4 Technical Facilities:

This entire unit of the building is referred to as the service shaft. It is required to ensure the effective and efficient functioning of the building. These facilities include; staircases, lifts, ducts, electrical and mechanical equipments, machine rooms, etc.

7.3.5 Security and safety:

These are facilities that are required for orderly activity within the building as well as for safety of the users. Safety of lives and property are essential considerations in case of hazards such as fire outbreak.

7.4 ENVIRONMENTAL FACILITIES:

The entire area which the building is located constitutes the environment and should be properly and carefully designed to reflect the quality of expression required. This deals with landscape elements both soft and hard.

7.5 RECREATIONAL AND SOCIAL FACILITIES:

To calm the stress of recurrent work and generate greater output, facilities such as outdoor recreational areas, sailing units are provided around the terminal facility.

7.5.1 Cruise Passenger Terminal:

This facility is a tourist facility and is designed to cater for the transfer of passengers and tourists between land and water. It is therefore an interface that houses facilities and concessions for passenger comfort and relaxation. Other facilities include the ticket office, weighing scales, security, phone centres, and relaxation spaces. It requires a straightforward and appropriate circulation which is meant to cater for the anticipated peak periods on a daily basis. The facility is also separated to prevent interference with the main port functions.

7.6 SCHEDULE OF ACCOMMODATION:

The entire port is made of various units and each unit contains sub-units. These are:

1. **Administration**: This is a conglomerate of various departments namely:

    -Security department

    -public relations department

    -industrial relations department

-engineering department

-stores department

-commercial department

-statistics department

-procurement department

-marketing department

-accounts department

-legal department

-personnel department

-records department

-administrative department.

2. **Traffic control unit**:

- Control tower

- Traffic control unit

-harbor department.

3. **Workshop:**

-Work shop department

-repair and maintenance yard.

4**. Fire station:**

-Fire management department.

5. **Storage facility:**

- Transit sheds

-warehouses

-Open stacking areas.

6**. Quay facilities:**

- wharf apron

- Passenger jetty.

7. **Medical facility**:

8**. Cruise terminal building.**

In all these, the planning aspect constitutes a major part of the work with proper detailing of some of the other facilities such as the administrative facility cruise terminal and others. To this end the spaces and their areas are as follows:

SPACE	**AREAm²**
ground floor administration	
entrance porch	260
lobby	442
Stairs, lounge, lifts, toilet.	120
Library	60
cafeteria and kitchen	72
Total	864
banking hall	102
waiting area	80
strong room	14
operations 2	30
Manager	14

Security	6
Circulation	20
Total	216
Security	43
store agents	17.5
Agents	17.5
head of industrial relations	15
head of public relations	15
general office	35
Total	143
grand total	**1223**

first floor administration

Void	60
stairs, lounge, lifts, and toilets	120
general office	32
chief ports engineer	12
Secretary	12
office 2	14
office 1	14
electrical services office	12
mechanical services office	12
civil engineering services office	14
planning and control office	14
Total	**316**

second floor administration

Void	60
stairs, lifts, lounge, toilets	120
office 1	10.5
office 2	10.5
head of statistics' office	10.5
head of marketing	10.5
head of audit	9
head of procurement	9
accounts department	8.4
head of commercials	8.4
general office	29
Total	**285.8**

third floor plan

Void	42
stairs, lifts, lounge, toilets	120
assistant port manager	10.5
lettable space 1	10.5
secretary/ waiting	10.5
lettable space 2	10.5
Records	9
lettable space 3	9
head of legal department	8.4
head of personnel	8.4
general office	26
Total	**258.8**

fourth floor plan

Void		25.2
stairs, lounge, lift toilets		120
lettable floor space1		10.5
	2	10.5
	3	9.9
	4	9.9
	5	9
	6	9
	7	23
Total		**227**

fifth floor plan

stairs, lounge, lifts, toilets	120
Conference	357
Total	**477`**

sixth floor plan

stairs, lounge, lifts, toilets	120
dining	24.6
reception	24
general port manager	30
total	**198.6**

