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Modeling Of Travelling Salesman Routing Problems In Akwa Ibom State, Nigeria A Dynamic Programming Approach: Part 1

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Abstract - The main objectives of this study on Travelling Salesman Routing Problems are to find out how the salesman can minimize travel costs by choosing the right route and the shortest route to the zone or area where he or she is to sell. In this study dynamic programming is used in solving routing problem of a travelling salesman from Uyo to Uruk-Akpan in Akwa Ibom State, Nigeria, so as to find the optimal distance for the sales man's trip and to minimize cost of transportation and other real life problems in the trip. From the study, the data was analyzed by using dynamic programming manually and Floyd's shortest route algorithm of Tora software 2.00 versions for the analysis. From the analysis, it was observed that $f_t(i) = 34km,$ and the shortest route from town 1 (Uyo) to town 10 (Uruk Akpan) goes from town 1 (Uyo) to town 3 (Itam) to town 10 (Uruk-Akpan). Checking back to the $f_2(3)$ calculations, we will see that the shortest route from town 3 (Uyo) to town 10 (Uruk-Akpan) is $3-6-9-10.$ Translating the numerical labels into real towns, we realize that the shortest route from Uyo to Uruk-Akpan passes through Uyo, Itam, Ikot Ikpe, Ikot Ekpene and Uruk-Akpan, Akwa Ibom, Nigeria. Therefore the shortest route is from town 1 - 3 - 6 - 9 – 10, and has its length as $f_t(i) = 34\ kilometers.$

Key Words: Traveling Salesman, Route, Optimization, Cost Transport and Minimize.

1. INTRODUCTION

The development of transport services and adequate infrastructures to handle freight flows hence become an important factor of economic competition between regions. Supply chain management is a recent development in the distribution and logistics business which helps the trading and manufacturing companies and even the government for redistribution of finished product in Nigeria [1]. Many companies are using the term logistics and supply chain to describe a process whereby both internal and external units are merged together to minimize cost and maximize profit in the performance to the consumer in terms of redistribution of their finished products [2].

The supply chain concept is related to the cycle-time concept in that the firms that develop a continuous flow inventory system frequently do so with a limited number of primary accounts, often using third party logistics support agencies. Thus, implementation of a cycle-time-to-market strategy may result in a focused implementation of a supply chain management strategy. The movement toward more responsible inventory systems, especially for primary accounts, will lead many to recognize supply chain management. An increasing number of fortune 500 firms have managers with "supply chain" in their official title. Usually, these managers design, develop and maintain a set of relationships both within and outside the firm (between the firm and vendors, third parties and customers) capable of executing the overall corporate strategy. As organizations design and manage internal and external supply chain [3], the importance of transporting products from their point of production to their point of consumption is also well documented in historical files.

Furthermore, the researchers' observed that due large productions of goods from most regions you found out they cannot consume all and will need products from other region who makes a better product and excess quantity that will be needed for the community such as timber, agricultural product, pottery, because of access to better raw materials for the production. These products will need to be redistributed to various regions that need the products through logistics and supply chain management. Thus, logistics application will begin with the inception of sourcing for raw material for production to the end point which is the consumers or at the market. In a more contemporary context, the industrial revolution and the advent of the mass production and mass consumption of the products towards economy brought about the beginning of mass distribution or redistribution of products within the Nigeria.

Producers' contribute significantly to the supply chain and inventory play a major role on the efforts to deliver the product at the right place and on time. Longer shipping of the products to the customers will need to be ordering the good in larger quantity. This is done in other to optimize transportation costs and time and for the organization to maximize profit. Moreso, an efficient transport system will help to reduce inventory cost by minimizing cost and time. If the shortest route or network is found [1]
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Freight distribution is now considered with more attention as productivity gains in manufacturing are increasingly derived from efficiency at terminals instead of from the of transportation modes efficiency [4]. [5] Suggests that the value of transit time and the standard deviation of transit time vary substantially between the two groups of industrial freight, with the revealed values being in general, higher for consumer goods than for capital goods. With emerging global

trade, production networks and distribution systems, particular emphasis was given to ports and related research covering many of these issues [6]; [7]; [8]; [9] and [10]. In this context, an increasing amount of work on intermodal freight transport and terminal issues appeared as well [11] and [12]. Generally, international trade increasingly contributes to the amount and the nature of physical distribution. Thus, globalization is now discussed as having a major impact on goods exchange [13]; [14]; [15] and [16].

Consequently, the role of sales and distribution by salesmen travelling from one place to another is an important measure that helps in the globalization trade and market generally through the logistics and supply chain management which provide substantial evidence in the enhancement of travelling salesman problem. The roles of traveling salesmen have been making a heavy impact in the aspect of redistribution of finished products from manufacturing companies. It has gone to the extent where by the travelling salesmen are also involved in promotion and advertisement of products while on duty in the developing countries like Nigeria, this was observed through the researchers' survey.

The travelling salesman problem (TSP) and the vehicle routing problem (VRP) are among the most widely studied combinatorial optimization problems. Both problems, as well as their numerous extensions, deal with optimally visiting customers from a central depot. A very large number of papers and books deal with these problems [17] and [18].

There are usually two characteristics of salesman routine problems. They are: every customer has to be serviced and that, consequently, no value is associated with the service. The redistribution of finished products from the manufacturers is part of the salesman responsibility which drags the salesman into the routing problem. However, some variant problems propose to select customers depending on a profit value that is gained when the visit occurs. This feature gives rise to a number of problems that we gather together under the name of travelling salesman problems with profits (TSPs with profits), when a single vehicle is involved [19]. When many problems occur in which several vehicles might be in operations, it is called routing problems. In this research we will review the existing literature on the travelling salesman routing problems, with an aim on Traveling Salesman Routing Problems, which have been more widely studied all over the world.

Many researchers that are interested in these problems address the problem in single-criterion versions. Thus, either the two objectives are weighted and combined linearly, or one of the objectives is constrained with a specified bound value. To our knowledge, the only attempts to solve the two-criterion problem are by [20] and [21], who call it the multi-objective vending problem, but their approaches, consist of sequentially solving single-criterion versions of the problem. One should note, however, that many articles deal with other kinds of multi-criteria TSPs. Interested readers are referred to [22] for a recent survey.

