

**Application of GIS Technology to Electrical Infrastructure Management  
(Case study of Ilaro Town, South Western Nigeria)**

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**Abstract**

*Infrastructure is a key, if not the first element for the generation of economic growth and development. It is no doubt the main driver of urban activities. Recalling from the large outcry from members of the Nigerian communities, experts have added that a durable and sustainable socio-economic development can never be realistic without paying due attention to the development and improvement of infrastructure. Infrastructures cross over any urban landscape. They vary substantially in form, use, structure, design, material and specific purpose and so their maintenance need, pattern and plan will differ. Nevertheless, the maintenance approach can be fundamentally the same. It is against this backdrop that this paper aimed at analyzing the existing infrastructural facilities in Ilaro town and proffer ways to imbibe a sustainable infrastructure management and maintenance culture. It examined the major problems of maintenance management of electric facilities in the public sector using GIS tools for analysis of gathered spatial data. Technology for development, Institutional factors, management and maintenance, equipment problems, Corruption and financial problems were identified. Several proposals have been exhausted. This paper proposes that appropriate strategies such as establishing a maintenance audit system; providing training and increasing staff capacity; establishing the capacity for maintenance management; undertaking institutional and legislative adjustments; promoting community participation to improve funding and investing in research and human resources which will enhance professionalism in technical and management skill.*

**KEY WORDS:** GIS, Infrastructural facility, socio-economy, development, maintenance, management, Electrical infrastructure, Community participation.

## **INTRODUCTION**

There are a number of laudable infrastructural facilities over the years that makes one proud of being a Nigerian. These facilities range from the Liberty Stadium, Ibadan (now called the Obafemi Awolowo Stadium) to the National Stadium Lagos, railways, Nigerian Telecommunications Limited, NITEL hospitals, schools and the refineries which got oil displacing agriculture as the mainstay of the economy to mention a few.

But these facilities, having been built and made to serve the immediate purpose they were meant to serve, in most cases they are abandoned and at its best given very little attention, leading to its poor maintenance and management. Then the question arises as to whether these facilities were actually made available in the short term or long term. It is expected that they are to serve a long term purpose. Nevertheless over the years, most laudable projects in Nigeria fault this notion.

Nigeria has had over the years on its once upon a time very laudable projects that are right now in the most deplorable state ever imagined which are definitely threats to the social economic and infrastructural advancement of Nigeria. Unfortunately, the poor state of infrastructural facilities resulting from poor management and maintenance culture has been a malady of Nigeria's economic development. The four requirements of any physical infrastructure projects are: design, finance, technology and management. The appropriate designs that will ensure value for money are not adopted. The finance is not adequate, is procured at high interest rates and financial management is lacked by most Nigerian contractors. The technology of construction is scarce and the management of infrastructure is lacking. The maintenance culture of Nigerians is poor thereby allowing most projects to decay.

This is with respect to the issue of maintenance of public infrastructural facilities and capital projects that are worthy of proudly making one a Nigerian, though for a short while. This problem of poor management and maintenance culture arise from the following:

- Bad Leadership resulting from poor management and maintenance attitude and practice.
- Inadequate funding
- Non availability of technology for development

- Corruption

Rather than being a blessing, disappointingly, the poor state of infrastructural facilities has been the malaise of Nigeria’s economic development. The near collapse if not total extinct of public infrastructure in the country is occasioned by many years of neglect by the government as well as lack of maintenance culture and effective planning.

Infrastructure consists of general facilities and structures provided to support or service structural development and economic and social activities (Chukwuma C.N., 2010). They are very diverse and complex set of facilities that serve a wide variety of economic and social needs often dispersed over very large areas and in certain proximities. They generally include the following:

- Transport infrastructure including roads, railways, seaports, water ways, and airport
- Water supply systems
- Sewer networks
- Energy infrastructure including power stations and distribution and transmission networks, gas stations and distribution networks, petroleum refineries and distribution pipelines.
- Postal and Telecommunications facilities
- Health facilities
- Education infrastructure

The study focused on analyzing the significance of maintenance management of energy infrastructures such as home electricity meters, transformers, electric power transmission networks e.t.c to national economy. A number of limited resources have constrained this study viz: fund, data, manpower etc. As a result the scope of the project has been streamlined to cover Ilaro town of Ogun state.