Total administration 2986.2m²

area……

cruise terminal building

ground floor plan

entrance porches	132
security	18
office 1	30
office 2	30
office 3	44
snacks	30
eatery	74
wc male	76
wc female	42
departure lounge	78
arrival lounge	78
courtyard	186.2
stairs	21
observation deck	783.2
circulation	54
jetty	150
total	**1716.4**

transit sheds

circulation	2640
stacking	2464
total	**5104**

traffic control units

entrance	39.5
traffic room	39.5
secretary	17
manager	17
conference	34
harbor master	17
assistant harbor master	17
maintenance	17
wcs	17
control tower	12
courtyard	200
circulation	48
total	**475**

GRAND TOTAL **10,281.6m² (with void)**

Without void……..10, 094.1m²

All values given in m².

7.7 DESIGN PROPOSAL AND REPORT:

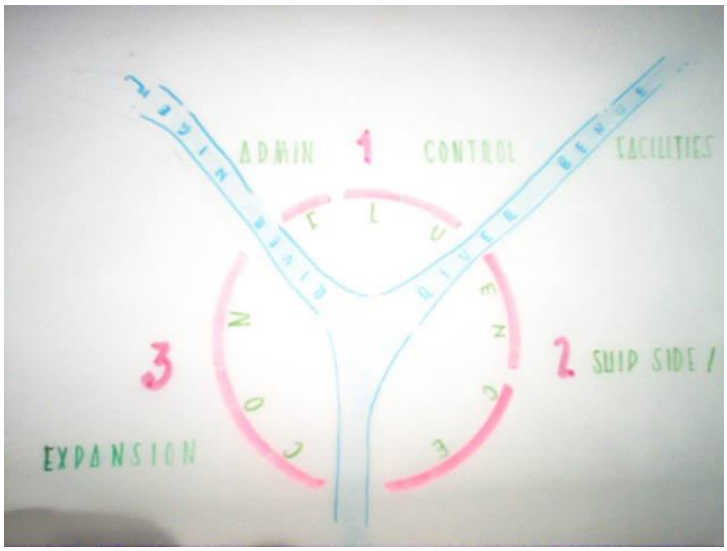
The task of designing a port requires careful planning and integration of the variables that make up the entire facility in a bid to attain to a clear vocabulary and syntax in its architecture. To reach this end, a design approach that has the capacity to give the required results is of importance.

7.7.1 Design approach and concept:

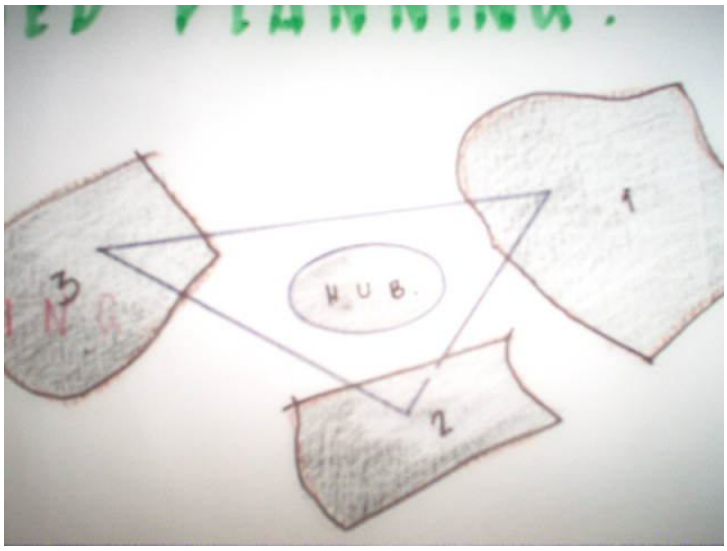
The basic design programme for the attainment of the port facility that organically, scientifically fits the subject of creating a hitch free circulation requires a thorough planning system which integrates the different variables of the entire complex in one language. This planning approach is scientific and logical, functional and aesthetic with its principle name being incrementalism.