Whenever organizations, in the business of providing mobility, are entrusted with moving goods and people a natural question that arises is how efficiently that organization can provide the services. To achieve basic requirement of efficient and productive mobility of goods and passengers are to have optimal routing and scheduling in a company. Finally, how these optimization problems, which are often difficult to solve using traditional optimization tools, have been solved using genetic algorithms are explained [19].

2. OBJECTIVE OF THE STUDY

The main objectives of this study on Travelling Salesman Route Problems is to find out how the salesman can minimize travel costs by choosing the right route and the shortest route to the zone or area where he or she is to travel to. Looking at it from this point, solving the Travelling Salesman Route Problems should result in finding the feasible solutions set such that neither objective can be improved without deteriorating the other. If the result is achieved, the model can be used to help the government in delivering ballot boxes during elections, mails, health treatments and other political or government interactions to various workers that need the services. The Travelling Salesman Route Problem will be useful to:

1) Foreign health officers who have limited time to visit several areas in their host country before leaving.
2) Other itinerary service providers (for example, Agric extension workers or government officials on familiarization or sensitization tours) who all need or wish to minimize their total distance or time of travel.
3) Politicians on constituency campaign rallies.
4) INEC and Nigerian Population Commission who have a need to distribute materials quickly and efficiently.

3. SIGNIFICANCE OF STUDY

This study is important if applied to the urban area and the entire country with the intention of minimizing cost and time. Since travel is not a general comfortable exercise, the technique will help to minimize the discomfort and risk involved in long travel. Travelling Salesman Routing Problem can help in the decongestion of traffics in most of the routes in the urban city and the country. Also, in the environmental impact issues, it can help in the reduction of most transport externalities (for example, pollution) in most routes.

Furthermore, it is used as the basis for other optimization methods once the distance of various routes are discovered. Even though the problem is computationally difficult, a large number of heuristic and exact methods would be deployed in solving the routing problems of similar cities in the country.

4. THE VEHICLE ROUTING MODEL

The vehicle routing model refers to all problems where optimal closed loop paths which touch different points of interest are to be determined. There may be one or more vehicles. Generally, the points of interest are referred to as nodes; the start and end nodes of a route are the same and often referred to as the depot. Widely, there are many classes of vehicle routing model, although they vary from one another depending on either origin or destination node and vehicle properties. Few of these models are described briefly below:

4.1 The Travelling Salesman Problem/ Model (TSP)

Here a single vehicle will be used to visit set of nodes exactly once before returning to its starting position. Such models are relying entirely on the assumption that the sum total of demand for services at the origin and destination nodes is less than the capacity of the vehicle. In this case, optimality of a route is measured in terms of minimum route length. A typical example of the Travelling Salesman Routing Problem/Model includes planning the route for a courier who has to visit certain homes/houses in an area for mail delivery: a doctor making house calls and a typical van salesman on redistribution of finished product [23].

The purpose of Travelling Salesman Problem algorithms is to find that path or route which offers the least distance or length. This can be worked out through a practical field study which will help to convince us on the shortest route with minimal distance or length. The TSP is a difficult optimization problem as the number of feasible routes (from which the best is to be found) increases at a very fast rate with the increase in the number of nodes. Nonetheless, some exact algorithms exist [24] which solve the TSP using polyhedral cutting plane procedures. However, the computation effort is extremely large and the process complexity (i.e., the complexity of the algorithms and their implementation) is prohibitively large. Similar observations are made by, among others [25] and [26]. It is not surprising, therefore, that even with the existence of exact algorithms, ever more efficient heuristics continue to be developed and reported [26]; [27] and [28]. Most of the recent heuristic algorithms are based on what [29] calls artificial intelligence techniques, like Simulated Annealing, Neural Networks, and Genetic Algorithms.

4.2 The Single Vehicle Pick-Up and Delivery Problem (SVPDP)

This problem is similar to a TSP except that, each node is either a pick-up node or a delivery node; further, there is a one-to-one, one-to-many, many-to-one, or many-to-many relation between problems [30] and dynamic programming procedure for SVPDP and their applicability is limited owing to their complexity. Hence, heuristic solution techniques continue to be developed. Furthermore, discussed extensively on [31]; [32]; [33] and [34] the pick-up and delivery problem [35] and [36] is also expressed further on the pick-up and delivery problem with time windows.

4.3 Multiple Vehicle Routing Problems/Models

In the case of multiple vehicle routine problems/models, the total of the services (or goods) demanded by all the origin/destination nodes is greater than the capacity of one vehicle. In such a case, more than one vehicle may be needed to be used. Although the criterion for optimization can remain the same as in the corresponding single vehicle case the multiple vehicle problems/models is in essence different from the single vehicle case [23]. The difference arises because, as opposed to the single vehicle case, here, one is not sure which nodes need to be served by a given vehicle. That is, a priori, one does not know which nodes a route should touch; all that is known is that all the routes put together should serve all the nodes in the problem/model. Typically, in these problems, it is assumed that complete service at a node must be provided by one vehicle; part service of a node is not allowed. Much work has been done on multiple vehicle routing problems; these are not discussed here [23]. Furthermore, [29]; [37]; [38]; [39] and [40] have many descriptions of the various concepts and models used in solving the different kinds of multiple vehicle routing problems.

5. METHODOLOGY

In solving travelling salesman route problems, dynamic programming and Floyd's algorithm can be used as one of the models to get an optimal solution, although there are many others. Programming model is a class of models that determines the optimal allocation of limited resources to meet given objectives. The dynamic programming used were solved manually while the Floyd algorithm which used dynamic programming in its Tora software in solving the algorithm using computer application. The algorithm model represents an n-node network as a square matrix with n rows and n columns, and is a class of models that determines the optimal allocation of limited resources to meet given objectives. The resources may be men, raw material, agricultural products, machines, vehicles, governmental election materials and others. This technique can be used to solve many optimization problems. Entry (i, j) of the matrix gives the distance d_{ij} from node i to node j, which is finite if i is linked directly to j, and infinite otherwise. The software for solving this algorithm, is Tora software version 2.0.

$$f_t(i) = Min Z\{cij + f_{t+1}(j)\}$$

Where j must be a stage $t + l$ city or town and $f_5(10) = 0$

5.1 Tora Software

Tora is an algorithm. That is a mathematical set of instruments or programs (mathematical software). It is an optimization system in the area of operations research which is very easy to use. Furthermore, Tora is menu-driven and windows-based which make it very user friendly [41].

