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TRANSPORT CORRIDOR SELECTION FOR A NEW FREIGHT VILLAGE PROJECT IN A LANDLOCKED DEVELOPING COUNTRY: CASE OF BURKINA FASO

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Abstract: **Burkina Faso as a landlocked country in West Africa has four alternative transport corridors (Tema - Ouagadougou; Lome-Ouagadougou; Abidjan-Ouagadougou; Cotonou -Ouagadougou) for shipment. This paper aims to examine the existing transport corridors in term of cost and time and to select the most suitable one that will be connected to a new freight village project intended to be located in Ouagadougou the capital city of Burkina Faso. Data on cost and time were obtained from both primary and secondary sources, then a joint cost and time matrix has been used to evaluate each corridor. The findings show that the freight village project considers three potential sites (Koubri, Tanghin-Dassouri, and Pabre) as the most suitable locations and for the site of Koubri the most suitable corridor comes to be Tema – Ouagadougou.The corridor of Abidjan–Ouagadougou appeared to be the most suitable one for the site of Tanghin-Dassouri. Both the corridor of Lome-Ouagadougou and Cotonou-Ouagadougou are the most suitable for the site of Pabre.**

Keywords: **Burkina Faso, City Logistics, Developing country, Freight village, Landlocked country, Transport corridor.**

1. INTRODUCTION

Burkina Faso landlocked state, coupled with its geographical position in West Africa, makes it a hub of regional corridors. Its landlockedness imposes high costs of imports and exports. As a result, the costs of transport are very sensitive to any inefficiency in customs administration, cross-border waiting times and in the transit chain. The geographic location of the country however, positions him as a natural transit hub for West Africa. Burkina Faso is a transit point for the neighboring landlocked countries of Niger and Mali and has the potential to take advantage of its geographical position (Briceño-Garmendia & Domínguez-Torres, 2011) . The country has four alternative corridors leading to four different seaports for shipment. These ports are located in the cities of Cotonou in Benin, Lome in Togo, Tema in Ghana and Abidjan in Ivory Coast. Burkina Faso's capital city Ouagadougou strategically lies at the intersection point of those corridors (Yankene, 2013). As a result of being a transit point for national and regional freight movement, Ouagadougou is facing many city logistics problems like increasing trucks accidents, congestion in the traffic, air pollution and noise etc…

Given these circumstances, Burkinabe's policy makers explored the concept of freight village linked to seaports via an efficient transport corridor as a potential mean to overcome city logistics problems in Ouagadougou and the country's landlocked related problems as well. This study proposes a framework for the selection of the most suitable corridor that will be linked to the new freight village project based on the cost and time criteria.

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2. STUDY AREA

Ouagadougou the capital of Burkina Faso is economically, culturally and administratively the center of the country. Like most African capital cities, Ouagadougou is experiencing a rapid urban growth. Its population is growing on average at 7% per year and is forecasted to be more than 4 million by the horizon 2025 (Les Ateliers, 2019). Furthermore, the city lies at the intersection point of the nation's transport corridors. Imported goods from the neighboring coastal countries of Ghana, Togo, and Benin are cleared in Ouagadougou as well as some goods from Ivory Coast. In the recent years, the city is experiencing an increasing freight movement due to an accelerated urban growth and the upswing of mining activities (Cia, 2017). Nevertheless, Ougadougou has a single logistics platform for the clearance of imported and exported goods by road named Ouagainter. The current location of Ouagainter in downtown Ouagadougou is source of traffic accidents, congestion in the traffic, air pollution and noise. In order to alleviate those problems, Burkinabe's policy makers planned to replace the Ouagainter logistics platform by a freight village linked to seaports via an efficient transport corridor to be built at the outskirts of the city. A critical issue for landlocked developing countries when addressing their access to the sea is either to privilege a single major corridor attached to a hub port or to encourage several alternative transit corridors to reach different seaports. Generally, landlocked developing countries do not have sufficient volumes of traffic to justify the additional infrastructure required for two or several corridors (African Union , 2017). Consequently, landlocked developing countries need to assess thoroughly their corridors performances and opt for multiple transit corridors or one major transit corridor.

