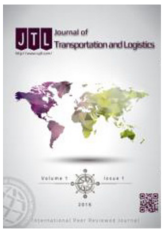

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RESEARCH ARTICLE

Locating Consolidation Centres For Aggregation of Subsistence Agricultural Products From The Southwestern Region of Nigeria

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ABSTRACT

The purpose of this study is to improve agriculture product supply capacity in a way that is beneficial for subsistence farmers and consolidators in the southwestern region of Nigeria. Data gathered includes the distance travelled between various locations, units demanded, and fixed and variable costs. The data were presented on Google maps and evaluated using Weber, Centre of Gravity (CoG), and Mixed Integer Linear Program (MILP) methods. Software deployed for analysis were Microsoft 2013-Excel Solver, and Statistical Analysis System (SAS). The Weber and CoG methods yielded similar results that the consolidation centre should be located at the Oshodi area of Lagos State to minimise distance travelled. However, the MILP model suggested that opening consolidation centres at the Mushin area of the Southwest region generated the optimal outcome in terms of cost and distance travelled to market and customers. The novelty of the developed model is that it provides alternative location candidates that can be critically explored in practical location decisions. Hence, the model is a support tool applicable by managers of agricultural businesses in their decision to establish consolidation centres in such a manner that minimises cost and distance travelled to meet customer and market demand.

Keywords: Location, Consolidation Centre, Agricultural Products, Transportation, Facility

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1. Introduction

A sustainable agricultural sector is expected to possess the capacity and capability to provide enough food to its population, contribute to foreign earnings, create employment for adults and youths, serve as a source of raw materials for industry conversion, and improve the socio-economic status of citizens. The agricultural sector is a solid foundation for growth in the industrial and economic activities of a nation from whence further accelerated economic growth and development can be achieved. Positive environmental benefits, such as sustainable natural resource management, biodiversity preservation, conservation of land, and development of the potential of rural areas, can be achieved through successful agricultural practice (Food and Agriculture Organization of the United Nations, 2018).

Dating back to the precolonial era, subsistence agricultural practices were prevalent in Nigeria. Subsistence agriculture in Nigeria has been a means of survival for small-scale farmers, and a shock absorber for the economy when agricultural output has declined, but it has not translated to the development of rural areas (Apata, Folayan, Apata & Akunlua, 2011). Subsistence agriculture, according to Apata, Folayan, Apata, and Akinlua (2011), plays an important role in food security but it has not translated to rural development in Nigeria. Small-scale farming has not been able to meet the challenges of contemporary agricultural development (Onakuse, 2012).

Despite policy support from the Nigerian government to set a pace for agricultural practices in the country, some factors keep agriculture at subsistence levels. Poverty in rural areas, the continuous increase in rural-urban migration, and the degradation of land have kept farming at subsistence levels (PricewaterhouseCoopers, 2017). Also, farmers do not have access to market their products due to facility problems and stringent government regulations (Gaal & Afrah, 2017). Farmers are not able to sell their crops at a profitable price after harvesting due to storage problems and lack of access to the market. This problem often leads to post-harvest food loss and waste in the agricultural supply chain in Nigeria. Additionally, the transportation facilities in Nigeria are poor, storage facilities are not adequate, and products harvested are left in remote areas without access to markets (Adeniran & Oladun, 2020).

Given the nature of subsistence farming and the corresponding predicaments that have been described, subsistence agriculture needs large-scale investment and a business environment that promises returns to farmers beyond survival to economic development. Nigeria has many opportunities to transform its economy, particularly in agricultural product processing. Special agricultural processing zones could promote agro-industrial development and employment (African Economic Outlook, 2020). Organised and guided programs that increase the size of farms, cost of labour reduction, and farming technique improvements could serve as a veritable means to enhance the income of subsistence farmers in Nigeria (Adeniyi, 2013). Similarly, the institutional changes that enhance efficiency would be of benefit to small-scale farmers by facilitating shifts from subsistence to commercial agriculture (Apata, Folayan, Apata & Akinlua, 2011).

Consequently, an approach that can be used to address the above issues is consolidation. The function of a consolidator in agricultural supply chains cannot be underestimated. The importance of the consolidation function has been ignored in recent literature suggesting improvements in agricultural practices in Nigeria (Nwangwu, 2019; Olayemi, Oko, Oduntan, 2020; Adsida, Nkomoki, Bavorova & Madaki, 2021, Anzaku & Charles, 2022). The consolidator aggregates small goods that belong to various shippers into full or truckload containers in such a manner that makes it easy to distribute goods cost-effectively, locally and globally (Caizza, Volpe & Stanton, 2015). Consolidators are agents, logistics companies, and export brokers that provide a complex set of services to agro-food SMEs (Caizza, Volpe & Stanton, 2015). Food crops produced through subsistence farming in the rural areas of the country by small farmers are consolidated by a company that aggregates demand from the small farmers and then enables supply to various parts of the country. The concept of consolidation becomes useful because the farmers produce in small lots, and it is not economically feasible for them to supply to the consumers or retailers in all other parts of the country. It is the job of a consolidator to aggregate the small produce and supply it to retailers, who further supply to consumers.

However, consolidation centres have to be located in a place that ensures easy access to customers and markets, and where operations are performed at the least cost. To achieve this, the purpose of this study is to examine how the location of consolidation centres for the aggregation of subsistence agricultural products of small-scale farmers can be used to improve their access to markets. The perspectives of this study have not been considered in much research relating to facility location within the context of agriculture in Nigeria. This indicates the need to bridge the gap by applying facility location models to optimise consolidation practices for aggregation, and supply of crops to areas of high demand in the Southwestern region of Nigeria.

2. Literature Review

In this section, Weber's least cost and the bullwhip effect theories were used to underpin this study. Additionally, some empirical literature was reviewed with a focus on the study objectives, methods deployed for data collection and analysis, the relevant findings, and conclusions.

2.1. Theoretical Review

Weber's least cost theory, also known as the theory of industrial location, was propounded in 1909 but later published in 1929 in his classic work titled *Uber den Standort der Industrien.* The essence of the theory was to determine the appropriate location of facilities (Weber, 1909). In regard to this study, Weber's least cost theory gives insights on the appropriate location to establish consolidation centres for the aggregation of agricultural products.

Based on Weber's least cost theory, the point for locating an industry that minimises transportation and labour requires the analysis of three factors. The first factor is that the point of optimal transportation is based on the cost of distance to the material index. The material index describes the ratio of the weight of localised materials divided by the weight of the finished product (Fearon, 2002). The location of consolidation centres, in this case, is largely influenced by the analysis of the material index. This is because the consolidation has to be close to farmers who supply the raw agricultural products. By so doing, the consolidator can effectively discharge aggregation responsibilities, making it easier for agricultural products to be stored and distributed in a cost-effective manner (Caizza, Volpe & Stanton, 2015).