### **1.1 AIM AND OBJECTIVES OF THE RESEARCH**

this work aimed at assessing the existing electrical infrastructural facilities in Ilaro town and proffering ways to imbibe a sustainable infrastructure management and maintenance culture. This is achieved through a number of objects viz”

- To establish the state of existing energy infrastructural facilities; their conditions
- To develop a GIS database for the acquired information about the facilities;
- To assess the causes of the state of disrepair of the facilities
- Proffer ways for developing management and maintenance strategies for these facilities

### **1.2 DATA SOURCES**

1. Field observations
2. 2014 Google Earth Image of the study area
3. Digital Map of the study area

### **1.3 GEOGRAPHICAL LOCATION**

Ilaro is situated on the rich cocoa belt of South Western Nigeria and with an above average rainfall Geographically, Ilaro is bounded on the north by the Oyo Province on the South by Lagos and the east by the Egba Division and on the west by Dahomey (Republic of Benin). The boundary on the South is defined in the “Colony of Nigeria boundaries order in council 1913” (see page 311 of Vol.IV laws of Nigeria.

It lies between 496505.830mE, 763173.51mN and 496435.980mE, 759321.670mN.

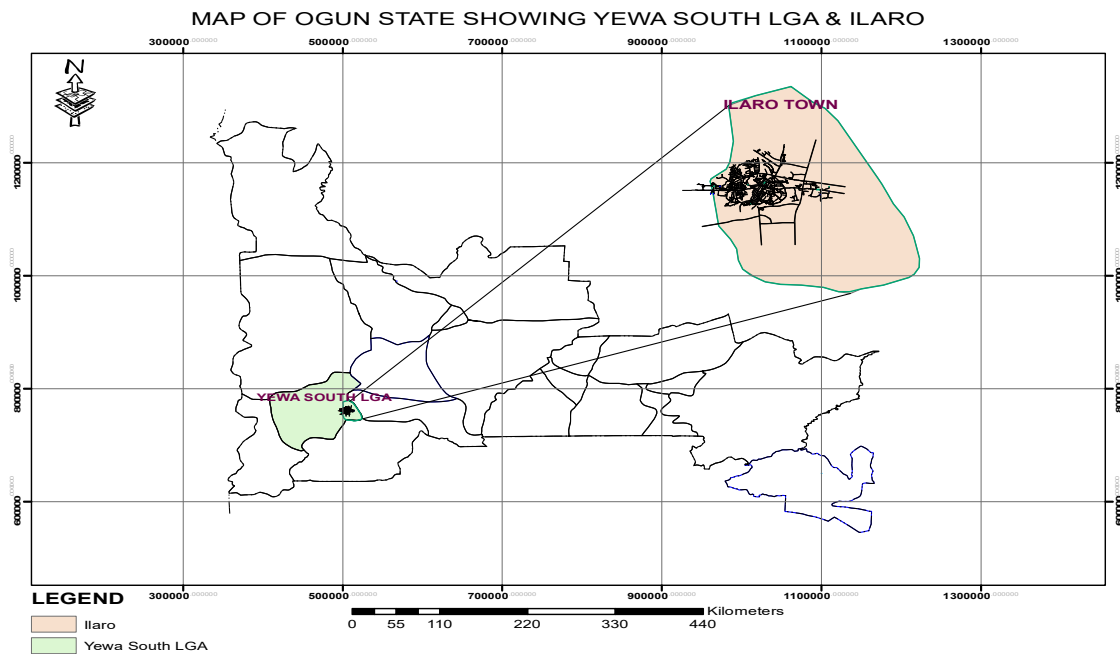


Figure 1: Map of Ilaro Town

## 2.0 THE CONCEPT OF INFRASTRUCTURE MANAGEMENT & MAINTENANCE INFRASTRUCTURE

Infrastructures are the basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons. These systems tend to be high-cost investments; however, they are vital to a country's economic development and prosperity. Infrastructure projects may be funded publicly, privately or through public-private partnerships. They are part of major facilities provided not only as outstanding investment, but serve as facilitators for government revenues. They serve as the base or foundation for all the economic activities and commerce.

