Using GIS Environment as a Remedy to Solve Rail Network in West Africa as a Global Village.

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SUMMARY

Railway construction was started by most of the colonial government which colonised the sub region in the late 1800's and the early 1900's. Most of the railways were developed to gain access to the rich agricultural and mineral resources in the hinterland at that time, orienting its network mostly to the seaports. Now its purpose has been so much useful for carriage of passengers and freight at a very cost effective manner. Since after independence from the colonial rule, most West African countries in the sub region of the sub Sahara Desert have not, even if they have, are unable to expand their rail network substantially enough in bringing about sustainable development to its people. Economic Communities of West African States (ECOWAS) which (is a body under the AU and UN) comprises the Heads of State of governments of West African countries have initiated to embark upon the rail transport network sector in the sub region into a global village. These initiatives which have been loudly applauded have been in existence for a decade now and some are under going feasibility studies whiles others are not. Clearly the advantages and benefits of rail transport cannot be overemphasised, but if the rail network into a global village should be a reality then each country needs to address its problem which of course is peculiar. This paper seek to address some of these peculiar problems and give suggestions using GIS environment as a remedy if this dream of rail transport network in West Africa into a global village needs to be achieved.

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1. INTRODUCTION

Railway enterprises constitute a vital ingredient in the socio-economic development of African countries in view of its capacity to transport relatively huge volumes of goods and numbers of persons at minimum cost, and to open up areas that are difficult to access by road.

Despite these primordial advantages, rail transport enterprises have, at all times been, rightly or wrongly, regarded as high spending companies that put a strain on the financial resources of states.

With the crisis in the mid -80s and at the instance of instructional donors, African states for that matter were subjected to Structural Adjustment Programme (SAP). Rail businesses were particularly affected by this crisis, more so the states did not have sufficient financial resources to offset the huge deficits generated by these state companies.

Several solutions were devised and implemented in several African counties, ranging from structuring, privatization and management agreements, all in an attempt to ensure the survival of rail enterprises. These measures were intended to steer the rail enterprises towards commercial competitiveness and financial viability.

The problems indeed, existed and have continued to exist with the recommended solutions producing at times unexpected results.

Hence this paper is going to address some recommended solution using the environment of GIS in the rail network sector.

2. WEST AFRICA RAIL TRANSPORT NETWORK

In West Africa, these are the countries with their railway length (km).

Countries	**Railway Length (km)**
Benin	578km
Burkina Faso	622km
Cape Verde	-
Chad	-
Cote d'Ivoire	660km
The Gambia	-
Ghana	953km

Guinea	1,115km
Guinea Bissau	-
Liberia	490km
Mali	729km
Mauritania	-
Niger	-
Nigeria	3557km
Senegal	906km
Sierra Leone	84km
Togo	525km
TOTAL	**10,219km**

2.1 Instructional Development in Railway Enterprises in West Africa

Most railway systems in West Africa were built during the colonial era which used them as a vital tool to gain access to the rich agricultural and mineral resources in the hinterland and opening up certain regions of the continent orienting its network to the ports.

2.1.1 Before Independent

At structural level, the entities responsible for rail operations management during that era was the Department of Administration whose budgets were part and parcel of the state budget.

2.1.2 Their Concern

The major concern of the Authorities of the time was o ensure the circulation of the railway trains, since these enterprises were operating in a context of total monopoly. The survival of the rail transport was absolutely not in question, and supply was often for below demand.

2.1.3 After Independent

West Africa states established railway companies with operational autonomy from both the financial and technical perspective. As the year went by, these companies began to portray serious managerial weakness which upset their financial equilibrium and seriously compromised their survival, notably as a result of:

a. Lack of financial resources to effectively carry out maintenance of the production tool.

d. Absence of investment in infrastructure and equipment.

c. Considerable technological gaps.

2. RAIL TRANSPORT OPERATIONS

Rapid expansion occurred in rail transport with the establishment of state companies under the auspices of a supervisory ministry. However, public management of rail transport had the following repercussion:

- Strong presence of supervisory authorities in rail operations thus Government interference with management structure.
- Over-bloated workforce.
- Chronic deficits, obliging the state to subsidize the enterprises to ensure the financial equilibrium for the sustainability of rail transport.
- The technical problems such as tight curves, steep gradients, rail buckling with associated track/speed limits
- Poor communications.
- Lack of freedom to set tariffs.
- Under funding.
- Mismanagement
- Unfair competition with other modes of transport, particularly road transport.
- Falling rolling stock levels.
- Plummeting traffic levels (freight and passenger)
- Irregular staff training
- Worn-out infrastructure.
- Lack of maintenance.