3. METHODOLOGY

This study proposes a systematic approach to determine the suitable corridor for each potential freight village location. Analyses are based on cost and time criteria and data were collected from both primary and secondary sources (see Fig. 1).

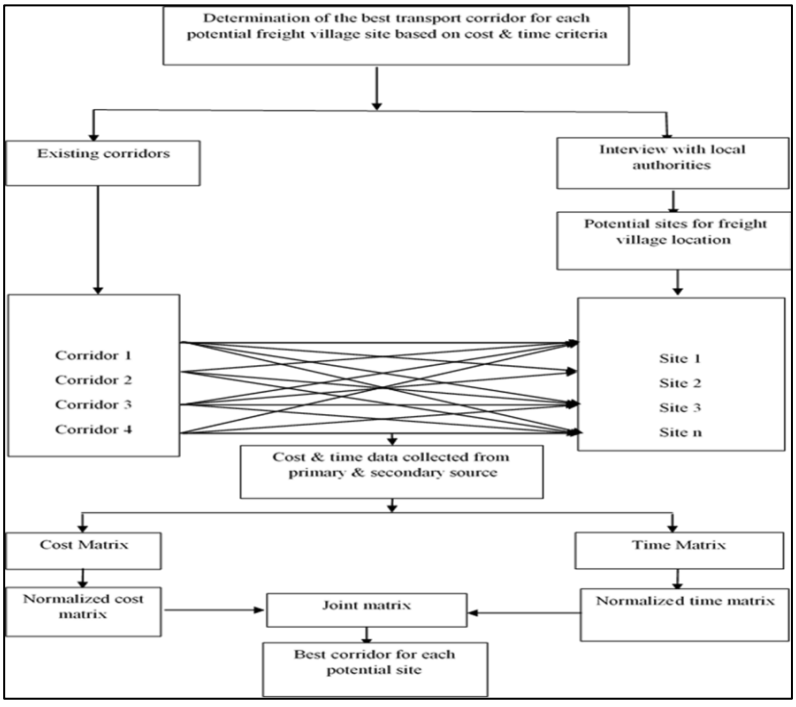

Figure 1: Flow Chart of Transport Corridor Selection Process

3.1. Potential sites determination for a freight village location

To determine the potential sites for a freight village in the city of Ouagadougou, semi-structured interviews have been used. Face-to-face interviews were carried out with local authorities. The interviewees involved were from the Ministry of Commerce and Industry, and the Directorate General of Urban Planning.

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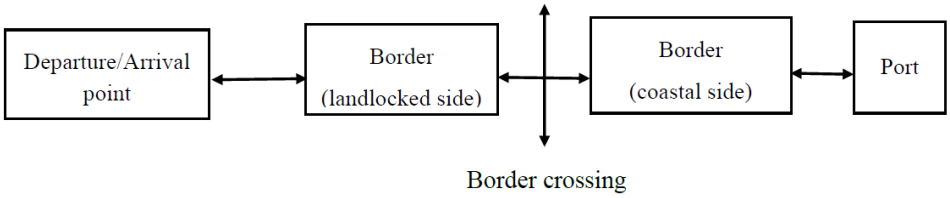
3.2. Time criterion analysis

The transit transport flow connecting Burkina Faso and ports is graphically shown in the Figure 2 with the port assumed as a starting point, freight departing from the port passes through a boundary customs house of a coastal country, then goes through the transit procedure at the boundary customs house of the landlocked country, and finally arrives at the customs house of the final destination. The route is reversed for export (JICA, 2018).



Source: JICA, Data Collection Survey on Traffic for International Port and International Corridor in Western Africa

Figure 2: Transit transport flow

Based on the transit transport flow described in Figure 2, the time analysis approach takes into account port clearance time, inland transportation time, border-crossing time, and clearance time at the final destination. The whole time components are represented in the Figure 3.