Infrastructure is a generic but huge problem of developing countries in which Nigeria has refused to be an exception. In some countries, this is worse still. In the World Economic Forum (2013)

report, it was indicated that the Program for Infrastructure Development in Africa (PIDA) forecasts investments of US\$ 360 billion up to 2040 and priority investments of US\$ 67.9 billion up to the year 2020 in the critical infrastructure sectors of energy, transboundary water supply, transport and ICT. However, Nigeria’s infrastructure deficits dwarf the above mentioned figures.

## **2.1 MANAGEMENT**

To manage means to control or guide; to have charge of; to direct; to administer; to succeed in accomplishing; to bring about by contriving; and to get a person to do what one wishes, especially by skill. Management includes planning, organizing, staffing, leading or directing, and controlling an organization to accomplish the goal. Resourcing encompasses the deployment and manipulation of human resources, financial resources, technological resources, and natural resources. Management is also an academic discipline, a social science whose objective is to study social organization.

Management of infrastructure projects is very complex process from both management and economic perspectives. The reasons for this complexity are not farfetched: limited financial dedications, lots of participants, , large volume of information, multidisciplinary conflict goals and criteria.

Ever growing urban infrastructure systems, such as water supply systems, traffic systems, sewage systems and others, contribute to the difficulty within a decision making process as regards their management that is very complex and social sensitive. Cities face the problem of managing big infrastructure projects, especially when is necessary to find solution which can meet requirements of all stakeholders and, at the same time, be a part of sustainable development concept.

Several attempts have been made by various agencies tp unravel the complex problem solving nature of infrastructure management.

A development in this regard is (EPA Clean Water State Revolving Fund, 2011). The site visits took place at ARRA GPR projects in: Spokane, Washington; Edmonton, Maryland ; Lenexa, Kansas ; Tacoma Park, Maryland; Nevada City, California. The findings in this report

demonstrate that there were common and overarching themes applicable to the projects that were identified. These include: the establishment of accountability and maintenance schedules through an O&M plan, the tracking and documentation of maintenance activities, training and education on green infrastructure maintenance, the presence of mechanisms to ensure compliance, and the importance of securing a dedicated source of funding to pay for O&M.

In another related development, (Oyedele, 2012), it was there in after opined that the challenges of Infrastructure development are copious but could be overcome if researches and development in infrastructure are continuous. The challenges include finance, technology for development, maintenance and design. The challenges also include international requirements of project to be sustainably developed. Projects must meet the carbon emission standard set by international organizations; communities must be bio-diversified and emit as little greenhouse gases (GHGs) as possible, natural environment must be preserved and so on.

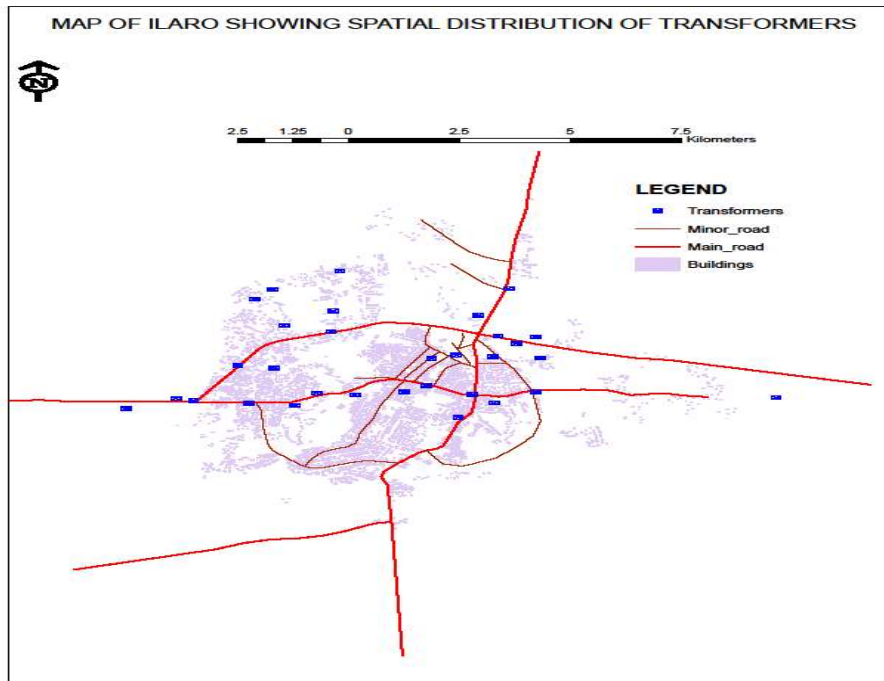
In a document, Public works department, 2007 which describes the National Infrastructure maintenance strategy. It argued that delivery needs to be understood as embracing not just the construction of infrastructure but the operation and maintenance of that infrastructure throughout its intended life.