Secondly, Weber's least cost theory posits that due to labour distortion, more favourable sources of lower labour cost might justify greater transport distance. Consequently, the location of consolidation centres in the rural area of the Southwest region is influenced by a study of labour dynamics in the region. A study of rural-rural migration by Agbonlahor & Philip (2015) shows that labour supply in Southwest Nigeria is mostly influenced, among other things, by the availability of farmland. Crop farming and farm labour constitute major livelihood options for migration to the rural community (Agbonlahor & Philip, 2015). A study of migration and sustainable development in Southwestern Nigeria showed that socio-economic variables such as income level, age, educational status, household size, and occupation influence the incidence of migration to areas like Ogun, Oyo, and Ekiti state (Adebayo, 2020). According to the study, the migrants' reasons for returning to the place of origin were the need for community development and for origin achievements such as club membership, chieftaincy title, and ownership of farm landed property, amongst others (Adebayo, 2020). Hence, locating consolidation centres in the Southwestern region of Nigeria is justified by labour migration potentials to the area.

The third factor, according to Weber's least cost theory, is agglomeration or concentration of firms and deagglomeration of firms. Agglomeration describes the collection of clusters of business firms located very close to each other. The general idea of agglomeration is to concentrate business activities close to one another with the goal of increasing their productivity and economic relevance (Kano, Lengyel, Elekes & Lengel, 2019). Agglomeration of firms, according to Weber's least cost theory, is necessary when there is adequate demand for support services of the organisation, nearness to the labour force, and opportunities for investment in new businesses (Fearon, 2002). Through an agglomeration strategy, firms build facilities that provide products and services that are in close contact with customers. Based on considerations such as cost of establishment, nearness of customers, and markets, one or more consolidation centres can be opened for aggregation of crops.

Weber's least cost theory further states that deagglomeration of firms occurs when organisations leave a particular environment due to reasons such as shortage of labour, overconcentration of firms, unprofitable industry, high cost of operation, and other issues (Kano, Lengyel, Elekes & Lengel, 2019). Consequently, Werber (1909) examined factors that lead to the diversification of an industry within horizontal relationships between processes within plants. Other factors of diversification are the attractiveness of the market or industry and government regulatory policies. Weber further examined factors leading to the diversification of an industry in the horizontal relations between processes within a plant (Fearon, 2002). Issues associated with industry location are highly relevant for an organisation's strategic positioning for competitiveness (Simiyu, 2020). Hence, from a diversification perspective, the establishment of consolidation centres for the aggregation of agricultural products is an emerging business opportunity for companies operating in the agri-business supply chain, and for other logistics companies in Nigeria's freight or shipping industry. Therefore, the use of the Weberian model justifies the use of cheap and unexploited labour, raw materials, and optimal transportation distance.

The bullwhip effect was first conceptualised by Jay Forrester's Industrial Dynamics (1961), and because of this, the concept was also named the Forrester effect (Forrester, 1961). The concept can further be traced to the work of Procter and Gamble (P&G) in the 1990s, who applied the idea to the observed variation between the company and its suppliers. The phenomenon of the bullwhip effect generally describes a situation when demand forecast yields supply chain inefficiencies, delay, and the inability to meet customer demands. The bullwhip effect is one of the most popularly celebrated concepts in the operations management research field (Wang & Disney, 2016). Bullwhips refer to inventory swings in response to shifts or changes in consumer demand, which amplifies a supply chain upstream (Lee, Padmanabhan, & Whang, 1997; Disney, 2008; Hoberg & Thonemann, 2014).

The bullwhip effect in the agricultural supply chain occurs due to the structure of the industry. Description of the agricultural value chain by Kim (2018) shows that the supply chain is long and fragmented. Conspicuous characteristics of the agricultural supply chain are the psychological and physical distance between suppliers and customers. More so, geographical fragmentation exists because farms are located in rural areas, and are usually far away from urban centres where customers are located. Psychological differences also occur due to sociocultural differences between the rural and urban areas (Kim, 2018). The physical and psychological distance increases the existence of intermediaries and gatekeepers, making the industry more fragmented, with small players who have myopic views of optimising profits and interest in the supply chain with little interest or consideration for issues affecting the entire supply chain (Kim, 2018). Hence, the negative impact of the bullwhip effect on the agricultural industry is more severe than in other industries. Ntihinyurwa and de Vries (2021), who observed physical farmland fragmentation, suggested farmland consolidation practices in line with other agricultural land protection policies and programs geared towards ensuring food security in the chain. Consolidation practices are very important approaches veritable tool for the reduction of fragmentation due to installed capacity for aggregation of products for further distribution in a supply chain in a cost and time-effective manner (Caizza, Volpe & Stanton, 2015).

2.2. Empirical Review

The single and multiple network location models have been applied in various studies as decision tools to solve facility location problems for the optimisation of firm performance in the agricultural industry. In the study by Islam, Uddin, Alam, and Faruque (2019) the mixed integer linear programming model was applied to investigate a two staged supply chain network for coordination of agricultural products during times of uncertainty amongst producers, wholesalers, retailers, and consumers. Information on agricultural products was collected from two hundred and thirty-five (235) players in the agricultural market. Other information gathered included the types of products, agricultural product hub facilities, variable and fixed cost of plant installation, distribution centres, warehouses, distances, and prices associated with the use of various transportation modes. Major findings adduced the reasons for shortage in the agricultural product supply to insufficient producer's production capacity. More so, improvement in profits before and after coordination is determined by a complete outsourcing decision, which is of benefit to the producer and wholesalers.

The mixed integer linear programming model was applied to integrated fish supply chain planning by Nurdin, Zarlis, Tulus, and Efendi (2020) to solve problems associated with a shortage in the supply of fish to some destinations, and to meet customer demand. The researchers gathered data from suppliers which covered transportation cost and distances, operational cost data, fish resources data, and distribution routine data, and it was presented in the form of matrix. Using the MILP method, the objective function was developed to minimise cost of inventory, transportation, and other costs related with distribution of fish in the supply chain network. The objective function was subject to demand and supply constraints, while the binary variable and fixed cost constraint were also included in the model. Application of the model showed that the operational cost of transporting fishes from suppliers to consumers at the various locations is minimised. The model further revealed that other costs, such as cost from suppliers to distribution centres and to consumers, and the inventory costs applicable to the suppliers and distribution centres, were minimised.

Hanifha, Ridwan, and Suksessanno (2020) demonstrated how the centre of gravity method and the mixed integer linear programming model were integrated to make decisions on site selection for new facilities. Data collected included the customer nodes from fifty-three villages on the x and y coordinates, and demand from the villages. Other information relates to the fixed and variable cost of transportation and establishment of the facilities. The objective function was to minimise the cost subject to demand and supply constraints. The binding constraints were used to determine whether to open the new facilities or not. Results showed that it was only feasible to open six (6) facilities in six villages for operation amongst the twenty-four (24) villages and even distributed across three (3) districts. Selecting the six facilities according to the model yields the minimum total costs.

Towards the design of a sustainable supply chain for meat distribution, Zarini and Javadian (2020) applied a multi objective mixed integer programming model. The model was applied to reduce challenges associated with product diversity, product shortage, and product tracking and visibility in the meat supply chain. The objective functions were to minimise costs, environmental impacts of the operation, maximise operational efficiency in the facilities, and to optimise social aspects such as job opportunities, days lost by worker and so on. The corresponding constraints included capacity constraints, demand and supply constraints, the binary variable, and non-negativity values. Data collected for the study included the demand for various types of meat products, purchasing costs, fixed and variable costs of operation, number of farms, slaughter houses, retailers, and customers, and time periods. Using the multi objective mixed integer programming model, findings revealed that application of this model reduces the total fixed and variable supply chain network costs.