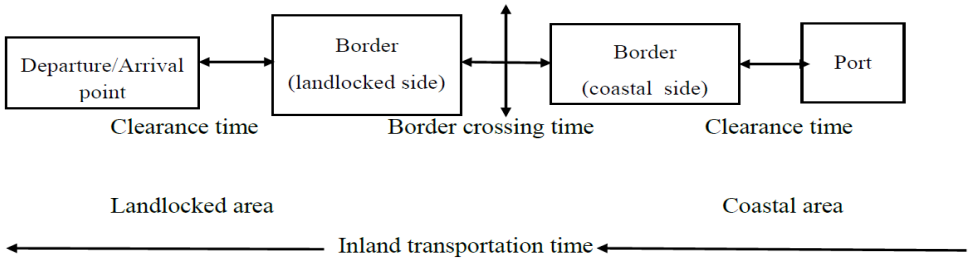


Figure 3: Time Components Flow Chart

3.3. Cost criterion analysis

The cost analysis takes into account the transit costs on each corridor to determine the best corridor in term of cost and the investment costs of establishing a freight village on one of the potential sites and the road rehabilitation cost of each corridor. The road rehabilitation cost has been taken into account in our cost analysis because; road transport is the dominant mode in Sub-Saharan Africa and carries over 75% of passengers and freight. It is capital for poverty reduction and economic growth. Unfortunately, the conditions of these roads are poor for more than 50% of them (Zietlow, 2018). The cost elements are represented in the Figure 4 and 5.

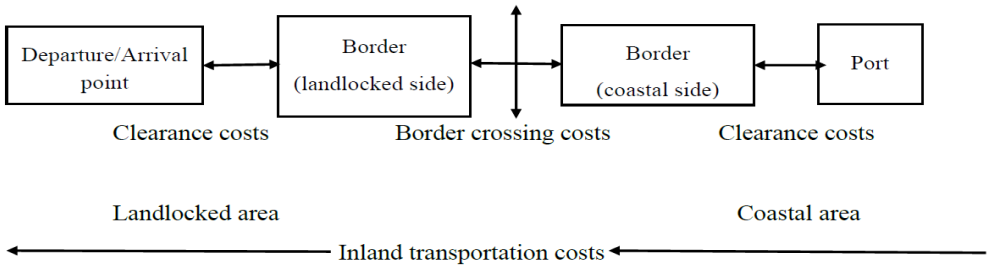


Figure 4: Transit Costs Components

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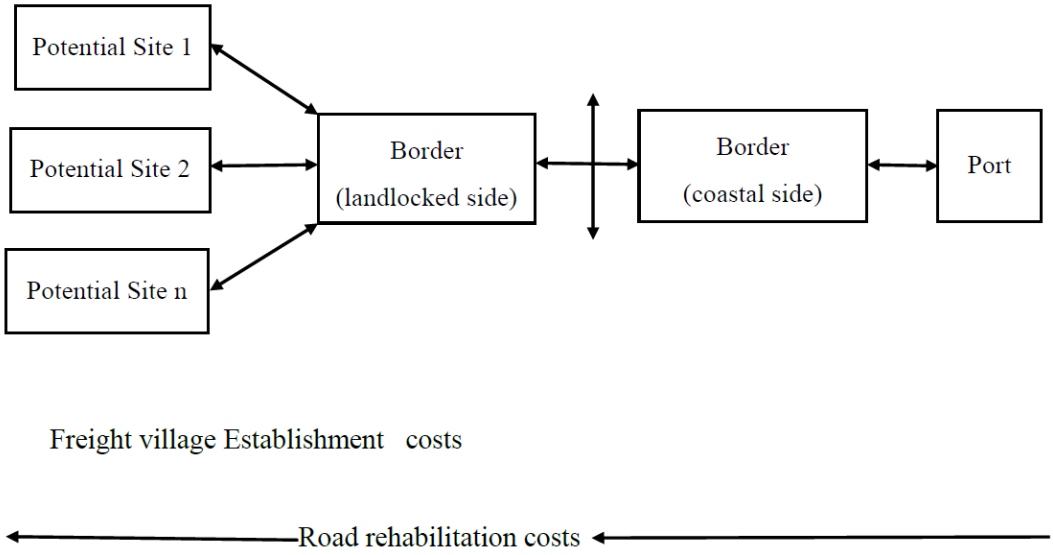