Tora software deals with solving of the following algorithms:

Solution of simultaneous linear equation
Linear programming
Transportation model
Integer programming
Network model
Project analysis by CPM/PERT
Zero-sum games.

6. DYNAMIC PROGRAMMING MODEL

In optimization problems involving a large number of decision variables or the inequality constraint, it may not be possible to use the methods of calculus for obtaining a solution. Classical mathematics handles the problems in a way to find the optimal values for all the decision variables simultaneously which for large problems rapidly increases the computations. That becomes difficult to handle even by the available computers. The obvious solution is to set up the original large problem into small sub- problems involving a few variables and that is precisely what the dynamic programming does. It uses recursive equation to solve a large, complex problem are broken into series of decision stages (sub-problems) where the outcome of the decisions at one stage affect the decisions at the remaining stages [42].

6.1. DYNAMIC PROGRAMMING APPROACH

In dynamic programming, there are some fundamental concepts. The first concept is the stage. The problem is divided into sub-problems and each sub-problem is referred to as a stage. A stage signifies a portion of decision problem for which a separate decision can be made. At each stage there are a number of alternatives and the decision making process involves the selection of one feasible alternative which may be called a stage decision. The second concept is the state. The variables which specify the condition of decision process and summarize the current status of the system are called state variables [42].

The procedure adopted in the analysis of dynamic programming problems can be summarized as follows:

1) Define the problem variables, determine the objective function and specify the constraints.

2) Define the stages of the problem by determining the state variables whose values constitute the state at each stage and the decision required at each stage. Specify the relationship by which the state at one stage can be expressed as a function of the state and decision at the next stage.

3) Develop the recursive relationship for the optimal return function which permits computation of the optimal policy at any stage. Decide whether to follow the forward or the backward method to solve the problem. Specify the optimal return function at stage 1, since it is generally a bit different from the general optimal return function for the other stages.

4) Make a tabular presentation to show the required values and calculations for each stage.

5) Find the optimal decision at each stage and then the overall optimal policy.

7. DATA PRESENTATION

A research survey was conducted to study a sales executive's routing problem of Godrej Nigeria Limited in Akwa Ibom State, Nigeria. This study was conducted by travelling with the sales executive for data collection. The research was conducted from Uyo town to Uruk-Akpan town. To achieve this journey there were many routes that the sales executive needed to follow. Those routes are from the origin i (Uyo) to the final destination j (Uruk-Akpan). Futhermore, Automatic Guided Vehicle (AGV) or Automatic Kilometer Reading Vehicle (AKRV) was used for the research to make a round-trip, starting and ending at the origin (i), to the destination (j) of the products. The AGV moves along horizontal and vertical aisles or division. The network diagram of the travelling salesman routine model is represented below and it shows those town and the routes.

8. DATA ANALYSIS

In solving a sales man routing problem, we will start by working backward. We have classified all the towns beginning from the nth day of the survey trip as stage n town. The researcher can only be in Ikot Ekpene or Ukana at the beginning of the fourth day (day 1 begins when he leaves Uyo); we classify Ikot Ekpene and Ukana as stage 4 town.

The idea of working backwards implies that we should begin by solving an easy problem that will eventually help us to solve a complex problem. Hence, we begin by finding the shortest route to Uruk-Akpan from each city in which is only one driving left (stage 4 towns). Then we use this information to find the shortest route to Uruk-Akpan from each town for which only some towns of driving remain (stage 3 towns). With this information, we will be able to find the shortest path to Uruk-Akpan from each town (stage 2 towns). Finally, we will also find the shortest path to Uruk-Akpan from each city (there is only one: Uyo).

To solve this problem, we simplify the exposition, by using the numbers 1, 2 …10 given in figure 1 above to represent the ten towns. We also define cij to be the road distance between town i and town j. Let $f_t(i)$ be the length of the shortest route from town i to Uruk Akpan, given that town i is a stage t town.

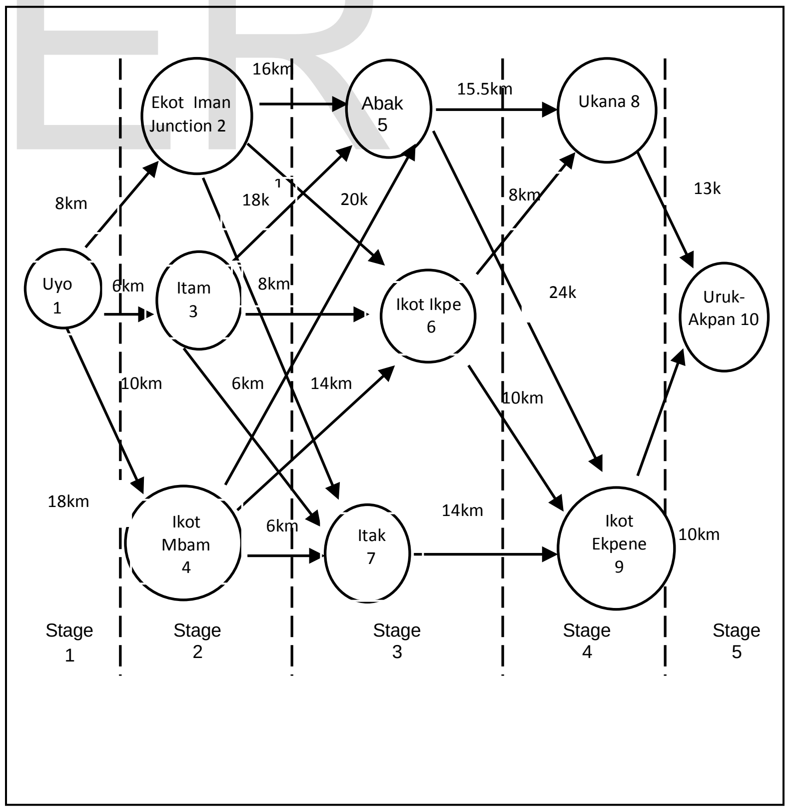

Figure 1: Survey Trip of a Traveling Salesman from Uyo to Urukakpan, Akwa Ibom State, Nigeria

8.1 Stage 4 Computations

First determine the shortest route to Uruk-Akpan from each stage 4 town. Since there is only one route from each stage 4 towns to Uruk-Akpan, we immediately see that $f_4(8) = 13$, the shortest route from Ukana to Uruk-Akpan simply being the only route from Uruk Akpan. Similarly, $f_4(8) = 11$, the shortest (and only) route from Ikot Epkene to Uruk -Akpan.