Furthermore, the study by Emidio, Lima, and Madrona (2021) demonstrated how the mixed integer linear programming method can be used to facilitate the supply chain decision and production planning of dairy manufacturers. The model was used to address issues relating to the type of milk to select and the pick-up schedule of the suppliers at the planning horizon. Data gathered covered parameters such as the warehouse space, cost, diary product demand, set up cost, inventory costs, fixed and variable costs, and so on. Major findings showed that the model proves useful for companies to reduce their costs of transportation, and inventory and product costs.

The empirical studies reviewed suggest that network location models have been applied by researchers to solve continuous single facility and network facility location problems. Some of the models are the centre of gravity model, Weber or minimum distance model, and the mixed integer linear program model. Hence, the models proved very useful veritable to proffer solutions to solving location problems within agricultural contexts. However, none of the studies examined issues relating to the location of consolidation centres for aggregation of subsistence agricultural products from local areas in the southwestern region of Nigeria to areas of high demand on the Lagos State Mainland.

3. Methodology

In this study, facility location models were deployed to prescribe feasible regions for the settlement of aggregation centres. Facility location models are useful for locating warehouses or distribution centres where the agricultural products of subsistence farmers can be consolidated and supplied to meet customers or market demand. Also, the models facilitate operational and tactical decisions such as operational cost minimisation, profit maximisation, optimal routing, and inventory decisions. The models application can be found in similar studies (Islam, Uddin, Alam & Faruque, 2019; Nurdin, Zarlis, Tulus & Efendi, 2020; Hanifha, Ridwan & Suksessanno, 2020; Zarini & Javadian, 2020; Emidio, Lima & Madrona, 2021). Hence, to solve the first problem objectives, facility location models used were Weber or Minimum Distance methods and the Centre of Gravity Method (CoG). Both methods are used to solve continuous location problems according to the first objective, which is to find a single location for the establishment of a consolidation centre where agricultural products can be supplied to selected destinations within the southwestern region. Primary data related to the distance between location x and y was collected through physical observation of distances. The Weber or Minimum Distance methods and the Centre of Gravity Methods (CoG) are shown below:

Using the Weber method, the model is given as follows:

$$Min\ Z = \sum_{k \epsilon K} W_k d_k\,(X,Y) = \sum_{k \epsilon K} W_k \sqrt{(X - X_k)^2 + (Y - Y_k)^2} \qquad (1)$$

The model finds the best point x and y coordinates in Euclidean space to establish a single consolidation centre to serve customers/markets in various destinations given the demand and distances.

Where: locations is k
W_k = Weight of location k
X_k = X coordinate of location k
Y_k = Y coordinate of location k
d_k = distance from location k to centre point (x,y)

Decision Variables
X = Horizontal or X coordinates of centre point
Y = Vertical or Y coordinate of centre point

Also, using the Centre of Gravity method, the model is given as follows:$_1$

$$CoG = \frac{W_1d_1+W_2d_2+W_3d_3.....}{W} \quad (2)$$

The model finds the centroid or pivotal point of balanced weighted x and y coordinates to establish a single consolidation centre to serve customers/markets in various destinations given the demand and distances. *(2)*

Where: W_k = Weight of location k, d_k = distance travelled from location k to centre point of destination.

The second objective of the study is to find multiple location or candidate consolidation centres, within the limits defined by the Weber and centre of gravity methods, where agricultural crops can be aggregated to minimise the total cost of distribution to other areas within the southwestern region. To approach this problem, the Mixed Integer Linear Programming (MILP) method was used. The objective function and constraints are specified in the model below:

$$\text{Min } Z = \sum_i \sum_j C_{ij}x_{ij} + \sum_i f_i Y_i \quad (3)$$

This condition specifies the minimum total cost, i.e. the flow based variable transportation cost and independent fixed costs of operation given that the consolidation centres are opened *(3)*

Subject to constraints:

$$\sum_j x_{ij} \leq s_i \quad \forall i \in S \quad (4)$$

The condition specifies that supply from the consolidation centres to the customer/market cannot be more than the centre capacity *(4)*

$$\sum_i x_{ij} \geq D_j \quad \forall i \in D \quad (5)$$

The condition specifies that the agricultural product supplied must be sufficient enough to meet customer/market demand in the various destinations. *(5)*

$$x_{ij} - M_{ij}Y_i \leq 0 \quad \forall_{ij} \quad (6)$$

A logical or linking constraint that connects the fixed cost of operation and flow units of goods from the consolidation centre to the customer/market. The constraint fulfils the condition that it is only possible to deliver the agro products from the consolidation centre if it is opened (6)

$$\sum_i Y_i \geq P_{MIN} \quad (7)$$

The condition specifies the minimum number of consolidation centres to open (7)

$$\sum_i Y_i \leq P_{MAX} \quad (8)$$

The condition specifies the maximum number of consolidation centres to open (8)

$$x_{ij} \geq 0 \qquad \forall_{ij} \quad (9)$$

The condition specifies that flow of agricultural products from the consolidation centres to customers/market in various regions must be greater than zero (9)

$$Y_i = \{0,1\} \quad \forall\, i \quad (10)$$

A condition specifies whether consolidation centre is opened or not opened (10)

Model Interpretation for indices and input data is such that:

i =The Consolidation centres (DC) for aggregation of crops

j = Customers or market

Si = Supply Availability at consolidation centres (DC) i (units) $\forall j \in S$

Dj = Customer/Market Demand j (units) $\forall j \in D$

Cij = Variable Cost of Providing Service to Customer/ Market j from DC i (₦/units) ∀ i, j

Fj = Fixed Cost of Opening DC i (₦) ∀ i, $\in S$

$PMIN$ = Minimum number of consolidation centres (DCs) that are required to be opened

$PMAX$ = Maximum number of consolidation centres (DCs) that are required to be opened

M = A big number or a linking constraint between the X_{ij}'s and Y_i's

The Decision Variables are such that:

Xij = the flow of a consolidation centre DC_i to the customer or market $_j$ (units) $\forall_j$

Yi = 1 provided that a consolidation centre DC is to be opened, or 0 otherwise if closed $\forall_i \in S$

The Weber and Centre of Gravity (CoG) location models suggest a single location for the establishment of a consolidation centre, i.e. a site at Oshodi-Isolo, as shown in figure 3.1, from which agricultural products can be supplied to some destinations within the southwestern region, such as Idimu, Berger, and Yaba. The Weber method minimises both the distance and the weights or units, and the CoG model ignores weights or units and focuses only on distance travelled (Fearon, 2002). The location suggested with the models assumes a Euclidean plane and pivotal space, of which assumptions are not perfectly fit for decisions to set up consolidation centres in practice. This is due to some potential physical and geographical factors associated with other locations within the feasible space ignored by the models (Simiyu, 2020). For example, the models ignore the underlying network roads, rails, or highways in the southwestern region that can be better assessed to facilitate the cost of transportation. Or the potential presence of swamps, bushes, or other factors in the environment that can prevent the establishment of a consolidation centre in the chosen location. Although the weakness of the single continuous location models (i.e. Weber and Center of Gravity (CoG)) reduces their practical relevance, they both generated insights that were useful for the selection of a list of location candidates.