2.1 Case of Nigeria

In Nigeria, the Nigeria Railway Corporation significantly reduced its running cost and transferred to the private sector of the activities that are not strictly relevant to rail transport business. The process is still ongoing, and the Nigeria Federal Government is backing these actions with massive investment. The workforce decreased from nearly 35,000 in 1988 to around 6,020 in 200. A huge investment programme has been put in place with international cooperation support particularly for the rehabilitation of some 4,300 km rail road, procurement of new locomotives and rehabilitation of the rolling stock.

Fig 01. 1740 arriving at Zaria

Fig 02. 2131 arriving at Zaria with a kano to Kaduna train,

2.2 Case of Cote d'Ivoire and Burkina Faso

The activities of the Cote d'Ivoire/Burkina Faso joint rail network leased to SITARAIL got underway in August 1995 under a lease agreement which provided for the creation to two property companies; one, to cater for the interest of the state in railway sector, and the other, to implement a substantial part of the network rehabilitation and modernization programme. The equipment and infrastructure remain the property of the state while the concessionaire takes charge of maintenance.

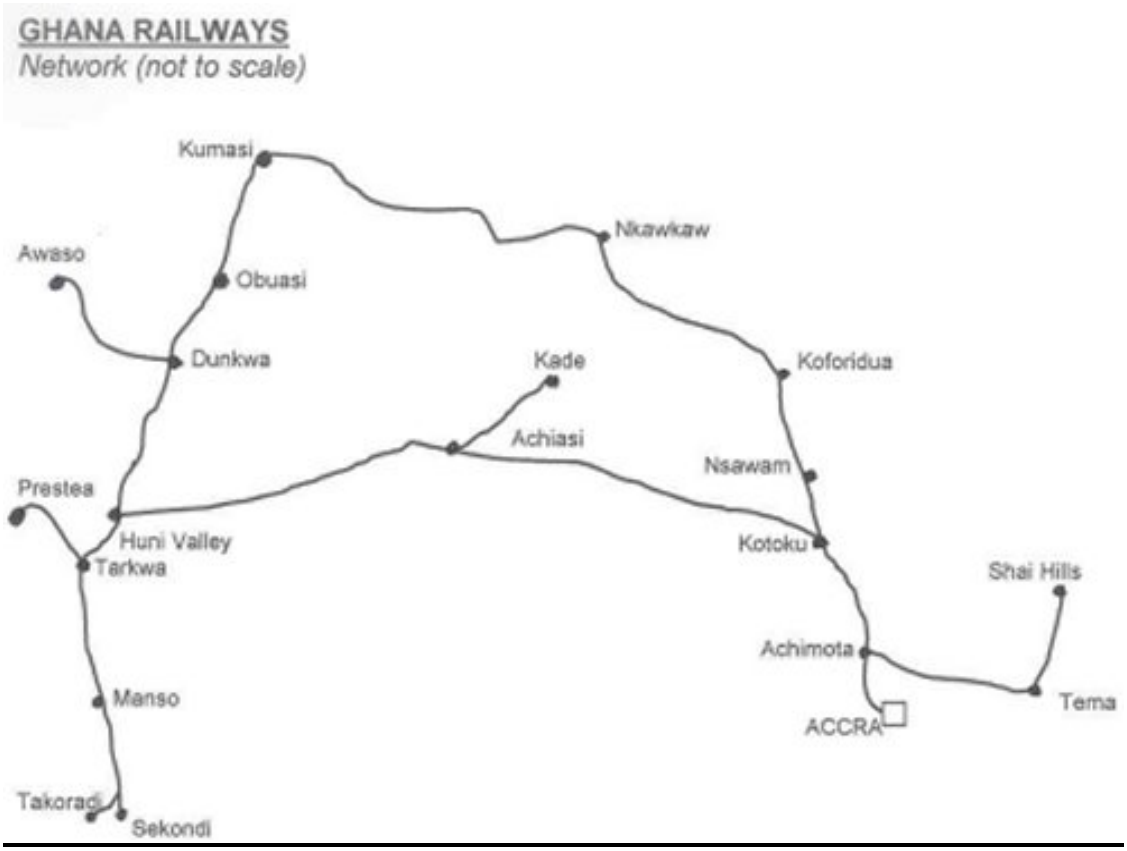
Given the problems posed by the financing of production tool renewal operations, the two states in 2002 set up a Railway Investment Fund financed mainly by the states and SITARAIL from the funds generated by rail road operations. The paucity of the Railway Investment fund made it hard for the huge volume of financing required for the renewal investment to be raised.

Since the events of September 2002 in Cote d'Ivoire, SITARAIL has been faced with operational difficulties which disrupted the activities of the network and, by agreement between the two states, led to the deferment of some provisions of the agreement.