8.2 Stage 3 Computations

You will work backward one stage (to stage 3 town) and find the shortest route to Uruk-Akpan from each stage 3 town. To determine this, $f_3(5)$, we note that the shortest route from town 5 (Abak) to Uruk-Apkan must be one of the following:
Route 1: go from town 5 to town 9 and then take the shortest route from town 8 to town 10.
Route 2: go from town 5 to town 9 and then take the shortest route from town 9 to town 10.
The length of route 1 will be written as $C_{58} + f_4(8)$, and the length of route 2 is written as $C_{59} + f_4(9)$. Hence, the shortest distance from town 5 to town 10 is written as:

$$f_3(5) = \min Z \begin{Bmatrix} C_{58} + f_4(8) = 15.5 + 13 = 28.5^* \\ C_{59} + f_4(9). \quad = 24 + 10 = 34 \end{Bmatrix}$$

The * indicates the choice of arc that attains the $f_3(5)$. Thus, we have shown that the shortest route from town 5 to town 10 is the route $5 - 8 - 10$. This result obtained, was made by the use of our knowledge of $f_4(8)$ and $f_4(9)$.
Similarly, to find $f_3(6)$, we note the shortest route to Uruk Akpan from town 6 must begin by going through town 8 to town 9. This takes us to the next equation:

$$f_3(6) = \min Z \begin{Bmatrix} C_{68} + f_4(8) = 8 + 13 = 21^* \\ C_{69} + f_4(9) = 10 + 10 = 20^* \end{Bmatrix}$$

Thus, $f_3(6) = 20$, and it is the shortest route. So the shortest route from town 6 to town 10 is the route $6 - 9 - 10$. To find $f_3(7)$ we form another equation which is:

$$f_3(7) = \min Z \begin{Bmatrix} C_{78} + f_4(8) = 16 + 13 = 29^* \\ C_{79} + f_4(9). = 14 + 10 = 24^* \end{Bmatrix}$$

Therefore, $f_3(7) = 24$, and the shortest route from town 7 to town 10 is the route $7 - 9 - 10$.

8.3 Stage 2 Computations

Having got the knowledge of $f_3(5), f_3(6)$, and $f_3(7)$, it is now easy to work backward one more stage and compute $f_2(2)$, $f_2(3)$and $f_2(4)$ and thus the shortest route to Uruk-Akpan from town 2, town 3, and town 4. To find the shortest route (and its length) from town 2 to town 10. The shortest route from town 2 to town 10 must start by going from town 2 to town 5, town 6, or town 7. Once this shortest route gets to town 5, town 6 or town 7, it must follow a shortest route from that town to Uruk-Akpan. From this, it shows that the shortest route from town 2 to town 10 must be one of the following:
Route 1: Go from town 2 to town 5, and then follow a shortest route from town 5 to town 10. A route of this type has a total length of $C_{25} + f_3(5)$.
Route 2: Go from town 2 to town 6. Then follow a shortest route from town 6 to town 10. A route of this type has a total length of $C_{26} + f_3(6)$.
Route 3: Go from town 2 to town 7. Then follow a shortest route from town 7 to town 10. A route of this type has a total length of $C_{27} + f_3(7)$. From here we form other equation as:

$$f_2(2) = \min Z \begin{Bmatrix} C_{25} + f_3(5) = 16 + 28.5 = 44.5km \\ C_{26} + f_3(6) = 15 + 20 = 35km^* \\ C_{27} + f_3(7) = 16 + 24 = 40km \end{Bmatrix}$$

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$$f_2(3) = \min Z \begin{Bmatrix} C_{35} + f_3(5) = 18 + 28.5 = 46.5km \\ C_{36} + f_3(6) = 8 + 20 = 28km^* \\ C_{37} + f_3(7) = 9 + 24 = 33km \end{Bmatrix}$$

Thus, $f_2(3) = 28km$, and the shortest route from town 3 to town 10 consist of arc 3-6 and the shortest route from town 6

$$f_2(4) = \min Z \begin{Bmatrix} C_{45} + f_3(5) = 20 + 28.5 = 48.5km \\ C_{46} + f_3(6) = 14 + 20 = 34km \\ C_{47} + f_3(7) = 6 + 24 = 30km^* \end{Bmatrix}$$

Thus, $f_2(4) = 30km$, and the shortest route from town 4 to town 10 consist of arc 4-7 and the shortest route from town 7 to town 10$(6 - 9 - 10)$.

8.4 Stage 1 Computation

We can now use our knowledge of $f_2(2), f_2(3), and\ f_2(4)$ to work backwards one more to stage to find $f_2(1)$ and the shortest route from town 1 to town 10. Note that the shortest route from town 1 to town 10 must begin by going to town 2, town 3 or town 4. From here it means that the shortest route from Uyo town to Uruk-Akpan town must be one of the following:
Route 1: Go from town 1 to town 2, and then follow a shortest route from town 2 to town 10. The length of such a route will be $C_{12} + f_2(2)$.
Route 2: Go from town 1 to town 3 and then follow a shortest route from town 3 to town 10. The length of such a route will be $C_{13} + f_2(3)$.
Route 3: Go from town 1 to town 4 and then follow a shortest route from city 4 to city 10. The length of such a route will be $C_{14} + f_2(4)$. The equation will now be:

$$f_1(1) = \min Z \begin{Bmatrix} C_{12} + f_2(2) = 8 + 35 = 43km \\ C_{13} + f_2(3) = 6 + 28 = 34km^* \\ C_{47} + f_3(7) = 10 + 30 = 30km \end{Bmatrix}$$

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Solving the traveling sales man routing problem with tora software using Floyd algorithm, we have some iterations in various tables below which show the result of the analysis.