### **3.0 RESEARCH METHODOLOGY**

- To establish the state of existing energy infrastructural facilities; their conditions
- To develop a GIS database for the acquired field information about the facilities;
- To assess the causes of the state of disrepair of the facilities
- Proffer ways for developing management and maintenance strategies for these facilities

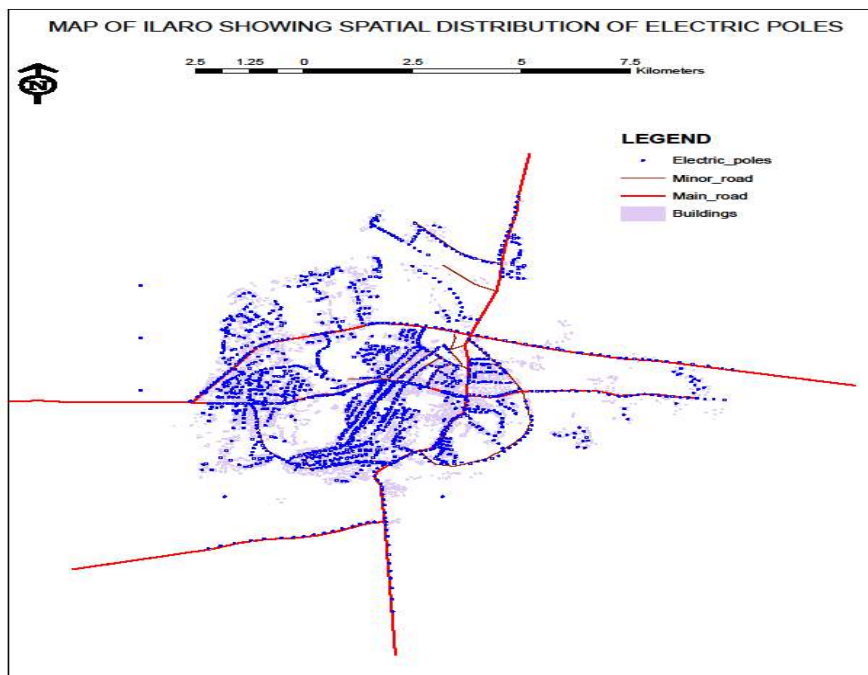
#### **3.1 THE EXISTING ENERGY INFRASTRUCTURAL FACILITIES**

Below is a map of Ilaro town showing the distribution of Transformers in the town



**Figure 3: Map of Ilaro Showing Transformer distributions**

Below is a map of Ilaro town showing the distribution of Electric Poles in the town.