Figure 5: Investment Costs Components

3.3.1. Transit and investment costs

Investment cost in this study considers the cost of establishing a freight village and the cost of rehabilitating road corridors. The transit cost on the other hand, considers the costs taken to get a product out of the transit ports to Burkina Faso's capital city (Ouagadougou). It is not easy to give exact and complete figures for the transit costs. However, to enable us to have some idea of the transit costs in the various transport corridors; we shall confine ourselves to port operation costs, trucking costs, border crossing costs and Operation costs at Ouagainter logistics platform. The customs tax and duties are not included in our cost analysis as they are not part of logistics cost.

3.4. Data collection on time and cost

Secondary data has been used to determine the investment cost. On the other hand, using a survey, the study collected primary data on the transit time and cost taken to get a product out of the transit ports to Burkina Faso's capital city (Ouagadougou). The data collected were processed using the MS Office Excel program. Seventy (70) forwarding companies were interviewed randomly. The survey focused on imports and especially on the main imported goods. We suggested five goods from the main imported goods. In order to ensure that the estimate time and cost made for different corridors are consistent, the study chose fast moving goods imported by sea or transiting through a port. Moreover, one type of handling mode is also considered in importation cargo, i.e. containerized up to Ouagadougou. Table 1 presents the selected products for the survey.

Table 1: Imported Products Selected for the Survey (Tons)

Products	2013	2014	2015	2016	2017
Wheat and wheat flour	134,792	140,480	185,427	198,731	221,829
Pharmaceutical product	9,606	6,400	6,933	9,778	7,590
Parts of machinery	3,809	1,565	4,799	5,078	5,728
Rice	440,320	361,740	379,592	484,577	515,977
Tobacco and manufactured tobacco substitutes	3,570	3,334	3,515	3,317	3,617

Source: INSD

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3.5. Joint cost and time matrix

The joint matrix is a matrix that combines both the normalized time and cost matrix assuming and equal weight of 0.5 given to both the cost and time criterion. Mathematically the data in the joint matrix calculation is presented as followed:

$Di = Wc \times Xi + Wt \times Yi$ Where,

Di: data in cell no i, of the joint matrix

Wc: cost weight,

Wt: time weight

Xi: data of the cell no i in the normalized cost matrix

Yi: data of the cell no i in the normalized time matrix

A high value from the joint matrix represents a high cost and time spent on the corridor with regards to the potential freight village location site

4. RESEARCH FINDINGS

Following the interviews with local authorities, it was revealed that a project for a freight village construction in Ouagadougou was underway and the feasibility studies would begin in the near future. Moreover, three potential sites have been suggested for the freight village. It has been suggested to be located in one of the municipalities intended to host the industrial clusters or the economic clusters zones envisaged in the new development plan of the city of Ougadougou named "Planning scheme of Grand Ouaga." The Figure 6 shows where each potential site is located.