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TABLE 1: ITERATION 1 – ITERATION 10

SHORTEST ROUTES -- FLOYD'S ITERATIONS

Title: TRAVELING SALESMAN

Iteration 0

Array D0

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	infinity	infinity
N2:Ikot E	8.00		infinity	infinity	16.00	15.00
N3:Itam	6.00	infinity		infinity	20.00	8.00
N4:Ikot M	10.00	infinity	infinity		18.00	14.00
N5:Abak	infinity	16.00	20.00	18.00		infinity
N6:Ikot I	infinity	15.00	8.00	14.00	infinity	
N7:Itak	infinity	18.00	6.00	6.00	infinity	infinity
N8:Ukana	infinity	infinity	infinity	infinity	15.50	8.00
N9:Ikot E	infinity	infinity	infinity	infinity	24.00	10.00
N10:Uruk A	infinity	infinity	infinity	infinity	infinity	infinity

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	infinity	infinity	infinity	infinity
N2:Ikot E	18.00	infinity	infinity	infinity
N3:Itam	6.00	infinity	infinity	infinity
N4:Ikot M	6.00	infinity	infinity	infinity
N5:Abak	infinity	15.50	24.00	infinity
N6:Ikot I	infinity	8.00	10.00	infinity
N7:Itak		16.00	14.00	infinity
N8:Ukana	16.00		infinity	13.00
N9:Ikot E	14.00	infinity		10.00
N10:Uruk A	infinity	13.00	10.00	

Array S0

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	5	6
N2:Ikot E	1		3	4	5	6
N3:Itam	1	2		4	5	6
N4:Ikot M	1	2	3		5	6
N5:Abak	1	2	3	4		6
N6:Ikot I	1	2	3	4	5	
N7:Itak	1	2	3	4	5	6
N8:Ukana	1	2	3	4	5	6
N9:Ikot E	1	2	3	4	5	6
N10:Uruk A	1	2	3	4	5	6

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	7	8	9	10
N2:Ikot E	7	8	9	10
N3:Itam	7	8	9	10
N4:Ikot M	7	8	9	10
N5:Abak	7	8	9	10
N6:Ikot I	7	8	9	10
N7:Itak		8	9	10
N8:Ukana	7		9	10
N9:Ikot E	7	8		10
N10:Uruk A	7	8	9	

Iteration 1

Array D1

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	infinity	infinity
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		16.00	20.00	8.00
N4:Ikot M	10.00	18.00	16.00		18.00	14.00
N5:Abak	infinity	16.00	20.00	18.00		infinity
N6:Ikot I	infinity	15.00	8.00	14.00	infinity	
N7:Itak	infinity	18.00	6.00	6.00	infinity	infinity
N8:Ukana	infinity	infinity	infinity	infinity	15.50	8.00
N9:Ikot E	infinity	infinity	infinity	infinity	24.00	10.00
N10:Uruk A	infinity	infinity	infinity	infinity	infinity	infinity

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	infinity	infinity	infinity	infinity
N2:Ikot E	18.00	infinity	infinity	infinity
N3:Itam	6.00	infinity	infinity	infinity
N4:Ikot M	6.00	infinity	infinity	infinity
N5:Abak	infinity	15.50	24.00	infinity
N6:Ikot I	infinity	8.00	10.00	infinity
N7:Itak		16.00	14.00	infinity
N8:Ukana	16.00		infinity	13.00
N9:Ikot E	14.00	infinity		10.00
N10:Uruk A	infinity	13.00	10.00	

Array S1

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	5	6
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		1	5	6
N4:Ikot M	1	1	1		5	6

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N5:Abak	infinity	16.00	20.00	18.00		infinity
N6:Ikot I	infinity	15.00	8.00	14.00	infinity	
N7:Itak	infinity	18.00	6.00	6.00	infinity	infinity
N8:Ukana	infinity	infinity	infinity	infinity	15.50	8.00
N9:Ikot E	infinity	infinity	infinity	infinity	24.00	10.00
N10:Uruk A	infinity	infinity	infinity	infinity	infinity	infinity

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	infinity	infinity	infinity	infinity
N2:Ikot E	18.00	infinity	infinity	infinity
N3:Itam	6.00	infinity	infinity	infinity
N4:Ikot M	6.00	infinity	infinity	infinity
N5:Abak	infinity	15.50	24.00	infinity
N6:Ikot I	infinity	8.00	10.00	infinity
N7:Itak		16.00	14.00	infinity
N8:Ukana	16.00		infinity	13.00
N9:Ikot E	14.00	infinity		10.00
N10:Uruk A	infinity	13.00	10.00	

Array S1

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	5	6
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		1	5	6
N4:Ikot M	1	1	1		5	6
N5:Abak	1	2	3	4		6
N6:Ikot I	1	2	3	4	5	
N7:Itak	1	2	3	4	5	6
N8:Ukana	1	2	3	4	5	6
N9:Ikot E	1	2	3	4	5	6
N10:Uruk A	1	2	3	4	5	6

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	7	8	9	10
N2:Ikot E	7	8	9	10
N3:Itam	7	8	9	10
N4:Ikot M	7	8	9	10
N5:Abak	7	8	9	10
N6:Ikot I	7	8	9	10
N7:Itak		8	9	10
N8:Ukana	7		9	10
N9:Ikot E	7	8		10
N10:Uruk A	7	8	9	

Iteration 2

Array D2

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	24.00	23.00
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		16.00	20.00	8.00
N4:Ikot M	10.00	18.00	16.00		18.00	14.00
N5:Abak	24.00	16.00	20.00	18.00		31.00
N6:Ikot I	23.00	15.00	8.00	14.00	31.00	
N7:Itak	26.00	18.00	6.00	6.00	34.00	33.00
N8:Ukana	infinity	infinity	infinity	infinity	15.50	8.00
N9:Ikot E	infinity	infinity	infinity	infinity	24.00	10.00
N10:Uruk A	infinity	infinity	infinity	infinity	infinity	infinity

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	26.00	infinity	infinity	infinity
N2:Ikot E	18.00	infinity	infinity	infinity
N3:Itam	6.00	infinity	infinity	infinity
N4:Ikot M	6.00	infinity	infinity	infinity
N5:Abak	34.00	15.50	24.00	infinity
N6:Ikot I	33.00	8.00	10.00	infinity
N7:Itak		16.00	14.00	infinity
N8:Ukana	16.00		infinity	13.00
N9:Ikot E	14.00	infinity		10.00
N10:Uruk A	infinity	13.00	10.00	

Array S2

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	2	2
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		1	5	6
N4:Ikot M	1	1	1		5	6
N5:Abak	2	2	3	4		2
N6:Ikot I	2	2	3	4	2	
N7:Itak	2	2	3	4	2	2
N8:Ukana	1	2	3	4	5	6
N9:Ikot E	1	2	3	4	5	6
N10:Uruk A	1	2	3	4	5	6