**Figure 4: Map of Ilaro Showing distribution of Electric Poles**

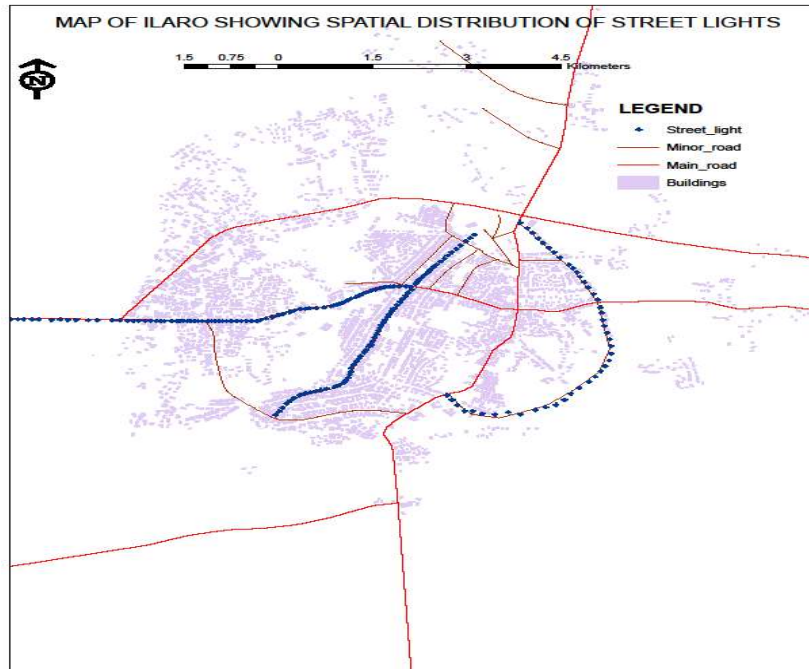


Figure 5: Map of Ilaro Showing distribution of Street light

### **3.2 MANAGEMENT AND DEVELOPMENT OF A GIS DATA BASE FOR THE EXISTING ENERGY INFRASTRUCTURES**

Field data about the state of existing infrastructures and their conditions were collected and a database created. In the creation of the database, both spatial and attribute data were structured in excel spreadsheet. The structured database where imported in ArcGIS 10.2 for spatial and statistical analysis to be performed on them.

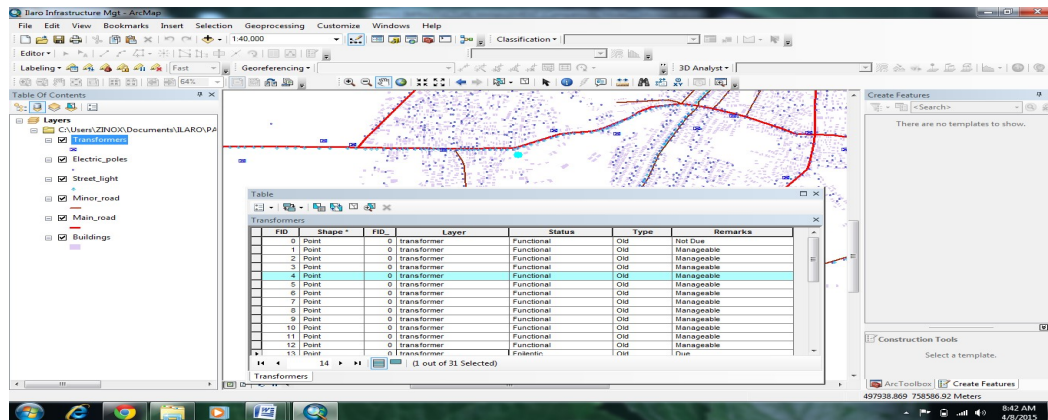


Figure 6: Showing created data base for Transformer in the Town

#### 4.0 DISCUSSION OF FINDINGS

In the query analyses from the database created, there are a total of 31 transformers in the town. Query analysis was performed on the data sets. The condition of these transformers was identified by the communities they are serving. The numbers of transformers that are manageable in the town are 23 out of total of 31. Of the remaining 8, 6 are old, epileptic and due for repair while only 2 are due for replacement. The reason behind this could possibly be that the number of communities/households they are serving are few compared to the ones in the Ilaro metropolis where the population is higher thus putting more pressure on the transformers. These two transformers are found around Ikosi area and along Oja Odan road. Bulk of the transformers is found around densely populated areas hence, much pressure on them due to much power load.

Again, there are 1574 electric poles in the town. Of these, 12 are in a state of disrepair. Most of these electric poles are slant as a result of tension force from buildings whose electric cables are directly or indirectly connected to them. This is dangerous to the serving communities.

There are 234 street lights serving about 11 roads in the town. Each of these roads is not less than 1.7km in length. None of these lights are found along the only express road that leads into and out of the town. Of all the roads, street lights are mounted on two minor roads and one main

road. Most of the street lights found along these roads are not functional. This could be due to lack of sufficient power supply, damaged parts or incomplete installation.