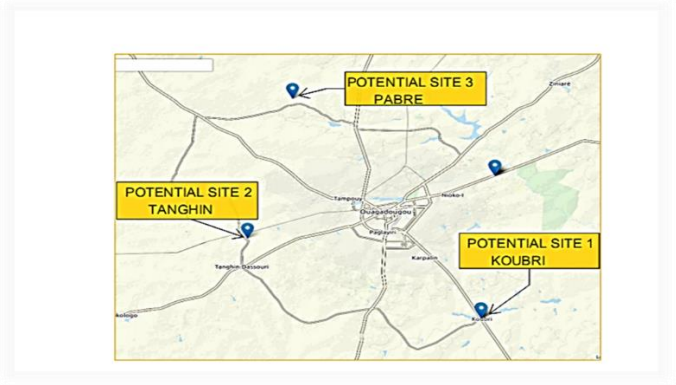

Figure 6: Location of Potential Sites on Google Map

4.1. Findings on transit cost and time

In order to determine transit cost and time, a survey was conducted in 2018. Seventy (70) forwarding companies were interviewed. Through the interviews, we collected the average transit cost and time on each corridor. Moreover, many fees and charges are included in transit cost, while some of them derived from transaction other are from the weight. To get a representative view of the transit cost, we standardized the unit cost of analysis to standard 20-foot container (TEU) assuming a maximum weight of 15 tons. Table 2 presents the characteristics of the selected products for the survey.

Table 2: Characteristics of Selected Products for the Survey

Product	Container Type	Weight (ton)	Average Annual Volume (ton) 2013-2017	Weight on Annual Volume
Wheat and wheat flour	20'	15	176,252	0.280
Pharmaceutical product	20'	15	8,061	0.013
Parts of machinery	20'	15	4,196	0.007
Rice	20'	15	436,441	0.695
Tobacco	20'	15	3,471	0.006
Total			628,421	1.000

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In order to be consistent with the share of each product in the total annual volume imported, in calculating the transit cost, the weighted average cost was first calculated based on the response of each respondent and then the simple average was computed. On the other hand, in calculating the average time we asked to respondents to provide for each activity the average time spent. The findings on the average transit cost and time on each corridor are as following:

Table 3: Average Transit Cost and Time

Cost & time Component/Corridor	Corridor No 1 (Tema - Ouagadougou)	Corridor No 2 (Lome-Ouagadougou)	Corridor No 3 (Abidjan-Ouagadougou)	Corridor No 4 (Cotonou - Ouagadougou)
Average port cost (Euro)	441	453	703	684
Average transport cost (Euro)	1584	1626	1710	1635
Average Border Crossing cost (Euro)	90	64	98	89
Average OUAGAINTER Operation cost (Euro)	607	607	607	607
Average transit cost (Euro)	2722	2750	3118	3015
Average port operation time (Day)	9.69	9.16	8.16	11.11
Average inland transport time (Day)	3.81	2.78	4.96	5.07
Average Ouagainter Terminal operations time (Day)	6.94	6.94	6.94	6.94
Average Transit time (Day)	20.44	18.88	20.06	23.13

Table 3 presents the average transit cost and time on each corridor. Overall, the corridor Lome-Ouagadougou and Abidjan-Ouagadougou present the shortest transit time (respectively 18.88 days and 20.06 days). On the other hand, the corridor Tema-Ouagadougou and Lome Ouagadougou, present the lowest import cost (respectively 2722 Euro and 2750 Euro). The corridor Cotonou-Ouagadougou is the least advantageous with the highest import time of 23.13 days. Moreover, in term of port operations efficiency, the port of Abidjan and Lome are better off with respectively a clearance time of 8.16 and 9.16 days. When it comes to the transport time, the corridor Lome-Ouagadougou and Tema-Ouagadougou present the shortest time with respectively 2.78 and 3.81 days.

4.2 Transit cost and time of each corridor linked to each potential site

The findings on transit cost and time summarized in Table 3 are true for the present corridors' characteristics highlighted in the Table 4.