The Mixed Integer Linear Programming Models (MILP) support the decision to select optimal location candidates, i.e. the establishment of one or more consolidation centres from which the agricultural products would be supplied to other areas in the southwestern region. Trade-offs for multiple locations, according to Ellet (2012), are associated both with costs and level of service. Therefore, the MILP model used for this study considers costs factors such as nature of assets, facility costs, and transportation costs.

3.1. Analysis of a Single Location Decision Problem

The study area, which is located in the Otta area of Ogun State, receives demand for major crops from Lagos. The major areas, however are the Idimu, Berger, and Yaba

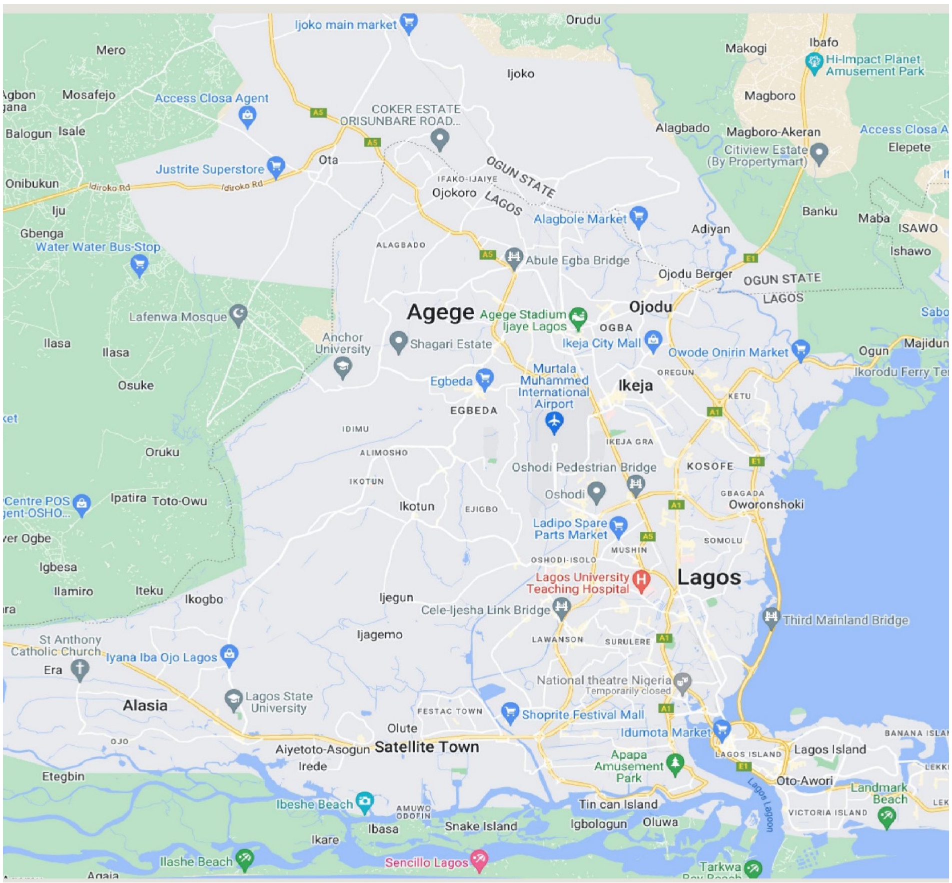
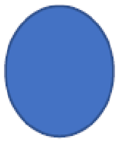
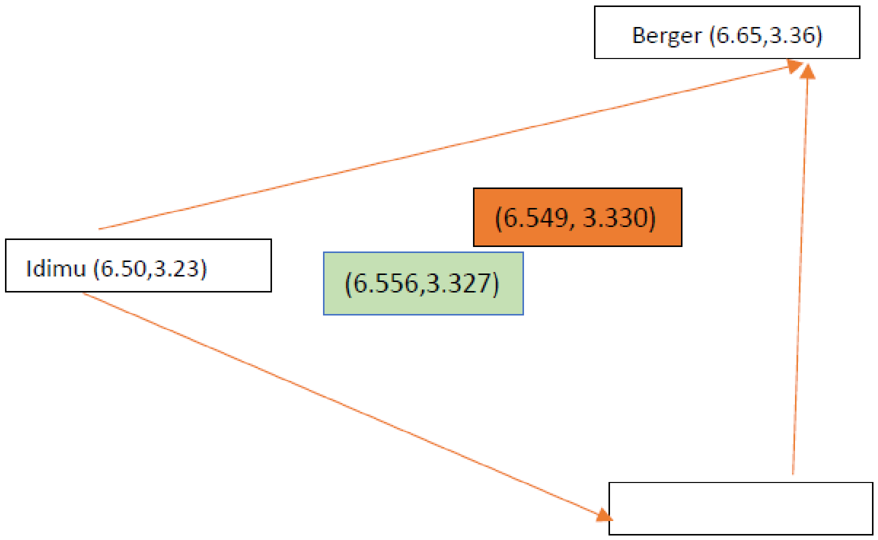


Figure 3.1. Location of the Demand Region and Aggregation Centres on the Map

Source: Google Map

areas of the Lagos Mainland. To provide enough capacity to meet demand in the areas, the managers decided to establish consolidation centres where the crops gathered from smaller farmers in [Ogun State Areas] can be stored and re-distributed to the major areas of high demand in Lagos State Mainland.





Analysis of Objective 1: To find a single location to set up a consolidation centre to serve the major areas of demand at Idimu (ID), Berger (BG), and Yaba (YB) that minimises the expected cost of transportation. The facility location variables are described such that:

Where: locations are k

W_k = Weight of location k

X_k = X coordinate of location k

Y_k = Y coordinate of location k

d_k = distance from location k to centre point (x.y)

Decision Variables

X = Horizontal or X coordinates of a centre point

Y = Vertical or Y coordinate of a centre point

Table 3.1: Output of the Weber and Centre of Gravity Methods

				Weber Method		**Centre of Gravity Method**	
City	Weight	x	Y	Distance	Weighted Distance	Distance	Weighted Distance
Berger	4250	6.65	3.36	0.10	446	0.10	423
Yaba	3200	6.47	3.35	0.08	262	0.09	285
Idimu	2200	6.50	3.23	0.11	246	0.11	247
	9650			Total Wgt. Dist.	954	Total Wgt. Dist.	955
Weber Coordinates		6.549	3.330	Weber (Average Distance) = 0.10 CoG (Average Distance) = 0.10			
CoG Coordinates		6.556	3.327				

Source: Author's analysis on Excel Solver

Analysis of table 3.1 shows the x and y coordinates where consolidation centres should be located. The Weber method suggests that a consolidation centre should be located at (6.54, 3.33) coordinates, which is an area within Ajao Estate, Oshodi-Isolo, Lagos State. Also, the CoG method suggests that a consolidation centre should be located at (6.55, 3.327) coordinates, which is also an area around Mafoluko, Oshodi, Lagos State. The consolidation centre will serve demand at Idimu (ID), Berger (BG), and Yaba (YB). However, it is not practically feasible to locate the consolidation centre at the area specified by the Weber Coordinates and the CoG methods. This justifies the need for the second objective, which is to select multiple locations from a list of candidates to locate consolidation centres that can serve demand in many destinations in such a manner that minimises the total cost of delivery.