Fig 03. Train at Ouagadougou

Fig 04. Goods train on arrival

2.3 Case of Ghana



Ghana Railways

Sekondi - Tarkwa built	-	1898 -1901
Tarkwa - Obuasi	-	December 1902
Obuasi - Kumasi	-	October 1903
Accra - Nsawam	-	August 1910
Tarkwa - Prestea (January 1911)	-	Passenger service suspended in 1998
Nsawam - Koforidua (1915)	-	Passenger service suspended in 2001
Koforidua - Tafo (1918)	-	Passenger service suspended in 2001
Tafo - Kumasi (1923)	-	" " " in 2001
Huni Valley - Achiasi - Oda (Oct. 1926)	-	" " "
Oda - Kade (December 1927)	-	Passenger service closed in 1985

Kojokrom - Takoradi (1928) -

Dunkwa - Awaso (1944) -

Achimota - Tema - Sahi Hills (1954) - Closed in 1995

Achiase - Kotoku (February 1956) - Passenger service suspended in 1998

Accra - Tema (1999) - (Reopening not realized)

Takoradi - Kumasi and Dunkwa-Awaso - Passenger services suspended due to high fuel prices in May 2006

Fig05. Kumasi train station

Fig06. Train arrival at Benso.

Fig 07 1661 arriving at Kojokrom, Takoradi.

Fig.08 Kotoku train station

3. GIS AS A REMEDY TO THESE PECULIAR PROBLEMS

GIS which have become a tool for management and solving problems in no doubt a system that must be embraced in the railway system if the dream of the West Africa railway system is to be realized.

3.1. Why the Need for GIS in the Railway Transport System

There are:

1. Geospatial data are poorly maintained.

2. Maps and statistics are out of date.

3. Data and information are inaccurate.

4. There is no data retrieval service.

5. There is no coordination (no data sharing).

The adoption of GIS will help in this system and can be classified into three categories:

4. ORGANIZATION

5. PUBLIC – PRIVATE PARTNERSHIP

6. STRATEGIC ORIENTATIONS

4. ORGANIZATION

Experience has demonstrated the need to separate infrastructure management from rail road separation.

This makes it possible:

1. To release rail road operation from the huge indebtness required for investment.

2. In the case of partnership with the private sector, it makes it easier for provision for the intervention of several operators on the sea infrastructure.

4.1 Railway Company

The rail company is responsible for passenger and goods traffic operations in accordance with established security standards, in the state. To incorporated GIS in this system for effective use, a company attribute table can be created as:

- Company id
- Company Name
- Type of organization (Private and Public)
- Establishment date
- First permit date
- First operational date

- Renaming date
- Merger date
- Dissolution date
- General area served

As part of its operations, a line attribute table (railroad line) needs to be adopted for GIS implementation.

Line attribute table (railroad line) will be:

- Line id
- Line name
- Current geographic coverage

(Start node and end node points, as well as major station id, station type, station name midpoints).

- Line type (rail, light rail, monorail, subway)
- Service type (Passenger, freight, both)
- Power mode (Electric, steam, diesel, etc…)
- Gauge (1067 mm)
- Open date of first segment
- Open date of newest segment
- Closing date of final segment (if entire line is closed)
- Renaming date
- Rerouting date

4.2 Property Company

The property company will be tasked to perform the following functions:

- Manager the unleased portion of the rail operation and the related activities that have not been taken over by the concessionaire as part of his/her operations.
- Oversee infrastructural investment works on behalf of the state,
- Monitor the rail contractual activities relating to infrastructure management.
- Finance investment in infrastructure through the rail road investment fund of which it serves as manager.
- Resume rail operations at the end of the concession or in the event of default by the contractor.
- Conduct rail road development studies on behalf of the state.

For the property company the following attribute table will be needed for GIS which are:

Segment Attribute Table

(Connection between two stations or junctions point of the rail network)

- Segment id
- Start node station
- End node station

- Permit date
- Opening date
- Suspension/re-opening date
- Closing date
- Multiple tracking date
- Grade separation date
- Electrification date
- Service date (Electric connector)
- Rerouting date
- Renaming date and names
- Inter-line through service date
- Time legs (multiple tacking, electrification)
- Land cover
- River crossing
- Road intersection with railway
- Cultural heritage
- Geology
- Soil.

Station Attribute Table (rail stations and junctions)

- Station id / Point id
- Station type / Point type (station, junction signal point at passing point on single touch segment).
- Station name
- Station opening date
- Suspension/Re-opening date
- Closing date
- Service type (Passenger, freight, both)
- Service level (local, semi express, express, limited express).

4.3 Regulator Agency

The regulatory Agency has a very key role to play in this organization. It has authority over the rail operators and the property company and will discharges the following functions:

- Put in place a stable instructional legislation to regulate competition and market mechanism, thereby producing services at the least possible cost while ensuring the financial profitability of the enterprises in the regulated sector.
- Coordinate the different modes of transport with a view to optimizing the material resources available in the country.
- Protect the interest of consumers.
- Ensure respect for security standards.
- Resolve cases of abuse of dominating position.
- Correct uncompetitive practices.
- Regulate access to infrastructure by several operators.