#### **4.1 THE CAUSES OF THE STATE OF DISREPAIR OF THE INFRASTRUCTURES**

Most programs developed in Nigeria, as a developing country example, do poise a good and long term effect on the economy, but with most lacking the planning of maintenance system at the inception and some die at the instance of change in government (lack of continuity), which might deny the funding of the projects. (Gordon, Monday Buboui et al, 2014). So many other factors that could lead to the disrepair of infrastructure viz:

- Bad leadership resulting from poor management and maintenance attitude and practice
- Inadequate funding
- Corruption
- Poor technology for development etc

#### **4.2 PROFFERING WAYS FOR DEVELOPING MANAGEMENT AND MAINTENANCE STRATEGIES FOR OUR ENERGY INFRASTRUCTURES**

There is the need for every Nigerian citizen to have a ‘change’ attitude to our present life; a positive attitude to the management and maintenance culture.

##### **4.2.1 FUNDING**

Funding cannot be sourced from public treasury alone. It is necessary that Governments should substantially increase budgetary allocation for infrastructure maintenance. Various possible sources of funding such as property tax, public private partnerships, commercialization, privatization should be explored and well exploited. Infrastructure Maintenance Trust Funds for the various classes of infrastructure or as may be specified in the policies should be established at the relevant levels of government.

##### **4.2.2 CURBING CORRUPTION**

As soon as public officer is prosecuted and convicted, the money recovered from him should be used for a road, a hospital, school, or such other project of national significance. Bold signposts,

with his pictures are then erected around the project, with inscriptions to the effect that the project was executed with stolen funds recovered from Mr. XYZ. This method will work effectively only if the criminal justice process is substantially reformed. Since the shaming exercise will not be effective until after a conviction to protect innocent people from suffering the same fate as the guilty, the current slow pace of dispensation of justice in Nigeria will be a major hindrance

#### **4.2.2.1 REFORMING OUR BANKING SYSTEM**

Banks are an important institution in the effective fight against corruption and other financial crimes. Our banks should be required to provide unfettered information to the authorities on transactions in private and public accounts kept with them, to alert the authorities on suspicious transactions which require to be flagged and create avenues for investigation. Large transactions, withdrawals and transfers to and from accounts, are reported to both the tax and financial crime authorities, to enable them investigate as appropriate. A man who can pay hundreds of millions of Naira to acquire government properties should be able to prove the source of his money, and how much taxes he has paid to the government in prior years from such income. These standard enquiries will go a long way to discourage intending criminals.

#### **4.2.3 TECHNOLOGICAL ADVANCEMENT**

The lack of appropriate maintenance know-how against technical staff can be overcome by organizing training programs, covering specific aspects of infrastructure maintenance technology on the different jobs. The training program should cover all aspects such as management and maintenance, systematic preventive maintenance, and construction operations for repair or rehabilitation of different types of infrastructure.

However, training emphasis will vary depending on the assessment of maintenance needs.

There is the need for Technical institutions and universities dealing with the training of professionals in the technology industries to adjust their curricula to inculcate and reflect the need for appropriate maintenance technology.

Likewise, there is need for comprehensive training in damage analysis, repair and rehabilitation and a variety of infrastructure elements. These trainings should pay attention to design, construction and installation details, which would eliminate errors that generate recurrent maintenance and repair needs.

Another area in technology is the embracement of the Smart Electronic Network technology developed by the Institute of Electrical and Electronics Engineers (IEEE) Instrumentation and Measurement Society’s Sensor Technology Technical Committee describing a set of open, common, network-independent communication interfaces for connecting transducers (sensors or actuators) to microprocessors, instrumentation systems, and control/field networks. One of the key elements of these standards is the definition of Transducer electronic data sheets (TEDS) for each transducer. The goal of this technology is to allow the access of user-energy (from the smart meter) data through a common set of interfaces where the users’ meters are connected to systems or networks via a wired or wireless means, So that issues like periods of consumption of energy, rate of consumption of energy and charges e.t.c can be monitored without actual visitation to the consumers. By this, consumers will be more conscious of energy wastage, thus managing energy.

#### **4.2.4 RECOMMENDATIONS**

- There is the need for a well-defined legal framework to guide all the stakeholders of energy sector.
- Primary energy sources such as coal, gas and petroleum sector should be deregulated.
- Imported power equipment should be subjected to rigorous standards tests.
- The Power Holding Company of Nigeria (PHCN) should make all their data transparent and accessible for academic research.
- Individuals or groups of individuals should be encouraged to participate in the energy activities.
- There should be more investment in research and human resources. This will enhance professionalism in technical and management skill.

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