Scientific and logical approach involves the study of existing facilities and their mode of operation to attain good results. In the studies carried out, it was established that linear, radial, dispersed planning patterns were the regular planning patterns in ports. It was then inferred that an existing **Y** formed by the streams flowing on the site should be the basis for facility location and the general network planning. In this is achieved the three planning patterns in one organic expression. The **Y** possesses the quality of having a focal point where the three branches meet which is common to the radial pattern of

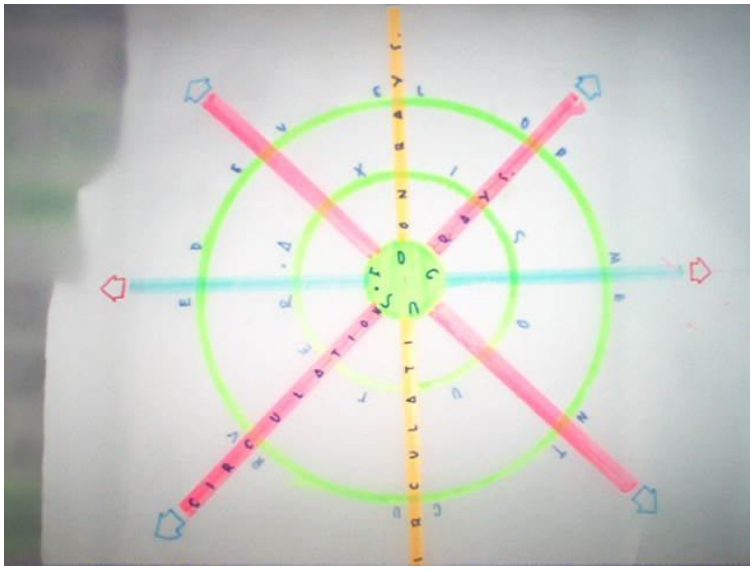
planning, on one flank it has a form of linearity, and on the other it has three distinct and separate parts to give the dispersed planning system.



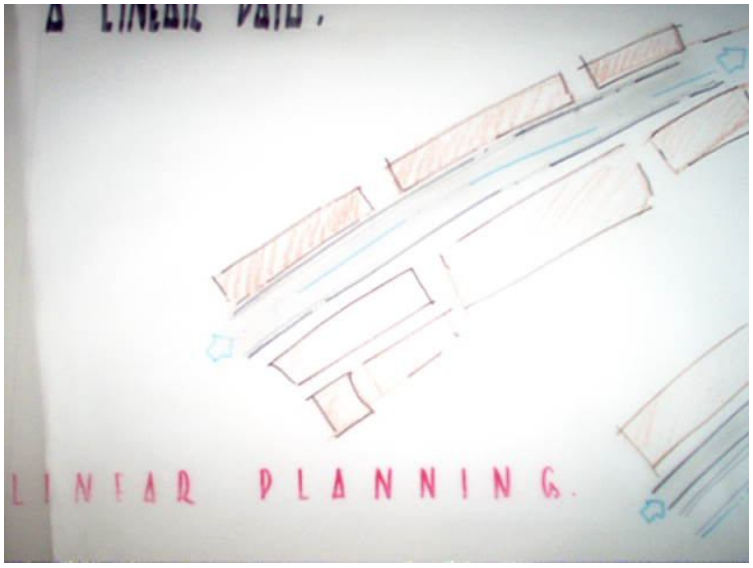
The ***"Y" pattern of planning. Plate 7a showing the concept drawn from the confluence.***