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	2	8	9	10
N2:Ikot E	7	8	9	10
N3:Itam	7	8	9	10
N4:Ikot M	7	8	9	10
N5:Abak	2	8	9	10
N6:Ikot I	2	8	9	10
N7:Itak		8	9	10
N8:Ukana	7		9	10
N9:Ikot E	7	8		10
N10:Uruk A	7	8	9	

Iteration 3

Array D3

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	24.00	14.00
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		16.00	20.00	8.00
N4:Ikot M	10.00	18.00	16.00		18.00	14.00
N5:Abak	24.00	16.00	20.00	18.00		28.00
N6:Ikot I	14.00	15.00	8.00	14.00	28.00	
N7:Itak	12.00	18.00	6.00	6.00	26.00	14.00
N8:Ukana	infinity	infinity	infinity	infinity	15.50	8.00
N9:Ikot E	infinity	infinity	infinity	infinity	24.00	10.00
N10:Uruk A	infinity	infinity	infinity	infinity	infinity	infinity

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	12.00	infinity	infinity	infinity
N2:Ikot E	18.00	infinity	infinity	infinity
N3:Itam	6.00	infinity	infinity	infinity
N4:Ikot M	6.00	infinity	infinity	infinity
N5:Abak	26.00	15.50	24.00	infinity
N6:Ikot I	14.00	8.00	10.00	infinity
N7:Itak		16.00	14.00	infinity

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	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N8:Ukana	16.00		infinity	13.00
N9:Ikot E	14.00	infinity		10.00
N10:Uruk A	infinity	13.00	10.00	

Array S3

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	2	3
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		1	5	6
N4:Ikot M	1	1	1		5	6
N5:Abak	2	2	3	4		3
N6:Ikot I	3	2	3	4	3	
N7:Itak	3	2	3	4	3	3
N8:Ukana	1	2	3	4	5	6
N9:Ikot E	1	2	3	4	5	6
N10:Uruk A	1	2	3	4	5	6

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	3	8	9	10
N2:Ikot E	7	8	9	10
N3:Itam	7	8	9	10
N4:Ikot M	7	8	9	10
N5:Abak	3	8	9	10
N6:Ikot I	3	8	9	10
N7:Itak		8	9	10
N8:Ukana	7		9	10
N9:Ikot E	7	8		10
N10:Uruk A	7	8	9	

Iteration 4

Array D4

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	24.00	14.00
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		16.00	20.00	8.00
N4:Ikot M	10.00	18.00	16.00		18.00	14.00
N5:Abak	24.00	16.00	20.00	18.00		28.00
N6:Ikot I	14.00	15.00	8.00	14.00	28.00	
N7:Itak	12.00	18.00	6.00	6.00	24.00	14.00
N8:Ukana	infinity	infinity	infinity	infinity	15.50	8.00
N9:Ikot E	infinity	infinity	infinity	infinity	24.00	10.00
N10:Uruk A	infinity	infinity	infinity	infinity	infinity	infinity

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	12.00	infinity	infinity	infinity
N2:Ikot E	18.00	infinity	infinity	infinity
N3:Itam	6.00	infinity	infinity	infinity
N4:Ikot M	6.00	infinity	infinity	infinity
N5:Abak	24.00	15.50	24.00	infinity
N6:Ikot I	14.00	8.00	10.00	infinity
N7:Itak		16.00	14.00	infinity
N8:Ukana	16.00		infinity	13.00
N9:Ikot E	14.00	infinity		10.00
N10:Uruk A	infinity	13.00	10.00	

Array S4

N1:Uyo		2	3	4	2	3
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		1	5	6
N4:Ikot M	1	1	1		5	6
N5:Abak	2	2	3	4		3
N6:Ikot I	3	2	3	4	3	
N7:Itak	3	2	3	4	4	3
N8:Ukana	1	2	3	4	5	6
N9:Ikot E	1	2	3	4	5	6
N10:Uruk A	1	2	3	4	5	6

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	3	8	9	10
N2:Ikot E	7	8	9	10
N3:Itam	7	8	9	10
N4:Ikot M	7	8	9	10
N5:Abak	4	8	9	10
N6:Ikot I	3	8	9	10
N7:Itak		8	9	10
N8:Ukana	7		9	10
N9:Ikot E	7	8		10
N10:Uruk A	7	8	9	

Iteration 5

Array D5

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	24.00	14.00
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		16.00	20.00	8.00
N4:Ikot M	10.00	18.00	16.00		18.00	14.00
N5:Abak	24.00	16.00	20.00	18.00		28.00
N6:Ikot I	14.00	15.00	8.00	14.00	28.00	
N7:Itak	12.00	18.00	6.00	6.00	24.00	14.00
N8:Ukana	39.50	31.50	35.50	33.50	15.50	8.00
N9:Ikot E	48.00	40.00	44.00	42.00	24.00	10.00
N10:Uruk A	infinity	infinity	infinity	infinity	infinity	infinity

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	12.00	39.50	48.00	infinity
N2:Ikot E	18.00	31.50	40.00	infinity
N3:Itam	6.00	35.50	44.00	infinity
N4:Ikot M	6.00	33.50	42.00	infinity
N5:Abak	24.00	15.50	24.00	infinity
N6:Ikot I	14.00	8.00	10.00	infinity
N7:Itak		16.00	14.00	infinity
N8:Ukana	16.00		39.50	13.00
N9:Ikot E	14.00	39.50		10.00
N10:Uruk A	infinity	13.00	10.00	

Array S5

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	2	3
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		1	5	6
N4:Ikot M	1	1	1		5	6
N5:Abak	2	2	3	4		3
N6:Ikot I	3	2	3	4	3	
N7:Itak	3	2	3	4	4	3
N8:Ukana	5	5	5	5	5	6
N9:Ikot E	5	5	5	5	5	6
N10:Uruk A	1	2	3	4	5	6

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	3	5	5	10
N2:Ikot E	7	5	5	10
N3:Itam	7	5	5	10
N4:Ikot M	7	5	5	10
N5:Abak	4	8	9	10
N6:Ikot I	3	8	9	10
N7:Itak		8	9	10
N8:Ukana	7		5	10
N9:Ikot E	7	5		10
N10:Uruk A	7	8	9	