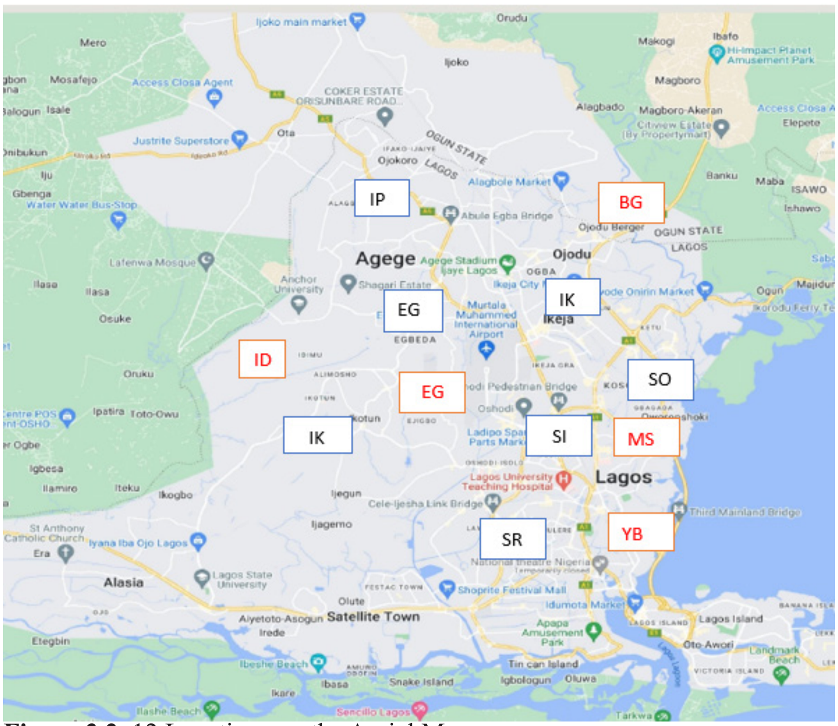


Figure 3.2. 12 Locations on the Aerial Map

Source: Google Map

2.2. Analysis of Multiple Location Decision Problem

Analysis of Objective 2: To select multiple locations from a list of candidates to locate consolidation centres that can serve demand in many destinations in such a manner that minimises the total cost of delivery.

Figure 3.2 shows a list of location candidates. The location candidates were selected based on managerial judgement and some practical considerations such as labour, population of the environment, extent of security/risks, availability of markets/customers, and nature of the environment. Five (5) location candidates selected for further analyses are Berger (BG), Ejigbo (EG), Yaba (YB), Idimu (1D), Mushin (MS), and other 7 locations. Other characteristics of the selected location, such as the distance, units demanded, and coordinates are presented in table 3.3. More so, the estimated Fixed Cost (Fi) for establishment of a consolidation centre is for ₦ 10,000,000. i.e. Further, the variable cost per distance (Cij) = ₦ 10,000 Mile/drive. Hence, the major task is to find amongst the list of candidate locations those that minimise the cost of delivering products to other destination points within the Lagos Mainland Area.

Table 3.2.: Location Characteristics

		Demand (Units)	Distance Between Cities					Coordinates	
ID	**City Name**	Dj	**BG**	**EG**	**YB**	**ID**	**MS**	**X**	**Y**
BG	Berger	4250	0	7.01	9.22	9.79	7.67	6.65	3.4
SI	Oshodi-Isolo	1200	8.7	5.59	3.61	6.23	1.66	6.53	3.3
SR	Surulere	4300	10.07	8.33	1.69	8.94	2.29	6.49	3.3
IK	Ikeja	1250	3.17	4.86	6.43	7.11	4.55	6.60	3.4
IT	Ikotun	1100	9.2	3.35	7.63	2.53	5.64	6.55	3.3
EJ	Ejigbo	860	8.36	3.57	5.9	3.77	4.01	6.56	3.8
SO	Somolu	1290	7.35	8.22	3.21	9.85	2.25	6.53	3.4
EG	Egbeda	2800	7.01	0	8.45	2.71	6.2	6.59	3.3
IP	Ipaja	660	7.53	1.12	9.86	2.31	7.55	6.61	3.3
YB	Yaba	3200	9.22	8.63	0	9.85	2.19	6.47	3.4
ID	Idimu	2200	9.79	2.71	9.85	0	7.76	6.50	3.2
MS	Mushin	1820	7.67	6.2	2.19	7.76	0	6.53	3.3
Source: Author's Field Survey									

The first scenario in table 3.3 assessed the cost and area coverage benefits of locating a single consolidation centre. Analysis shows that a consolidation centre should be opened at Mushin (MS) to serve customers in 12 locations, which are Berger (BG), Egbeda (EG), Ejigbo (EJ), Idimu (ID), Ikeja (IK), Ipaja (IP), Ikotun (IT), Mushin (MS), Oshodi-Isolo (SI), Somolu (SO), Surulere (SR), and Yaba (YB). However, a total cost of ₦10,109,548 would be incurred. The second scenario assessed the cost of locating two (2) consolidation centres and coverage benefits. Analysis shows that one consolidation centre should be opened at Egbeda (EG) to serve customers in 7 areas, which are Berger (BG), Egbeda (EG), Ejigbo (EJ), Idimu (ID), Ikotun (IK), Ipaja (IP), and Ikotun (IT). Also, another consolidation centre should be opened at Yaba (YB) to serve customers in 5 areas, which are Mushin (MS), Oshodi-Isolo (SI), Somolu (SO), Surulere (SR), and Yaba (YB), to

Table 3.3: Location Decision Scenarios and Cost Implication

(1,0)		**BG**	**EG**	**EJ**	**ID**	**IK**	**IP**	**IT**	**MS**	**SI**	**SO**	**SR**	**YB**
0	**BG**	0	0	0	0	0	0	0	0	0	0	0	0
0	**EG**	0	0	0	0	0	0	0	0	0	0	0	0
0	**ID**	0	0	0	0	0	0	0	0	0	0	0	0
1	**MS**	4250	2800	860	2200	1250	600	1100	1820	1200	1200	4300	3200
0	**YB**	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 1: Total Cost = ₦10109548													
0	**BG**	0	0	0	0	0	0	0	0	0	0	0	0
1	**EG**	4250	2800	860	2200	1250	660	1100	0	0	0	0	0
0	**ID**	0	0	0	0	0	0	0	0	0	0	0	0
0	**MS**	0	0	0	0	0	0	0	0	0	0	0	0
1	**YB**	0	0	0	0	0	0	0	1820	1200	1290	4300	3200
Scenario 2: Total Cost = ₦20069139													
1	**BG**	4250	0	0	0	1250	0	0	0	0	0	0	0
1	**EG**	0	2800	860	2200	0	660	1100	0	0	0	0	0
0	**ID**	0	0	0	0	0	0	0	0	0	0	0	0
0	**MS**	0	0	0	0	0	0	0	0	0	0	0	0
1	**YB**	0	0	0	0	0	0	0	1820	1200	1290	4300	3200
Scenario 3: Total Cost = ₦30037264													
1	**BG**	4250	0	0	0	1250	0	0	0	0	0	0	0
1	**EG**	0	2800	860	2200	0	660	110	0	0	0	0	0
0	**ID**	0	0	0	0	0	0	0	0	0	0	0	0
1	**MS**	0	0	0	0	0	0	0	1820	1200	1290	0	0
1	**YB**	0	0	0	0	0	0	0	0	0	0	4300	3200
Scenario 4: Total Cost = ₦40029819													
1	**BG**	4250	0	0	0	1250	0	0	0	0	0	0	0
1	**EG**	0	2800	860	0	0	660	110	0	0	0	0	0
1	**ID**	0	0	0	2200	0	0	0	0	0	0	0	0
1	**MS**	0	0	0	0	0	0	0	1820	1200	1290	0	0
1	**YB**	0	0	0	0	0	0	0	0	0	0	4300	3200
Scenario 5: Total Cost = ₦50022889													
Source: Author's computation on SAS Studios, SAS Programmer													