The dispersed pattern of planning. Plate 7b



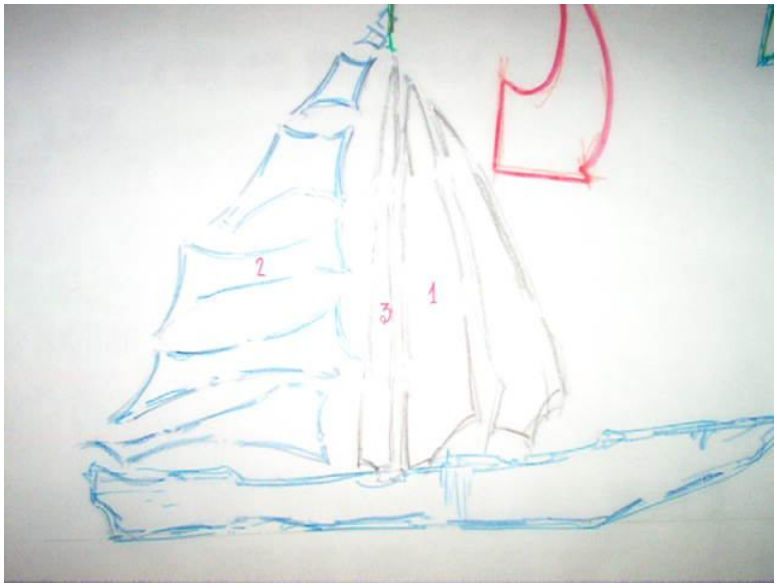
The radial pattern of planning. plate 7c



The linear pattern of planning. Plate 7d

This principle of combining the different planning types is what is known as incrementalism. Through it a functional segregation of parts is attained and yet unified in its entirety. In a bid to attain an organic flow in the planning, the facilities were placed on the site in their natural outlook.

The administration building is simply a ship at berth beside the stream following the landform existing on the given site.



Ship at berth. Plate 7e showing the form concept of the port building: a ship at berth along a river.

7.8 SERVICES:

Drainage:

The site is generally a water logged area with a gentle topography all drainage are to take the natural order. Ducts are created in each case to send water down the building in as little time as possible.

Fresh water:

Fresh water pipes have to be laid as none is available at the moment in the area given for the port.

Electricity, telecommunication and air conditioning:

The building has been designed to cater for itself through little use of artificial ventilation; by extension use of electricity. Telecommunications on the other hand is available now through the general service mobiles.

Sewage disposal:

Sewage disposal is effected in this design through piping at various collecting points from inspection chambers to septic tanks and finally soak away pits.

Fire control:

The use of an open design enables easy evacuation of the building. Fire hydrants are also suggested at various points.

Security:

The use of fences as well as security posts inhibits the risk of security. Also the use of separators through bridges based on the geomancy has reduced the risk of theft drastically.

7.9 MATERIAL USAGE AND CONSTRUCTION METHOD

In every building the use of materials play a vital role in the performance of the building be it in terms of durability or user comfort. The location of the building and the available technology also plays a great role in the choice of materials to be used in construction. These factors put together alongside cost govern the architects' specification of materials.

In this thesis, the choice of materials has a lot to do with the cycle of interaction between the facility and the environment. In a waterfront structure, durability of the building plays an all important part. Since interaction between the building and the forces of environment is increased, the materials should as much as possible play a balancing role. The forces of nature include those climatic evaluations mentioned in chapter 6 of this work. The most important of them to be considered in the choice of materials include:

i. relative humidity and moisture translocation: This accounts for 80% of the premature wear expenditure made on buildings even away from the water front all over the world; Deal (2004). Moisture causes damage to buildings through mold growth, corrosion, loss of structural strength, and adverse indoor air quality if not properly managed.

Moisture migrates in buildings through vapour in the air, through direct contact with the building or through migration from the soil. Moisture migrates from the warm side of buildings to the cold side of buildings. In hot humid climates even slight negative interior pressures can pull hot outdoor moisture. Similarly. Positive exterior pressure can push warm moist air from indoors into chilled exteriors with the result being one of the damages earlier outlined. Thus assuring the integrity of both the interior and exterior wall may be the first line of defence for a building in a waterfront environment.

To prevent this occurrence, the design of the port administration building provides a complete envelope on the exterior made of two materials with high moisture resistance namely: poly tetra fluoro ethylene membrane and acrylic

polycarbonate plastic sheets which are highly humidity independent and possess high permanent static control on the two surfaces. Each of these plastic modules has airflow screens allow air into and out of the building thus accomplishing the ventilation requirements. These two materials enclose the main building and prevent its contact with direct environmental forces thus a void is created between a double wall cavity on the exterior of the building. Air flows through the void along the main building wall and is directed into the building spaces through the use of horizontally opened windows. To further cater for moisture movements through the soil, a six layer asphalt is specified for each floor in direct contact with the soil.