Iteration 6

Array D6

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	24.00	14.00
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		16.00	20.00	8.00
N4:Ikot M	10.00	18.00	16.00		18.00	14.00
N5:Abak	24.00	16.00	20.00	18.00		28.00
N6:Ikot I	14.00	15.00	8.00	14.00	28.00	
N7:Itak	12.00	18.00	6.00	6.00	24.00	14.00
N8:Ukana	22.00	23.00	16.00	22.00	15.50	8.00
N9:Ikot E	24.00	25.00	18.00	24.00	24.00	10.00
N10:Uruk A	infinity	infinity	infinity	infinity	infinity	infinity

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	12.00	22.00	24.00	infinity
N2:Ikot E	18.00	23.00	25.00	infinity
N3:Itam	6.00	16.00	18.00	infinity
N4:Ikot M	6.00	22.00	24.00	infinity
N5:Abak	24.00	15.50	24.00	infinity
N6:Ikot I	14.00	8.00	10.00	infinity
N7:Itak		16.00	14.00	infinity
N8:Ukana	16.00		18.00	13.00
N9:Ikot E	14.00	18.00		10.00
N10:Uruk A	infinity	13.00	10.00	

Array S6

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	2	3
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		1	5	6
N4:Ikot M	1	1	1		5	6
N5:Abak	2	2	3	4		3
N6:Ikot I	3	2	3	4	3	
N7:Itak	3	2	3	4	4	3
N8:Ukana	6	6	6	6	5	6
N9:Ikot E	6	6	6	6	5	6
N10:Uruk A	1	2	3	4	5	6

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	3	6	6	10
N2:Ikot E	7	6	6	10
N3:Itam	7	6	6	10
N4:Ikot M	7	6	6	10
N5:Abak	4	8	9	10
N6:Ikot I	3	8	9	10
N7:Itak		8	9	10
N8:Ukana	7		6	10
N9:Ikot E	7	6		10
N10:Uruk A	7	8	9	

Iteration 7

Array D7

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	24.00	14.00
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		12.00	20.00	8.00
N4:Ikot M	10.00	18.00	12.00		18.00	14.00
N5:Abak	24.00	16.00	20.00	18.00		28.00
N6:Ikot I	14.00	15.00	8.00	14.00	28.00	
N7:Itak	12.00	18.00	6.00	6.00	24.00	14.00
N8:Ukana	22.00	23.00	16.00	22.00	15.50	8.00
N9:Ikot E	24.00	25.00	18.00	20.00	24.00	10.00
N10:Uruk A	infinity	infinity	infinity	infinity	infinity	infinity

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	12.00	22.00	24.00	infinity
N2:Ikot E	18.00	23.00	25.00	infinity
N3:Itam	6.00	16.00	18.00	infinity
N4:Ikot M	6.00	22.00	20.00	infinity
N5:Abak	24.00	15.50	24.00	infinity
N6:Ikot I	14.00	8.00	10.00	infinity
N7:Itak		16.00	14.00	infinity
N8:Ukana	16.00		18.00	13.00
N9:Ikot E	14.00	18.00		10.00
N10:Uruk A	infinity	13.00	10.00	

Array S7

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	2	3
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		7	5	6
N4:Ikot M	1	1	7		5	6
N5:Abak	2	2	3	4		3
N6:Ikot I	3	2	3	4	3	
N7:Itak	3	2	3	4	4	3
N8:Ukana	6	6	6	6	5	6
N9:Ikot E	6	6	6	7	5	6
N10:Uruk A	1	2	3	4	5	6

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	3	6	6	10
N2:Ikot E	7	6	6	10
N3:Itam	7	6	6	10
N4:Ikot M	7	6	7	10
N5:Abak	4	8	9	10
N6:Ikot I	3	8	9	10
N7:Itak		8	9	10
N8:Ukana	7		6	10
N9:Ikot E	7	6		10
N10:Uruk A	7	8	9	

Iteration 8

Array D8

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	24.00	14.00
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		12.00	20.00	8.00
N4:Ikot M	10.00	18.00	12.00		18.00	14.00
N5:Abak	24.00	16.00	20.00	18.00		23.50
N6:Ikot I	14.00	15.00	8.00	14.00	23.50	
N7:Itak	12.00	18.00	6.00	6.00	24.00	14.00
N8:Ukana	22.00	23.00	16.00	22.00	15.50	8.00
N9:Ikot E	24.00	25.00	18.00	20.00	24.00	10.00
N10:Uruk A	35.00	36.00	29.00	35.00	28.50	21.00

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	12.00	22.00	24.00	35.00
N2:Ikot E	18.00	23.00	25.00	36.00
N3:Itam	6.00	16.00	18.00	29.00
N4:Ikot M	6.00	22.00	20.00	35.00
N5:Abak	24.00	15.50	24.00	28.50
N6:Ikot I	14.00	8.00	10.00	21.00
N7:Itak		16.00	14.00	29.00
N8:Ukana	16.00		18.00	13.00
N9:Ikot E	14.00	18.00		10.00
N10:Uruk A	29.00	13.00	10.00	

Array S8

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	2	3
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		7	5	6
N4:Ikot M	1	1	7		5	6
N5:Abak	2	2	3	4		8
N6:Ikot I	3	2	3	4	8	
N7:Itak	3	2	3	4	4	3
N8:Ukana	6	6	6	6	5	6
N9:Ikot E	6	6	6	7	5	6
N10:Uruk A	8	8	8	8	8	8

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	3	6	6	8
N2:Ikot E	7	6	6	8
N3:Itam	7	6	6	8
N4:Ikot M	7	6	7	8
N5:Abak	4	8	9	8
N6:Ikot I	3	8	9	8
N7:Itak		8	9	8
N8:Ukana	7		6	10
N9:Ikot E	7	6		10
N10:Uruk A	8	8	9	

Iteration 9

Array D9

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	24.00	14.00
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		12.00	20.00	8.00
N4:Ikot M	10.00	18.00	12.00		18.00	14.00
N5:Abak	24.00	16.00	20.00	18.00		23.50
N6:Ikot I	14.00	15.00	8.00	14.00	23.50	
N7:Itak	12.00	18.00	6.00	6.00	24.00	14.00
N8:Ukana	22.00	23.00	16.00	22.00	15.50	8.00
N9:Ikot E	24.00	25.00	18.00	20.00	24.00	10.00
N10:Uruk A	34.00	35.00	28.00	30.00	28.50	20.00