incur a total cost of ₦20,069,139. The third scenario assessed the cost of locating three (3) consolidation centres. Analysis shows that one consolidation centre should be opened at Berger (BG) to serve customers in 2 areas, which are Berger (BG) and Ikotun (IK). Also, another consolidation centre should be opened at Egbeda (EG) to serve customers in 5 areas, which are Egbeda (EG), Idimu (ID), Ipaja (IP), and Ikotun (IT). More so, the third consolidation centre should be opened at Yaba (YB) to serve customers in 5 areas, which are Mushin (MS), Oshodi-Isolo (SI), Somolu (SO), Surulere (SR), and Yaba (YB) to incur a total cost of ₦30,037,264. The fourth scenario assessed the cost of locating four (4) consolidation centres. Analysis shows that a consolidation centre should be opened at Berger (BG) to serve customers in 2 areas, which are Berger (BG) and Ikotun (IK). Also, another consolidation centre should be located at Egbeda (EG) to serve customers in 5 areas, which are Ejigbo (EJ), Idimu (ID), Ipaja (IP), and Ikotun (IT). More so another consolidation centre should be opened at Mushin (MS) to serve customers in 3 areas, which are Mushin (MS), Oshodi-Isolo (SI), and Somolu (SO). Furthermore, the company should open a consolidation centre to cover 2 areas, which are Surulere (SR) and Yaba (YB) to incur a total cost of ₦40,029,819. The fifth scenario assessed the cost of locating five (5) consolidation centres. Analysis shows that a consolidation centre should be opened at Berger (BG) to serve customers in 2 areas, which are Berger (BG) and Ikeja (IK). Also, a consolidation centre should be opened at Egbeda (EG) to serve customers in 4 areas, which are Egbeda (EG), Ejigbo (EJ), Ipaja (IP), and Ikotun (IT). Furthermore, the company should open a consolidation centre at Idimu (ID) to serve customers in a single area, Idimu. More so, a consolidation centre should be opened at Mushin (MS) to serve customers in 3 areas, which are Mushin (MS), Oshodi-Isolo (SI), and Somolu (SO). Furthermore, a consolidation centre should be opened at Yaba (YB) to serve customers in 2 areas, which are Surulere (SR) and Yaba (YB), to incur a total cost of ₦50,022,889.

Table 3.4: Location Decision Scenarios and Area Coverage Scope

Scenarios	**Ratio of Consolidation Centre (s) to Location (s)**					**Coverage Scope (Rank)**
Scenario 1	MS					
	1 to 12					5th
Scenario 2	EG	YB				
	1 to 7	1 to 5				4th
Scenario 3	BG	EG	YB			
	1 to 2	1 to 5	1 to 5			3rd
Scenario 4	BG	EG	MS	YB		
	1 to 2	1 to 5	1 to 3	1 to 2		2nd
Scenario 5	BG	EG	ID	MS	YB	
	1 to 2	1 to 4	1 to 1	1 to 3	1 to 2	1st

Source: Author's computation on SAS Studios, SAS Programmer

Table 3.4 presents the other benefit attached to the selection of multiple consolidation points. Benefits associated with the selection of multiple sites were measured in terms of scope of areas covered by multiple consolidation centres. In scenario 5, facility ID serves customers in 1 area, while facility BG and YB, amongst others, serves customers in 2 areas. In comparison with other options, scenario 5 was ranked highest among others because it offered the best option in terms of closeness between facility and area coverage scope.

Table 3.5: Summary and Comparison of Options

	Center = 1	**Center =2**	**Center = 3**	**Center = 4**	**Center = 5**
Total Cost	₦10,109,548	₦20,069,139	₦30,037,264	₦40,029,819	₦50,022,889
Cost of Transportation	₦109,548	₦69,139	₦37,264	₦29,819	₦22,889
Facility Cost	₦10,000,000	₦20,000,000	₦30,000,000	₦40,000,000	₦50,000,000

Source: Author's computation on SAS Studios, SAS Programmer

Table 3.5 shows that opening a single location pays off in terms of the cost of transportation, facility, and distance. More transportation costs are incurred as longer distances are travelled to get goods to customers. The decision to open 1 consolidation centre pays off in terms of the lowest total cost of ₦10,109,548. Hence, the best choice for the location of the consolidation centre is to open just 1 centre at Mushin (MS) to serve customers in other areas such as Berger (BG), Egbeda (EG), Ejigbo (EJ), Idimu (ID), Ikotun (IK), Ipaja (IP), Ikotun (IT), Mushin (MS), Oshodi-Isolo (SI), Somolu (SO), Surulere (SR), and Yaba (YB). Through experience gained in one consolidation centre, decisions can be made as to how to open other centres in the future, but managers need to reduce the fixed cost of opening a facility as more new centres are opened.

4. Results and Discussion

In this study, location models were applied to suggest feasible options for the establishment of consolidation centres for the aggregation of subsistence agricultural products from the southwestern region of Nigeria. This is also an attempt to bridge the gap between demand and supply of agricultural products from the rural areas of the southwestern region to urban centres where household food consumption expenditure is high (National Bureau of Statistics, 2020). Both the Weber or Minimum Distance methods and the Centre of Gravity Methods (CoG) were used to prescribe a solution to the first problem objective, which is to find a single location for the establishment of a consolidation centre where agricultural products can be supplied to selected destinations within the southwestern region. Result of the Weber method indicate that a consolidation centre should be located at (6.54, 3.33) coordinates, which is an area within Ajao Estate, Oshodi-Isolo, Lagos. Also, the CoG method further suggests that a consolidation centre should be located at (6.55, 3.327) coordinates, which is also an area around Mafoluko, Oshodi, Lagos.

The result of the mixed integer linear programming method was presented based on the five scenarios explored. The outcome of the first scenario also shows that a consolidation centre should be opened at Mushin (MS) to serve customers in other areas, such as Berger (BG), Egbeda (EG), Ejigbo (EJ), Idimu (ID), Ikeja (IK), Ipaja (IP), Ikotun (IT), Mushin (MS), Oshodi-Isolo (SI), Somolu (SO), Surulere (SR), and Yaba (YB). By so doing, the company will incur a total cost of ₦10,109,548. Findings based on the second to fifth scenarios give general insights that decisions to open more than one consolidation centre attract an extra cost of location. The model suggests that the establishment of consolidation centres is feasible based on the consolidation of costs and distances in such a manner that would serve areas of high demand in the southwestern region of the country.