Features of the plastic envelope include the following:

i. They are virtually unbreakable, resistant to weather, easily fabricated and installed high temperature performance, custom made sizes thickness and colours, low flammability, excellent sound insulation, hail resistant. Its thickness is up to 12.5mm.

ii. Temperature and comfort levels: A Comfort level in the building has to do with all the indices that play a role in the immediate environment. The building is designed to give an optimal control to these forces and provide the utmost condition for comfort to be attained. Proper ventilation is attained through the use of open floors and forced convection. Cooling is therefore easily generated.

iii. Sunshine: the intensity of the sunshine directly has a bearing on the building which conducts heat and eventually causes discomfort to the users of the building. The outer envelope of the building thus reduces

the sunshine intensity through the void and creates an interior that is optimal for the tropics. All the materials on the façade of the buildings resist heat generated from the sunshine intensity. On the other buildings enough shading is provided through the use of eaves which prevents excessive contact of the sun rays with the building.

The entire circulation routes in the port are covered with asphalt and drained by down spouts.

7.10 MAINTENANCE:

The choice of materials for the building has significantly reduced the task of maintaining the buildings since plastics have a low penetration rate of moisture which accounts for a large percent deterioration in buildings while the membrane acts as the first barrier against moisture.

REFERENCES:

1. Deal. B.M (1998). Commissioning for humidified buildings: www.buildingscience.com. p.1.

2. Lin. M. W. (2003).non linear finite element modelling of moisture migration in a masonry structure with FRP upgrade. www.building science .com. p.1.

3. Wilson. A. (2003).moisture control in buildings. www.eeba.com. pp1-4.

CHAPTER EIGHT: CONCLUSION AND RECOMMENDATION

The river port at Lokoja has been a long dream of the Nigerian government just like the other river ports. In the task of establishing this research work, this facility came into play for the predominant conflicts in circulation noticed in ports. Exploring alternative circulation pattern in ports was carefully expressed through studies carried out on the problem of the causes and effects of careless planning as is seen in reported case studies. It was also discovered that various planning patterns existed and each of these planning patterns convey a meaning yet incomplete in the attainment of what is required for a completely uninhibited facility. This research has been able to arrive at the possibility of having a port facility that combines not only the planning patterns of the ports but also combined the advantages of these planning patterns through the conceptual realization of the land geomancy and the possibilities in each given case. It has also revealed that a port can be as natural as any other facility through meticulous organic planning of the various aspects that make the whole.

Tourist facilities have also been put into the design to initiate interest in the activities of the port. The port carries a strong water front expression to excite a conscious impression of water front character on the face of the interior lands. In achieving this point a lot of limitations were there to inhibit the work especially in a country like Nigeria still developing with the complete absence of facilities of this nature. Ports outside the shores of the developing world feature a lot interesting activity something completely strange to this part of the world such as the absence of a host of facilities and poor coordination of the growth pattern. In the light of this, the port shall establish a new consciousness of possibilities of different dimensions in the face of the interior. This consciousness could

to some extent ginger some psychological interest in the environment to step up businesses as well as employment.

On the larger scale, the Lokoja port facility has been one with a long history from the colonial era to the present day it is yet to see the dawn of reality. In 2003 the invitation to look into this project was reawakened in the master plan for integrated transport infrastructure with a condensed feasibility study on how real this project can be with every indices to point at projections for the future. The federal government of Nigeria will do the people of Nigeria a great good if reconsideration is given to this task especially with the following positions of research and other salient points not duly mentioned in this inference. Since again Nigeria is trying to address her economic woes this project shall create employment, generate revenue and enhance growth and development in Lokoja and its environs.

The form expression has originality to convey to focus the UNCTAD regulations on waterfront architecture.

8.2 Recommendations:

Transportation is the base for economic growth the absence of which causes great inhibition to the economic wheel of any nation. It is the basic means of interaction whether intellectually or materially. River ports are therefore important in the drive for economic upliftment of the people of Nigeria more especially as the serve as distribution centers to the various parts of Nigeria. The government of Nigeria therefore owes Nigeria the duty of ensuring that this task is realized not in isolation but in conjunction with the necessary facilities the have to go with functionally. Such facilities are other circulation modes or means of conveyance of goods and services.

