

# Dry Port Location along the Douala – Ndjamen

## Corridor

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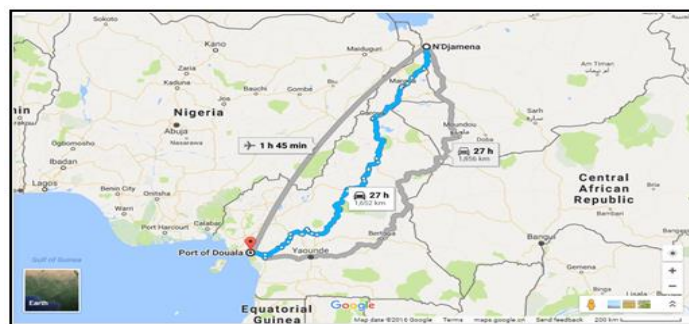
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**Abstract:** Transportation continues to play a major role in the supply chain, as it enables goods to be moved from where they are less desirable to where they are more desirable. A good transport network together with a dry port would bring about economic growth and development in the hinterland. This paper is centered on the Douala – Ndjamen transit corridor in Cameroon. The objective is to situate a dry port along the corridor, using the weighted scoring model, which would facilitate the flow of goods along the corridor. The chosen sites are Edea, Ngaoundere, Maroua and Garoua. The researchers used five selection criteria which are; economic factors, potential of encouraging modal shift, proximity to market, environmental factors and nearness to the port of Douala. In the researchers' analysis, Ngaoundere was the best location to situate the dry port.

**Keywords:** Dry port, Supply Chain Management, Modal Shift, Road Transport, Rail-road Transport.

## I. INTRODUCTION

As globalization has become imminent in today's world of commerce, logistics has become more substantial in facilitating the physical, financial and information flow across the supply chain. This has enabled nations to foster bilateral trade hence promoting regional cooperation. International trade plays a critical role in the economic development of any nation. According to (IMO, 2014) maritime transport is the backbone of globalization hence international trade. Maritime shipping services have become more and more increasing over the years, and there has been the emergence of numerous seaports across the globe to meet this overwhelming demand status. Seaports across the globe play a massive role as an interface between the sea and the hinterland, as it is the case of the port of Douala in Cameroon. The port of Douala serves as a doorway to the hinterland nations of Central African Republic (CAR) and Chad. The Douala – Ndjamen corridor is one of the transit corridors to Central Africa. However, barriers such as high transport cost along the transit corridor and administrative bureaucracy has affected trade between Chad and other countries abroad. The key commodities exported from Chad are oil, uranium and gold. They constitute about 95% of total exports. The top 3 export destinations of Chad are the United States, China and France. The port of Douala plays a vital role in facilitating Chad's import and export activities by providing access to the sea. The modes of transport used to convey the goods are road and rail road. This paper seeks to locate a dry port along the transit corridor that would enable Chad, Central African Republic, Cameroon and other stakeholders to boost regional and international trade and also bring about a modal shift from road transport to rail-road transport along the corridor.



Source: Google map

Figure 1: Map showing Douala and Ndjamen

## II. LITERATURE REVIEW

### 2.1 The Concept of Dry Ports:

The rapid expansion of human settlement in relation to socioeconomic growth has brought about the advancement of transportation facilities; this has led to increased movement of people, goods and services. According to (Kwame, Archibald & Abdul 2017), the transportation industry has gone through several development stages to the dry port concept. A dry port is an inland intermodal terminal that is connected directly to seaports with a high capacity transport means, where customers can leave or pickup their standardized units as if directly to a sea port (Rodrigue, Debrue & Gouvello, 2010). In addition (Rodrigue et al 2010) also defined a dry port by stating that, it should be an area where there is massive cargo flow, availability of containers and the use of dedicated terminals with the service of high capacity corridor. On the other hand, (SEStran, 2012) described a dry port as an intermodal facility situated inland, linking rail and road facilities with seaports. They contribute to a shift in freight from road to rail and sea options. (Ng, 2009) added that, one of the factors shipping lines might consider when selecting a port of call is its inland connection. He further stated that the viability of dry ports depends on the following core features:

- Geographical locations where there is enough demand and access to high capacity corridor.
- Capability to provide efficient and sophisticated value-added services.
- Ability to integrate seaports with shipping lines.