Major insights from the results are that the establishment of consolidation centres for aggregation of agricultural products supplied by the subsistence farmers from the rural areas of the southwestern region is feasible. From the consolation centres, supplies can be moved to meet the demand from urban centres in the southwestern region. The possibility of establishing consolidation centres implies that special agro-processing zones could promote agro-industrial development and employment (African Economic Outlook, 2020). This also implies new investment opportunities for firms, increasing the possibility for agglomeration, where businesses are located close to each other and move towards increasing their productivity and economic relevance (Kano, Lengyel, Elekes & Lengel, 2019). Services provided by the consolidation centres imply that products and services are in close contact with customers and markets (Fearon, 2002). This offers additional opportunities to agents, logistics companies, and export brokers that provide a complex set of services to agro-food SMEs (Caizza, Volpe & Stanton, 2015).

The feasibility of locating one or more consolidation centres in the southwestern region implies the possibility of aggregation function, which in other words means that the small agricultural outputs of the subsistent farmers will be combined and maintained in such a manner that makes the distribution of agro products easy and cost-effective (Caizza, Volpe & Stanton, 2015). This is a panacea to the bullwhip effect in the agricultural value chain caused by psychological, geographical, and physical fragmentation between suppliers and customers (Kim, 2018; Ntihinyurwa & de Vries, 2021). By so doing, the small-holder value chain is promoted from subsistence to profit generation (Fan, Brzeska, Keyer & Halsema, 2013). Therefore, consolidation practices prove veritable for reduction of fragmentation due to installed capacity for aggregation of products for further distribution in a supply chain in a cost and time-effective manner (Caizza, Volpe & Stanton, 2015).

5. Conclusions and Recommendations

The study developed a model that facilitates decision making in the establishment of consolidation centres for aggregation of crops produced by subsistence farmers operating in the rural areas of the southwestern region of Nigeria and being supplied to the high-demand zones located at the urban centres. By applying the model, managers in the agricultural sector can improve consolidation practices in such a manner that reduces the cost of operation, minimises distance travelled to customers and markets, and improves service levels. The model is very useful, as it suggests various alternatives that managers can explore to improve their location decisions in a practical context. Therefore, it serves as a veritable decision support tool for managers and administrators in the agricultural sector to facilitate location planning.

However, some recommendations are made for improvement and implementation of this model in practice. Decision makers should start small by establishing one consolidation centre at the pinpointed area, which would serve demand from highly populated areas in the southwestern region. By so doing, practitioners can observe the market trend and nature of the new business while the lowest cost is incurred. Based on profit, market attractiveness, and operational feasibility of the establishment of one site, managers can further decide based on the model on the location of consolidation centres in other sites within the region.

Researchers interested in facility location studies can develop the model to include factors such as average customer distance travelled, average demand distance, inbound cost of transportation, inventory costs, and multiple agricultural products. This gives additional insights to decision makers on whether to maintain more than one consolidation centre based on costs, distance, and types of agricultural product considerations.

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Sunday, 20 June 2021 14:58:58 2

The OPTMODEL Procedure

Solution Summary	
Solver	MILP
Algorithm	Branch and Cut
Objective Function	TotalCost
Solution Status	Optimal
Objective Value	10109548
Relative Gap	0
Absolute Gap	0
Primal Infeasibility	0
Bound Infeasibility	0
Integer Infeasibility	0
Best Bound	10109548
Nodes	0
Solutions Found	2
Iterations	0
Presolve Time	0.00
Solution Time	0.00

TotalCost
10109548

[1]	open
BG	0
EG	0
ID	0
MS	1
YB	0

flow												
	BG	EG	EJ	ID	IK	IP	IT	MS	SI	SO	SR	YB
BG	0	0	0	0	0	0	0	0	0	0	0	0
EG	0	0	0	0	0	0	0	0	0	0	0	0
ID	0	0	0	0	0	0	0	0	0	0	0	0
MS	4250	2800	860	2200	1250	660	1100	1820	1200	1290	4300	3200
YB	0	0	0	0	0	0	0	0	0	0	0	0

Var open[BG] BINARY

Figure 5. Establish One Consolidation Centre
Source: Author's Computation on SAS Studios, SAS Programmer, 2021

Appendix

Scenario 1: Opening a Single Consolidation Centre

Scenario 2: Opening Two (2) Consolidation Centres

Sunday, 20 June 2021 15:24:18 **2**

The OPTMODEL Procedure

Solution Summary	
Solver	MILP
Algorithm	Branch and Cut
Objective Function	TotalCost
Solution Status	Optimal
Objective Value	20069139
Relative Gap	0
Absolute Gap	0
Primal Infeasibility	2.583792E-13
Bound Infeasibility	0
Integer Infeasibility	0
Best Bound	20069139
Nodes	1
Solutions Found	3
Iterations	40
Presolve Time	0.00
Solution Time	0.00

TotalCost
20069139

[1]	open
BG	0
EG	1
ID	0
MS	0
YB	1

flow												
	BG	EG	EJ	ID	IK	IP	IT	MS	SI	SO	SR	YB
BG	0	0	0	0	0	0	0	0	0	0	0	0
EG	4250	2800	860	2200	1250	660	1100	0	0	0	0	0
ID	0	0	0	0	0	0	0	0	0	0	0	0
MS	0	0	0	0	0	0	0	0	0	0	0	0
YB	0	0	0	0	0	0	0	1820	1200	1290	4300	3200

```
Var open[BG] BINARY
```

Figure 6. Establish Two Consolidation Centres
Source: Author's Computation on SAS Studios, SAS Programmer, 2021

Scenario 3: Opening Three (3) Consolidation Centres

Sunday, 20 June 2021 15:26:57 2

The OPTMODEL Procedure

Solution Summary	
Solver	MILP
Algorithm	Branch and Cut
Objective Function	TotalCost
Solution Status	Optimal
Objective Value	30037264
Relative Gap	0
Absolute Gap	0
Primal Infeasibility	0
Bound Infeasibility	0
Integer Infeasibility	0
Best Bound	30037264
Nodes	1
Solutions Found	2
Iterations	25
Presolve Time	0.00
Solution Time	0.00

TotalCost
30037264

[1]	open
BG	1
EG	1
ID	0
MS	0
YB	1

flow												
	BG	EG	EJ	ID	IK	IP	IT	MS	SI	SO	SR	YB
BG	4250	0	0	0	1250	0	0	0	0	0	0	0
EG	0	2800	860	2200	0	660	1100	0	0	0	0	0
ID	0	0	0	0	0	0	0	0	0	0	0	0
MS	0	0	0	0	0	0	0	0	0	0	0	0
YB	0	0	0	0	0	0	0	1820	1200	1290	4300	3200

```
Var open[BG] BINARY
```

Figure 7. Establish Three Consolidation Centres
Source: Author's Computation on SAS Studios, SAS Programmer, 2021

Scenario 4: Opening Four (4) Consolidation Centres

Sunday, 20 June 2021 15:28:24 **2**

The OPTMODEL Procedure

Solution Summary	
Solver	MILP
Algorithm	Branch and Cut
Objective Function	TotalCost
Solution Status	Optimal
Objective Value	40029819
Relative Gap	0
Absolute Gap	0
Primal Infeasibility	2.273737E-13
Bound Infeasibility	0
Integer Infeasibility	1.249306E-16
Best Bound	40029819
Nodes	1
Solutions Found	2
Iterations	25
Presolve Time	0.00
Solution Time	0.00