Table 4: Characteristics of Corridors

	Port Country	Road Distance in km	Average Transport Cost (Euro)	Transport Cost per /km (Euro)	Other Transit Cost (Euro) (Port & Border Crossing & Ouagainter)	Average Transit Time (Days)
Corridor No 1 (Tema - Ouagadougou)	Ghana	1,040	1,584	1.523	1,138	20.44
Corridor No 2 (Lome-Ouagadougou)	Togo	948	1,626	1.715	1,124	18.88
Corridor No 3 (Abidjan-Ouagadougou)	Ivory Coast	1,148	1,710	1.489	1,408	20.06
Corridor No 4 (Cotonou Ouagadougou)	Benin	1,060	1,635	1.542	1,380	23.13

Table 4 gives the data on transit cost and time under the assumption that final destination of all inbound trucks is Ouaginter located in Ouagadougou. However, linking each corridor to each potential site for a freight village will bring some changes on the cost and time data. The Table 5 presents the distance of each corridor linked to each potential site.

Table 5: Distance of each Corridor Linked to each Potential Site (Km)

	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)	Ports	Port country
Corridor No 1 (Tema - Ouagadougou)	1015	1066.6	1120.5	Tema	Ghana
Corridor No 2 (Lome-Ouagadougou)	965.8	1017.4	963.8	Lomé	Togo
Corridor No 3 (Abidjan-Ouagadougou)	1171.6	1126	1179.9	Abidjan	Ivory Coast
Corridor No 4 (Cotonou - Ouagadougou)	1077.8	1129.4	1075.8	Cotonou	Benin

Source: CBC 2018

Knowing the distances of each corridor linked to each potential site, the transport cost on each corridor is computed (see Table 6), based on the value of the transport cost /km provided in Table 5.

Table 6: Transport Cost of each Corridor Linked to each Potential Site (Euro)

	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)	Ports	Port country
Corridor No 1 (Tema - Ouagadougou)	1,546	1,625	1,707	Tema	Ghana
Corridor No 2 (Lome-Ouagadougou)	1,657	1,745	1,653	Lomé	Togo
Corridor No 3 (Abidjan - Ouagadougou)	1,745	1,677	1,758	Abidjan	Ivory Coast
Corridor No 4 (Cotonou - Ouagadougou)	1,662	1,742	1,659	Cotonou	Benin

Table 6 gives the new transport cost of each corridor assuming that all inbound trucks final destination will be one of the potential sites of Koubri, Tanghin-Dassouri - and Pabre. Based on the new data on transport cost the new data on transit cost and time of each corridor linked to each potential site is computed and the findings are summarized in the Table 7 and 8.

Table 7: Transit Cost of each Corridor Linked to each Potential Site (Euro)

	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)	Ports	Port country
Corridor No 1 (Tema - Ouagadougou)	2,684	2,763	2,845	Tema	Ghana

Corridor No 2 (Lome-Ouagadougou)	2,781	2,869	2,777	Lomé	Togo
Corridor No 3 (Abidjan - Ouagadougou)	3,153	3,085	3,166	Abidjan	Ivory Coast
Corridor No 4 (Cotonou - Ouagadougou)	3,042	3,122	3,039	Cotonou	Benin

Table 8. Transit Time of each Corridor Linked to each Potential Site (Day)

	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)	Ports	Port country
Corridor No 1 (Tema - Ouagadougou)	19.91	20.92	21.98	Tema	Ghana
Corridor No 2 (Lome-Ouagadougou)	19.23	20.26	19.19	Lomé	Togo
Corridor No 3 (Abidjan - Ouagadougou)	20.46	19.67	20.61	Abidjan	Ivory Coast
Corridor No 4 (Cotonou - Ouagadougou)	23.51	24.63	23.46	Cotonou	Benin

4.3. Road rehabilitation costs

This section is intended for the estimation of Burkinabe's road corridors rehabilitation cost. To achieve our goal, we made use of secondary data collected from the government official data. In fact, we have established the cost average from road construction projects planned by the National Economic and Social Development Plan for the period of 2016-2025. The average unit cost for road infrastructure projected for the period of 2016-2025 is 642,030 Euro/km (Pndes, 2017). This unit costs are indicative as it is obvious that even for two roads of the same type, unit cost may experience deviations depending on the nature of the ground, the distance and the number of structures to be built or rehabilitated. Therefore, for the sake of estimating the cost of rehabilitating road corridors, the unit cost of 642,030 Euro/km is considered. Then, the unit cost is timed by the estimated distance of each corridor portion in Burkina Faso linked to each potential site (see table 9) to get the estimated rehabilitation cost of each corridor linked to each potential site (see table 10).