In all of these, the role of architecture in the achievement of this goal can clearly not be overemphasized since it possesses the ability to manifest the culture of the people physically to international tourists as well as others.

BIBLIOGRAPHY

1. Adeeko.A. (1998). "Introducing Tincan Island Port": *Tincan island port handbook*.p.5. Lagos; Nigeria Ports Authority.
2. *Architecture and transportation*; Volume 64 #5\6; Academy Editions London
3. Bookman (1996) *The Future of Marine Activities*; www.ports in usa.com.
4. Bull. A. (2004). Traffic Congestion-The Problem and how to deal with it. *United Nations publication*; ECLAC.p.54.
5. Cassons (1986). The Role of Vertical Integration in the Shipping Industry; *Journal of Transportation Economics and Policy 20*.
6. Chan- Heflin. (2003).Modernization In Ports: "*The Future of Marine Activities*". www.ports in usa.com.
7. Dabo (2002). Digest of Transport Statistics: *Transport Monitor.* Abuja. Federal Ministry of Transport; 6th edition 7; # 23.9; pg 29.
8. Dabo. (2002). State of the Ports: Nigerian Ports Authority News. Journal of the Nigerian Ports Authority. Volume 3 #15. p.5.
9. Freight Transport Demand of Industry in Nigeria; D*ock and Harbor.* Volume 4.
10. Haskoning (2004); Proposed Port Facility for Lokoja–*Tender Document*; Haskoning Engineering Consult; Lokoja.
11. Hayuth.Y. (1980); Inland Container Terminal: Function and Rationale; *Maritime Policy and Management.* In B.S Hoyle et al*: Modern Transport Geography*. London: Belhaven press.
12. Hayuth.Y. (1987); Intermodality: Concept and Practice. *Structural Changes in the Freight Transport Industry*. London. Lloyds of London press.
13. Hoyle. B.S (1992); *Modern Transport Geography*; Belhaven press; London

14. Hoyle B.S (1973); *Transport and Development*; Macmillan press.

15. Jones (1990) *Cargo Security* – A Nuts and Bolts Approach. USA. Boston printing.

16. MITI (2003). Extension of Transportation Networks. *Master Plan for Integrated Transport Infrastructure*

17. Mohammed. R.T. (1999). *River Port Terminal for Baro;* Integrating Forms and Space with Immediate Port Environment. Unpublished M.Sc. Thesis Dept of Architecture. Zaria: A.B.U.

18. N.P.A (2004). *Introducing Tin Can Island port.* Lagos*:* Tin Can Island Corporate Affairs Department.

19. N.P.A (2004). *Port and Terminal Facilities*; Marina, Lagos.

20. N.P.A (2004*); RORO Port Handbook*. Lagos: Corporate Affairs Department; RORO Port.

21. Olgyay.V. (1973); *Design for Climate*. New Jersey: Princeton university press.

22 Porteous.J. (1977). *Canal Ports* – The Urban Achievement of the Canal Age. London: Academy Press.

23. *Port Engineering* (1993). Volume 1&2; 4th edition. Houston: Per Brunn Gulf Publishing Company.

24. Schnell et al (1974). *Transport and Communication*- Federal Republic of Germany; Press and Information Office of the Government of the Federal Republic of Germany.

25. Snyder. J. (1979*). Introduction to Architecture.* New York*:* Mc Graw hill.

26. Taylor.D. (1949*). Docks, Wharves and Piers.* New York*:* Stoughton Press.

27. *Transport Monitor:* Federal Ministry of Transport. November 2002. pg 28-29

28. Ullman.E.L. (1956). The Role of Transportation and the Bases for Interaction. In: W.L. Thomas (Ed) *Mans Role In Changing The Face Of The Earth*. Illinois: University of Chicago press.

29 Walker.G. (1959). *Traffic and Transport in Nigeria* – The Example of an Underdeveloped Tropical Territory. London: Her Majesty Stationery Office.

30. *World Freight Technology*; Volume 24; #13; London.