TotalCost
40029819

[1]	open
BG	1
EG	1
ID	0
MS	1
YB	1

flow											
	BG	EG	EJ	ID	IK	IP	IT	MS	SI	SO	SR	YB
BG	4250	0	0	0	1250	0	0	0	0	0	0	0
EG	0	2800	860	2200	0	660	1100	0	0	0	0	0
ID	0	0	0	0	0	0	0	0	0	0	0	0
MS	0	0	0	0	0	0	0	1820	1200	1290	0	0
YB	0	0	0	0	0	0	0	0	0	0	4300	3200

```
Var open[BG] BINARY
```

Figure 8. Establish Four Consolidation Centres
Source: Author's Computation on SAS Studios, SAS Programmer, 2021

Scenario 5: Opening Five (5) Consolidation Centres

Sunday, 20 June 2021 15:29:43 **2**

The OPTMODEL Procedure

Solution Summary	
Solver	MILP
Algorithm	Branch and Cut
Objective Function	TotalCost
Solution Status	Optimal
Objective Value	50022889
Relative Gap	0
Absolute Gap	0
Primal Infeasibility	0
Bound Infeasibility	0
Integer Infeasibility	0
Best Bound	50022889
Nodes	0
Solutions Found	2
Iterations	0
Presolve Time	0.00
Solution Time	0.00

TotalCost
50022889

[1]	open
BG	1
EG	1
ID	1
MS	1
YB	1

flow												
	BG	EG	EJ	ID	IK	IP	IT	MS	SI	SO	SR	YB
BG	4250	0	0	0	1250	0	0	0	0	0	0	0
EG	0	2800	860	0	0	660	0	0	0	0	0	0
ID	0	0	0	2200	0	0	1100	0	0	0	0	0
MS	0	0	0	0	0	0	0	1820	1200	1290	0	0
YB	0	0	0	0	0	0	0	0	0	0	4300	3200

```
Var open[BG] BINARY
```

Figure 9. Establish 5 Consolidation Centres
Source: Author's Computation on SAS Studios, SAS Programmer, 2021

ARTICLES REQUESTING CORRECTION

Table 1: Referee Response File

Referee	Referee Opinion	Referee Proposal	Reply to referee
Referee 1	Major correction	The methods used are good in terms of function, but there are problems in use. The CoG and Weber method could have been designed to contribute to the MIP method. One more constraint could be added to the MIP model and the maximum distance to the positions obtained in Weber or CoG models could be kept below a certain value. In the manuscript, Weber and CoG methods give us only a theoretical position and that this position may not be appropriate.	In the study, both the weber and CoG methods were applied to determine a feasible site where a consolidation centre can be located. Both methods generated similar outcome in terms of the suggested coordinates, and distance travelled from the site to the customers/market. The weber and CoG methods both methods provided a foundation for the application MILP method in terms of selection of location candidates within the triangle. The practical reasons for consideration of various location candidates analysed with the MILP methods was to examine other potential areas where the consolidation centres can be located instead of focusing on just the weber and CoG prescription. The constraints used in MILP represents the scope considered based on our access to information.
		It is not clear where the weights used in Weber and CoG methods come from. Do the demands of the locations constitute the weights? These weights could be found with multi-criteria decision-making methods by determining different criteria. Likewise, service quality, customer satisfaction, etc., other than the cost mentioned in the manuscript. cases can also be added as a constraint to the MIP model.	The demand of the location in units constitutes the weights and it is also an important factor we considered in this study because beside the distance between the locations, and the costs of establishment, the market size attracts investors to agricultural business in the study environment.
		The equations showing the constraints and objectives in the MIP model should be explained one by one, and what the model does should be explained more clearly to the reader. This interpretation also applies to the Weber and CoG method.	The equations showing the constraints and objectives in the MILP, weber and CoG methods has been explained one by one in pages 7 and 8.
		Some of the figures used in the manuscript should be converted into tables. So the manuscript will have a better and more professional look.	Some figures have been converted into tables. Tables 3.1 to 3.4.has been clearly presented on pages 10, 12, 13 and 14. Thanks you for your time and professional advice to making this paper better
Referee 2	Minor correction	The introduction section should be improved. In the introduction section the literature gap and the purpose of the study should be described.	Based on your comments and suggestions, the introduction section has been improved to reflect the gap in literature and purpose of the study. We reflected this on the last four paragraphs of the introduction section.
		The data in figures 2, 3, and 4 should be given in table format.	Also, the data has been presented in table format on 3.1, 3.2, 3.3 and 3.4 on pages 10, 12 and 13.
		The analysis results should address the methodological calculations and notations given in Section. 2.	The result and discussion has been presented on page 14 to reflect the methodological calculations. Reasons and justifications for the methods adopted has been reflected in section 3 on page 6.

		The methodology applied is introduced in Sect. 2 however insufficient detail on why these methods are adopted is given. The authors should explain why they choose this methods and review similar studies applying CoG and MILP combined	Empirical evidences of the application of similar methodology were cited on page 6 and critically explained in the review of empirical studies in pages 5 and 6.
Referee 3	Major Correction	The originality of the evaluation model and its approach in the Abstract can be emphasized more clearly. Also the author should give brief information about the evaluation process and contribution	The originality of the model and its contribution to facilitate decision making in the agricultural sector has been reflected in the abstract.
		There may be a Section 2 (Literature Review) it is important to add all the studies related with the topic and utilized methods seperately. In other words, could it be advisable to look at other references which are up-to-date? I think introduction should be separated and literature survey section needs a more adequate reference to recent contributions.	Another section 2 (literature review) has been added in page 2 and it included the theoretical and empirical review. Recent materials that showed various contexts within which similar methods were applied to solving location decision problems in the agricultural sector were reviewed.
		It is necessary to improve the (Conclusion) and clarify the need for focused topics and its contribution	The conclusion has been adjusted based on your suggestions.
		I suggest that Figures and Tables should be revised. The quality of image is very low and there may be some typing errors in these Figures (Times new roman APA standarts etc.)	More so, the figures and tables has been revised to improve the quality of presentation.
Referee 4	Major Revision	Additional analysis is needed to support claims of the potential advantages in case of multiple consolidation points.	Within the scope of this study, the analysis between pages 10 to 12 indicated the outcomes of opening more than one consolidation point in terms of cost alone and area coverage. Also, the analytical scenario on table 3.4 in page 13 suggests that the more consolidation points opened the more areas, locations or markets served. Due to additional cost of gathering information we did not objectively indicate some benefits associated with increasing the number of consolidation centres such as placing limits to distance travelled to supply customers/ market, but presentation on the table means that more areas are covered as more consolidation centres are opened.
		In the annexces, there is information on type of produce however this information is not used in any research conclusions - it either should be used or omitted from the paper	The information on the type of produce provided in the appendix has been removed as advised.
		The table showing comparison of options is well detailed and sufficient - there is no need to detail it in the text: one-two summarizing sentences are sufficient (current text also contains an error)	The information on table 3.5 which includes comparison of options has been modified.