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	12.00	22.00	24.00	34.00
N2:Ikot E	18.00	23.00	25.00	35.00
N3:Itam	6.00	16.00	18.00	28.00
N4:Ikot M	6.00	22.00	20.00	30.00
N5:Abak	24.00	15.50	24.00	28.50
N6:Ikot I	14.00	8.00	10.00	20.00
N7:Itak		16.00	14.00	24.00
N8:Ukana	16.00		18.00	13.00
N9:Ikot E	14.00	18.00		10.00
N10:Uruk A	24.00	13.00	10.00	

Array S9

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	2	3
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		7	5	6
N4:Ikot M	1	1	7		5	6
N5:Abak	2	2	3	4		8
N6:Ikot I	3	2	3	4	8	
N7:Itak	3	2	3	4	4	3
N8:Ukana	6	6	6	6	5	6
N9:Ikot E	6	6	6	7	5	6
N10:Uruk A	9	9	9	9	8	9

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	3	6	6	9
N2:Ikot E	7	6	6	9
N3:Itam	7	6	6	9
N4:Ikot M	7	6	7	9
N5:Abak	4	8	9	8
N6:Ikot I	3	8	9	9
N7:Itak		8	9	9
N8:Ukana	7		6	10
N9:Ikot E	7	6		10
N10:Uruk A	9	8	9	

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Iteration 10

Array D10

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		8.00	6.00	10.00	24.00	14.00
N2:Ikot E	8.00		14.00	18.00	16.00	15.00
N3:Itam	6.00	14.00		12.00	20.00	8.00
N4:Ikot M	10.00	18.00	12.00		18.00	14.00
N5:Abak	24.00	16.00	20.00	18.00		23.50
N6:Ikot I	14.00	15.00	8.00	14.00	23.50	
N7:Itak	12.00	18.00	6.00	6.00	24.00	14.00
N8:Ukana	22.00	23.00	16.00	22.00	15.50	8.00
N9:Ikot E	24.00	25.00	18.00	20.00	24.00	10.00
N10:Uruk A	34.00	35.00	28.00	30.00	28.50	20.00

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	12.00	22.00	24.00	34.00
N2:Ikot E	18.00	23.00	25.00	35.00
N3:Itam	6.00	16.00	18.00	28.00
N4:Ikot M	6.00	22.00	20.00	30.00
N5:Abak	24.00	15.50	24.00	28.50
N6:Ikot I	14.00	8.00	10.00	20.00
N7:Itak		16.00	14.00	24.00
N8:Ukana	16.00		18.00	13.00
N9:Ikot E	14.00	18.00		10.00
N10:Uruk A	24.00	13.00	10.00	

Array S10

	N1:Uyo	N2:Ikot E	N3:Itam	N4:Ikot M	N5:Abak	N6:Ikot I
N1:Uyo		2	3	4	2	3
N2:Ikot E	1		1	1	5	6
N3:Itam	1	1		7	5	6
N4:Ikot M	1	1	7		5	6
N5:Abak	2	2	3	4		8
N6:Ikot I	3	2	3	4	8	
N7:Itak	3	2	3	4	4	3
N8:Ukana	6	6	6	6	5	6
N9:Ikot E	6	6	6	7	5	6
N10:Uruk A	9	9	9	9	8	9

	N7:Itak	N8:Ukana	N9:Ikot E	N10:Uruk A
N1:Uyo	3	6	6	9
N2:Ikot E	7	6	6	9
N3:Itam	7	6	6	9
N4:Ikot M	7	6	7	9
N5:Abak	4	8	9	8
N6:Ikot I	3	8	9	9
N7:Itak		8	9	9
N8:Ukana	7		6	10
N9:Ikot E	7	6		10
N10:Uruk A	9	8	9	

SHORTEST ROUTES -- FLOYD'S OUTPUT SUMMARY

Title: TRAVELING SALESMAN

From	To	Distance	Route
1-Uyo	10-Uruk A	34.00	1- 3- 6- 9- 10

9. DISCUSSION OF RESULT

The analysis shows that $f_t(i) = 34km,$ is the shortest route from town 1 (Uyo) to town 10 (Uruk Akpan). From town 1 (Uyo) to town 3 (Itam) shows the shortest route from town 3 (Itam) to town 10 (Uruk Akpan). Checking back to the $f_2(3)$ calculations, it was observed that the shortest route from town 3 (Uyo) to town 10 (Uruk Akpan) is $3 - 6 - 9 - 10.$ Translating the numerical labels into real towns, we realize that the shortest route from Uyo to Uruk-Akpan passes through Uyo, Itam, Ikot Ikpe, Ikot Ekpene and Uruk-Akpan. Comparing the two models, that is, dynamic programming model and algorithm model, we will find out that the two models gave the same result of route distance from the origin node (i) Uyo to the destination node (j) Uruk-Akpan through node 1- 3- 6- 9- 10, i.e. $f_t(i) = 34\ kilometers.$

10. CONCLUSION

The objective of this field work of a Travelling Salesman Routing Models or Problems is to understand how the salesman will achieve his target of visiting every customer to distribute his product at a minimal distance and minimal cost, especially in real-life contexts. However, people are often interested in how to tackle the optimization of vehicles visiting the complete set of towns in everyday itineraries to achieve their objective at a minimal cost and distance. From the study, the analysis shows that $f_t(i) = 34km,$ and the shortest route from town 1 (Uyo) to town 10 (Uruk Akpan) runs from town 1 (Uyo) to town 3 (Itam) and then follows the shortest route from town 3 (Itam) to town 10 (Uruk Akpan). From the analysis, we will observe that the shortest route from town 1 (Uyo) to town 10 (Uruk Akpan) is 1 - $3 - 6 - 9 - 10.$ Translating the numerical labels into real towns, we realize that the shortest route from Uyo to Uruk-Akpan passes through Uyo, Item, Ikot Ikpe, Ikot Ekpene and Uruk-Akpan has a length of $34\ kilometers.$ Indeed, the Travelling Salesman Routing Problem or Model does not imply special difficulties for modeling and tackling of problems. Hence, many real-life problems fit within the framework we have defined, seeing the need for more realistic models and seeing the modern computing abilities and the efficient algorithmic solutions. There is the need for still more realistic models. This study has considered the case of a network in a state in nig, using a dynamic programming approach. Our suggestion is that the approach used can be extended to solve similar problem in most parts of a developing countries with limited interconnected road network. It is thus hoped that this survey will be helpful for the purpose of travelling salesman in distribution and logistics actualization and for the design of new efficient solution procedures for transportation models.

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