- Regulate multi-modal transport and inter connections.
- Resolve conflicts between operators.

For the regulatory Agency on attribute Event table will be drawn up for GIS thus:

Event Table

- Event id
- Year, month and day
- Event summary
- Affected entity (company, line, segment, station)
- Market mechanisms
- Consumers feedback on operation
- Resolve case (Type of cases)
- Type of event (line opening, company merger, company renaming, line renaming)
- Security standards
- Geographic elements affected (start and end point of a node line section)

Once a GIS implemented, the following benefits are expected

- Geospatial data are better maintained in a standard format.
- Revision and updating are easier.
- Geospatial data and information are easier to search, analyze and represent.
- More value added product.
- Geospatial data can be shared and exchanged freely.
- Productivity of the staff is improved and more efficient.
- Time and money are saved.
- Better decision can be made.

If the GIS implementation is put in place, the package looks good for the next category thus.

5. PUBLIC- PRIVATE PARTNERSHIP

The private sector may then be invited to operate the railway system under a lease contract which delay spells out conditions of the operation under the supervision of the regulator.

6. STRATEGIC ORIENTATIONS

The creation of the African Union supported by sub-regional bodies such as the Economic Community of West Africa State (ECOWAS), the common market for Eastern and Southern African states (COMESA), the Economic community of sahelo-saharan states (CEW-SAD) and other groupings such as the Arab Maghreb Union will allow for the establishment of significant trade flows between African states.

The adoption by heads of the NEPAD program to combat poverty in Africa is an opportunity to put in place an integrated transport and modern interconnected and efficient rail system into a global village should adopt the following:

6.1 Railway Interconnections

1.1 There should be a guide plan of rail links
1.2 Standardization of material and equipment
1.3 Spacing of rail lines

6.2 Standards of Maintenance and Repair of the Material Towed

1.2.3 Brake system
1.2.4 Unification of gauges
1.2.5 Types of attachment

6.3 Rail Line Standards and Specifications, examples

1.3.1 Rails of 36kg/m minimum and heavier from 45 to 60kg for the renewal of the railway and construction of new lines.
1.3.2 Maximum slopes of 10% for new lines
1.3.3 Maximum speeds of 120km/h for metric gauge track and 160km/h for railway with 1435mm spacing.
1.3.4 Radiuses of curves higher than 300m for new lines.

6.4 Human Resources Development

1.4.1 Center of Brazzaville: The Africa higher school for executives of Railway transport management (ESSAC-GT) exists and functions since 1987.
1.4.2 The Nigerian Railway Institute for Transport Technology (NITT) in Zaria.
1.4.3 The warden center created by United Nation (the ILO). The center trained trainees for Egyptian, Sudanese, Ethiopia, Ghanaian, Namibia and Kenya railways.
1.4.4 The Kabwe Center

The Kabwe center which takes care of the Southern African network.

6.5. Implementation of Geographic Information System

A significant amount of information exists on the development of railroads in West Africa. Within the framework of the establishment, a GIS base needs to be created in order to equip member networks with a general signal system for planning and monitoring all aspects of management and railway operation.

7. CONCLUSION

Geographic Information Systems are powerful tools for rapid analysis and visualization of spatial phenomena and their relationships. Although creation of a GIS database

covering an extensive rail network is a major undertaking, the resulting computerized record of conditions and changes offers much potential.

The adoption of GIS is therefore vital that rail transport business undergo real transformation, both structural and organizational so that its package can be attractive for inputs from increased international, regional and sub-regional cooperation and the private sector, to enable the business to play its catalytic role in social and economic development of the member states.

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BIOGRAPHICAL NOTES

Stephen Fiatornu has over nine years experience in various aspects of Geodetic Engineering and over five years experience in all aspects of Integrated Map and Geo-information Production. His areas of specialization include ground control survey, road survey, route location, and GIS Standard Facility Development. Mr. Fiatornu is an expert in Geographical Positioning Systems and serves as a consultant to a number of firms undertaking GPS related Surveys including Geotech Engineering, Mobitel, Areeba Scancom mobile network, Town and Country Planning, Feeder Roads Department and Survey Department. His in-depth knowledge in Geographic Information System is an asset in helping some companies, district assemblies and chiefs in their efficient execution of all aspects with regard to revenue generation. He has worked extensively in Ivory Coast and Senegal helping client to develop GIS Database. His involvement in assisting the Feeder Roads in their Pilot Roads Inventory in the Northern Region has added value to the GIS section.

Mr. Fiatornu serves as a resource person for seminars focused on imparting knowledge on modern trends

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