A good connection linking seaport, rail and roads brings about speedy and reliable movement of goods. (Roso, Woxenius & Rumsder, 2009) stated that, the quantity of rail road interface and the quality of access to the port can be used to assess the performance of dry ports. The dry port offers value added services ranging from depot, maintenance of containers and customs clearance, to actors that operate within the dry port network.

### 2.2 Functions of Dry Ports within the Supply Chain:

The supply chain of products shows how material flows from the source to the final consumer. The supply chain consists of nodes and modes. The nodes are the fixed structures such as ports, dry ports, container terminals, warehouses and the mode is the transport link between two nodes. The function of dry ports within the supply chain is best explained by using five criteria that ensures their role as interface between international and local freight distribution as stated by (Rodrigue et al. 2012)

#### - **Location:**

Location talks about an area where the dry port will be constructed. Inland ports require a good site connected to the rail as well as road. It's accessibility to a large population base is imperative as it will be connected to the rate of import and export activities handled by the dry port.

#### - **Cargo rotation:**

Inland ports play a huge role in reconciling inbound and outbound flows of containers as a result of imbalances in flow.

#### - **Repositioning:**

Inland ports provide logistical capabilities to ensure empty containers are efficiently repositioned as a result of excess import over export, which gives rise to excess containers.

#### - **Trade Facilitation:**

An inland port also helps in promoting both import and exports in an area, especially to small businesses. This is because; they cannot achieve economies of scale on their own, so they could consolidate with others. The hinterland opportunities offered by dry ports are related to lower transport cost and improved accessibility.

#### - **Governance:**

It is the way a dry port is owned and operated. It looks at the relationship between the government and private. In addition it points out the requirements of the entities..

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### 2.3 Merits and Demerits of Dry Ports:

The merits derived from using a dry port are divided over the actors which are: mode of transport operators, shippers, the government, seaport and the community.

#### - *Shipper:*

The merits that the shipper gets in using a dry port are an increase in efficiency; which leads to a reduction in cost. Dry ports ensure a reduction in cost by consolidating the shipments hence benefiting from economies of scale.

#### - *Transport Mode Operators:*

The transport mode operators are the road and rail operators. They benefit by working together with the dry port (Roso, (2010). Rail operators are exposed to economies of scale, which leads to a decrease in the fixed cost per container. On the other hand, with the road operators, the goods spend less time on roads that are congested and in seaport terminal. As a result of a decrease in shipment time, more shipment is handled (Roso, 2010).

#### - *Government:*

The government benefits by the capabilities of dry ports to reduce road congestion where the seaport is situated (Henttu, 2011), (Nosorowka, 2010).

#### - *Seaport:*

The merit to the seaport is that it enables it to serve a larger hinterland. Dry ports can also be located in a landlocked country.

#### - *Community:*

The advantage to a local community is that it brings about an increase in jobs in the area. It also attracts new businesses to the region. Local businesses can easily get access to the international market (Rahimi, 2008).

The demerits with dry ports is that the initial set up cost are high, hence implementing a dry port is expensive (Do et al. 2011). In additions, rail ways may not reach every city.

## III. METHOD FRAMEWORK

### 3.1 The Weighted Scoring Model (WSM):

The WSM finds out the criteria used in locating a dry port, and every other potential site is compared to the factors. Numerical values are assigned to every alternative for each selection criteria and the factors are weighted separately. A summation of the weighted values is taken, and the potential site with the highest score is selected (Celeste, 2012).

#### 3.1.1 Steps in Weighted scoring model:

- Step 1: State the location criteria
- Step 2: Allocate weights to the location criteria

The weight of the various location criteria is gotten by using the AHP model. (Gianpaolo et al. 2013), used a similar approach in their analysis.

- Given that  $\alpha$  is number of location criteria selected, and let  $\lambda$  be an  $\alpha \times \alpha$  matrix with entries  $\lambda_{pq}$ ,  $p = 1, \dots, \alpha$ ,  $q = 1, \dots, \alpha$ ,  $p \neq q$ , shows the comparative importance of criterion  $p$  vis a vis criterion  $q$  and  $\lambda_{pq} = 1/\lambda_{qp}$ ,  $p = 1, \dots, \alpha$ , should be put in the formula, that is,  $p = 1, \dots, \alpha$ ,  $q = 1, \dots, \alpha$ ,  $p \neq q$ . Entries  $\lambda_{pp}$ ,  $p = 1, \dots, \alpha$ , of the diagonal are equal to 1.
- Let  $w_1, w_2, w_3, \dots, w_\beta$  be the selection criteria used in locating the dry port;