Table 9: Estimated Distance of each Corridor (from the border to Ouagadougou) Linked to each Potential Site (Km)

	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)	Ports	Port country
Corridor No 1 (Tema - Ouagadougou)	145	196.6	250.5	Tema	Ghana
Corridor No 2 (Lome-Ouagadougou)	298.8	350.4	296.8	Lomé	Togo
Corridor No 3 (Abidjan - Ouagadougou)	533.6	488	541.9	Abidjan	Ivory Coast
Corridor No 4 (Cotonou - Ouagadougou)	387.8	439.4	385.8	Cotonou	Benin

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Table 10: Estimated Rehabilitation Cost of each Corridor linked to each Potential Site (Euro)

	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)	Ports	Port country
Corridor No 1 (Tema - Ouagadougou)	93,094,350	126,223,098	160,828,515	Tema	Ghana
Corridor No 2 (Lome-Ouagadougou)	191,838,564	224,967,312	190,554,504	Lome	Togo
Corridor No 3 (Abidjan - Ouagadougou)	342,587,208	313,310,640	347,916,057	Abidjan	Ivory Coast
Corridor No 4 (Cotonou - Ouagadougou)	248,979,234	282,107,982	247,695,174	Cotonou	Benin

4.4. Freight village establishment cost

Secondary data collected from the government official data have been used for the estimated cost of a freight village. In fact, the National Economic and Social Development Plan Structuring Industrial and Artisanal Transformations project for the period of 2016-2025 has forecasted a budget of 118,507,176 Euro to build a freight village in the agglomeration of Ouagadougou (Pndes, 2018). The feasibility studies are yet to start in the near future.

4.5. Findings on cost matrix

In the previous section, cost component and related data has been presented. Table 11 provides a summary of those cost components and they related data.

Table 11: Detailed Cost Components

Corridors	Cost Component	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)	Port	Port Country
Corridor No 1 (Tema - Ouagadougou)	Transit cost	2,684	2,763	2,845	Tema	Ghana
	Road rehabilitation cost	93,094,350	126,223,098	160,828,515		
	freight village establishment cost	118,507,176	118,507,176	118,507,176		
	TOTAL COST	211,604,210	244,733,037	279,338,536		
Corridor No 2 (Lome-Ouagadougou)	Transit cost	2,781	2,869	2,777	Lome	Togo
	Road rehabilitation cost	191,838,564	224,967,312	190,554,504		
	freight village establishment cost	118,507,176	118,507,176	118,507,176		
	TOTAL COST	310,348,521	343,477,357	309,064,457		
Corridor No 3 (Abidjan - Ouagadougou)	Transit cost	3,153	3,085	3,166	Abidjan	Ivory Coast
	Road rehabilitation cost	342,587,208	313,310,640	347,916,057		
	freight village establishment cost	118,507,176	118,507,176	118,507,176		
	TOTAL COST	461,097,537	431,820,901	466,426,399		
Corridor No 4 (Cotonou - Ouagadougou)4	Transit cost	3,042	3,122	3,039	Cotonou	Benin
	Road rehabilitation cost	248,979,234	282,107,982	247,695,174		
	freight village establishment cost	118,507,176	118,507,176	118,507,176		
	TOTAL COST	367,489,452	400,618,280	366,205,389		

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Taking the total costs' data from Table 11, into account, the cost matrix is sum up in Table 12.