Therefore,

$$\text{Matrix } \lambda = \begin{matrix} & \begin{matrix} w_1 & w_2 & w_3 & \dots & w_\beta \end{matrix} \\ \begin{matrix} w_1 \\ w_2 \\ w_3 \\ \cdot \\ w_\alpha \end{matrix} & \begin{matrix} \lambda_{11} & \lambda_{12} & \lambda_{13} & \dots & \lambda_{1\beta} \\ \lambda_{21} & \lambda_{22} & \lambda_{23} & \dots & \lambda_{2\beta} \\ \lambda_{31} & \lambda_{32} & \lambda_{33} & \dots & \lambda_{3\beta} \\ \cdot & \cdot & \cdot & \dots & \cdot \\ w_{\alpha 1} & w_{\alpha 2} & w_{\alpha 3} & \dots & w_{\alpha \beta} \end{matrix} \end{matrix}$$

Comparison between the values p and q is made using the scale suggested by Saaty;

Table 3.1: Comparison between 2 criteria

Comparison judgment between criteria p and q		
p and q are equally important	1	1
p is moderately preferable to q	1	1/3
p is quite preferable to q	1	1/5
p is decidedly preferable to q	1	1/7
p is extremely preferable to q	1	1/9
q is moderately preferable to p	1/3	1
q is quite preferable to p	1/5	1
q is decidedly preferable to p	1/7	1
q is extremely preferable to p	1/9	1

Source: Introduction to logistics system by Gianpaolo et al. (2013)

Signifying the mean of the elements of the p<sup>th</sup> row of λ, The weight of the location criterion α is then derived as;

$$W_p = \frac{\bar{w}_p}{\sum_{\beta=1}^{\alpha} \bar{w}_\beta}, p = 1, \dots, \alpha$$

The weights are normalized thus,

$$\text{Weight } \beta = \frac{\sum_{q=1}^{\beta} \lambda_{pq}}{\beta}$$

$$\sum_{p=1}^{\alpha} W_p = 1$$

A total score is allocated to each selected site based on the given criteria

Let Y represent the different potential sites. Each criterion p is matched to each site with weight,  $W_p \in (0,1)$  based of its significance to the other criteria

- Step 3: Mapping scale for decision factor into scores Let  $T_{\beta p}, \beta \in Y$ , be the score from one to five associated with criterion p for a location β. The scores attributed to the potential dry port locations by the researchers were from the least to the highest (1, 2, 3, 4, 5) respectively,
- Step 4: Score each location criteria for each alternative, and multiply the score by its weights and sum the weighted scores.

The sum  $S_\beta$  of the locations  $\beta \in T$  is calculated as,

$$S_\beta = \sum_{p=1}^{\alpha} W_p S_{\beta p}$$

Since a location ( $\beta^*$ ) has to be selected, the one with the highest total score is chosen, that is,  $\beta^* = \arg \max \{S_\beta\}$

#### IV. FINDINGS

##### 4.1 Overview of alternative sites:

- **Ngaoundere:** It is a town located in the north-central part of Cameroon and found on longitude 13.58 and latitude 7.33. The town is positioned at an height of 1128 meters above sea level (World atlas). The town is the capital of the Adamawa Region of Cameroon and has a population of about 231,357 inhabitants, making it the largest city in the Adamawa Region (World atlas). Ngaoundere is the northern end point of the Trans-Cameroon railway to the national and economic capitals of Cameroon, Yaounde and Douala respectively. The industries found in the town include; perfume manufacturing, dairying, slaughtering preparations of skins and hides, and cotton ginning. The town has an airport, customs and meteorological station (Encyclopedia Britannica, 2013).
- **Maroua:** It is a town situated in the Far North Region of Cameroon, found on latitude 10.59 and longitude 14.3. It is located at a height of 406 meters above sea level (World atlas). The city is the capital of the Far North Region, and has a population of about 319,941 inhabitants, making it the largest city in the Far North Region. It has a sahelian climate and it is hot and dry for most part of the year. The city has an airport with a good road intersection from Bogo northwest, Mokolo in the northeast, and Garoua in the southwest. Industries in the city include a cotton factory and agro industry Pop. (2005) 201,371
- **Garoua:** It is a town situated in the North Region of Cameroon found on longitude 13.40 and latitude 9.30. It is located at a height of 199 meters above sea level, and has a population of about 436,899 inhabitants, making it the biggest city in the North Region (World Atlas). Industries in the city include dyeing, spinning, leatherwork and spinning. The town has several banks, insurance companies and customs stations (Pop, 2005).
- **Edea:** It is a city situated in the Littoral Region of Cameroon found on latitude 3.80 and longitude 10.13. It is located at a height of 27 meters above sea level, and has a population of about 203,149 inhabitants, making it the second largest city in the Littoral Region (World Atlas). It is along the Sanaga River and linked by road and rail to Douala and Yaounde, and to Kribi, by road Pop. (2005) 66,581. The factories in the city are; bauxite, aluminum processing, steel and timber industries. The city also has palm oil mills and banana, cocoa and rubber plantations.

##### 4.2 Location of Dry Port using the Weighted Scoring Model:

The Criteria for Location selection are;

- **Economic factors:** The economic factors include; land price, labor availability and cost of construction. Dry port constructions are capital intensive, and the closer the site is to the settlement in a region, the higher the prices. The economic factors of each alternative site are considered in the assessment.
- **Potential of encouraging modal shift:** Connectivity to transport networks is very important for dry ports operation (Roso, 2008), (Pdilha and Ng, 2012). As a result of the important nature of dry ports as a node in the transport network, it should possess sufficient transport infrastructure for effective distribution of goods (Roso, 2008). Hence, the sites are also analyzed taking into consideration their abilities to promote modal shift, so that fewer goods will be transported by roads along the corridor.
- **Proximity to customers and potential market coverage:** The location of dry ports to hinterlands helps shippers reduce their cost of transportation (Jarzemskis and Vaiiauskas, 2007). The sites are analyzed to ascertain which one can be a hub in the hinterland in order to promote trade and development.
- **Environmental factors:** Environmental concerns is very significant in dry port locations, hence it is important to locate a dry port in a very suitable environmentally site, that is safe and secured.
- **Transit time – Distance:** Nearness of the dry port to the sea port is also important as this would enable goods to be shipped to and from the seaport fast. The average distance of the different sites to the port is factored in the analysis.

4.3 Normalized matrix of the different location:

Table IV-1: Normalized matrix

Normalized Matrix					
	Economic Factors	Modal Shift	Market Coverage	Enviromental Factors	Proximity to Port
Economic Factors	0.22	0.11	0.69	0.30	0.39
Modal Shift	0.65	0.36	0.14	0.22	0.39
Market Coverage	0.04	0.36	0.14	0.30	0.04
Enviromental Factors	0.03	0.07	0.02	0.04	0.04
Proximity to Port	0.06	0.11	0.01	0.13	0.13

Source: Derived from pair wise comparison matrix

4.3.1 The weight of the criteria derived are:

$$\text{Weight } \beta = \frac{\sum_{q=1}^{\beta} \lambda_{pq}}{\beta}$$



$$\sum_{p=1}^{\alpha} Wp = 1$$

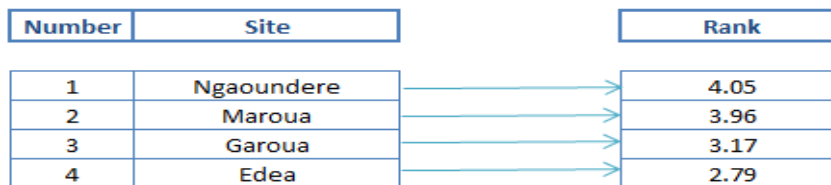
4.3.2 The scores of each alternative are:

	Edea	Ngaoundere	Maroua	Garoua
Economic Factors	3	3	4	4
Modal Shift	2	5	4	2
Market Coverage	3	4	5	4
Enviromental Factors	2	5	3	3
Proximity to Port	5	4	2	3

Source: Derived from questionnaire

4.3.3 Calculating the overall weighted score of each site to determine the best location:

$$S_{\beta} = \sum_{p=1}^{\alpha} WPS\beta P$$



Since Ngaoundere has the highest score, the dry port should be built there.

V. CONCLUSION

Location analysis is one of the important factors made before constructing a dry port in order to have an efficient and effective operation. In response to the objective of the study, four potential sites; Edea, Ngaoundere, Maroua and Garoua were analyzed and it was found that, Ngaoundere is the best place to situate a dry port in order to foster regional and international trade between Cameroon and its neighboring countries hence encouraging export. Further, a constructed dry port in Ngaoundere will reduce the over reliance of road transport along the corridor and more freight would be shipped via rail.

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