Table 12: Cost Matrix

Corridor/Site	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)
Corridor No 1 (Tema - Ouagadougou)	211,604,210	244,733,037	279,338,536
Corridor No 2 (Lome-Ouagadougou)	310,348,521	343,477,357	309,064,457
Corridor No 3 (Abidjan -Ouagadougou)	461,097,537	431,820,901	466,426,399
Corridor No 4 (Cotonou -Ouagadougou)	367,489,452	400,618,280	366,205,389

From the Table 12, the normalized cost matrix is provided by dividing the values on each line by the highest value on the same line. Table 13 provides the data on the normalized cost matrix.

Table 13: Normalized Cost Matrix

Corridor/Site	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)
Corridor No 1 (Tema - Ouagadougou)	0.76	0.88	1.00
Corridor No 2 (Lome-Ouagadougou)	0.90	1.00	0.90
Corridor No 3 (Abidjan -Ouagadougou)	0.99	0.93	1.00
Corridor No 4 (Cotonou -Ouagadougou)	0.92	1.00	0.91

4.5. Findings on time matrix

The data on time matrix provided in Table 8 are the same with the data on the transit time of each corridor linked to each potential site provided. From the Table 8, the normalized time matrix is provided by dividing the values on each line by the highest value on the same line. Table 14 provides the data on the normalized time matrix.

Table 14: Normalized Time Matrix.

Corridor/Site	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)
Corridor No 1 (Tema - Ouagadougou)	0.91	0.95	1.00
Corridor No 2 (Lome-Ouagadougou)	0.95	1.00	0.95
Corridor No 3 (Abidjan -Ouagadougou)	0.99	0.95	1.00
Corridor No 4 (Cotonou -Ouagadougou)	0.95	1.00	0.95

4.6. Findings on joint matrix

Table 15: Joint Matrix

Corridor/Site	Site No 1 (Koubri)	Site No 2 (Tanghin-Dassouri)	Site No 3 (Pabre)
Corridor No 1 (Tema - Ouagadougou)	0.83	0.91	1.00
Corridor No 2 (Lome-Ouagadougou)	0.93	1.00	0.92
Corridor No 3 (Abidjan -Ouagadougou)	0.99	0.94	1.00
Corridor No 4 (Cotonou -Ouagadougou)	0.94	1.00	0.93

A high value from the joint matrix represents a high cost and time spent on the corridor with regards to the potential freight village location site. In other words, a high value from the joint matrix represents a high cost and time spent between the start node of the corridor (port) and the end node (one of the potential freight village location site). Based on the data obtained from the joint matrix, the best corridor for each site is as following:

Corridor 1(Tema – Ouagadougou) : Site 1- Koubri

Corridor 2 (Lome-Ouagadougou) : Site 3 - Pabre

Corridor 3 (Abidjan –Ouagadougou) : Site 2 – Tanghin-Dassouri

Corridor 4 (Cotonou -Ouagadougou) : Site 3 – Pabre

5. CONCLUSION

This study explored Burkina Faso's transport corridors in term of cost and time and proposed a framework for selecting the most suitable corridor that will be link to a new freight village intended for the city of Ouagadougou. Three potential locations (Koubri, Tanghin-Dassouri, and Pabre) and four corridors (Tema -Ouagadougou; Lome-Ouagadougou; Abidjan -Ouagadougou; Cotonou -Ouagadougou) were taken into account. The findings showed that if the freight village has to be located in the site 1 (Koubri) the suitable corridor will be the Corridor 1(Tema – Ouagadougou), if it has to be in the Site 2 (Tanghin-Dassouri) the suitable corridor will be the Corridor 3 (Abidjan –Ouagadougou) and finally if it has to be in the Site 3 (Pabre), both the Corridor 2 (Lome-Ouagadougou) and Corridor 4 (Cotonou -Ouagadougou) could be suitable.

The outcome of this study brings some implications. Indeed, a freight village construction project is a huge scale project that involved many stakeholders. The government should lead all stakeholders for an economic, social, technical, environmental and operational feasibility studies to select the best location and to ensure a successful implementation. In addition, the government should develop good policy in other to ensure a good partnership with the neighboring countries, both coastal and landlocked.

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