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ABSTRACT

In applied mathematics literature, "Combinatorial Optimization" is a topic that consists of finding an optimal object from a finite set of objects. VRP meaning, vehicle routing problem combined with TSP, or traveling salesman problem, and MSP minimum spanning tree problems are some of the examples of Combinatorial Optimization topics. This topic further complicates while vehicle route and terminal junctions are assigned with certain constraints.

The paper also contains an example concerning the mathematical model of a routed ship engine carrying crude/refined oil vessel ship from a reservoir port to download at several destination petroleum refinery port reservoirs, and the ship operation schedule is based on the multistage decision-making process. The Indian oil petroleum refinery processors use the petrochemical solutions carried with the proper vessel ship shuttles from abroad crude petroleum exploring oil wells, uploaded at abroad seaport oil reservoir, and dispatched to Indian refinery locality seaports within definite sea routes periodically, in time inventory schedules.

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In applied mathematics literature, "Combinatorial Optimization" is a topic that consists of finding an optimal object from a finite set of objects. VRP meaning, vehicle routing problem combined with TSP, or traveling salesman problem, and MSP minimum spanning tree problems are some of the examples of Combinatorial Optimization topics. This topic further complicates while vehicle route and terminal junctions are assigned with certain constraints.

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The routed ship carried crude/refined oil vessel download at several Indian Seaport is compared to a multistage decision-making model for uniform distribution of energy resource solutions considering the operational resource material needs. The algorithm for solving the problem is a specific combinatorial optimization problem-solving technique, which is focused on the paper.

Keywords: combinatorial optimization, vehicle routing problem, multi-stage decision-making.

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I. INTRODUCTION

More or less the specific Operational resource problems namely Assignment problem, shunt closure problem, constraint satisfaction problem [1], cutting stock problem[1], technician scheduling problem, travelling salesman problem [1], vehicle rescheduling problem [1], vehicle routing problem and security protection combined problems [2] are indirectly solving by the renewable energy serving agencies while they are procuring the energy resource material.

1.1 Genetic Algorithm for ship Routing and scheduling problem with time window

TSP and VRPTW are examples of genetic algorithms. The TSP or traveling salesman problem (may be TSP meaning Transit signal process) based on a salesman who must visit n clients and return to the initial place of departure. The objective is to visit all clients without passing the ones previously visited. The VRPTW or vehicle routing problem with the time window (or may be Virtual record process time window), is a generalization of TSP where the clients request either delivery or pickup of a cargo amount. The VRP differs from TSP is the fact that more than one vehicle is needed to deliver the cargoes with the associated costs. Linear shipping, marine inventory routing and optimal speed, are some of the constraints to the virtual record process time window for a Transit signal process. However, (I) capital depreciation costs relating to the loss of a ship cargo's market value with respect to initial investment, (II) costs for ship and cargo maintenance, insurance, crew salaries (III) day-to-day operation costs such as fuel consumption, port and customs expense, tolls paid at canals etc. are the constraints to Vehicle routing Problem and Travelling salesman problem.

The Vehicle Routing problem can be assumed as Vessel fleet routing through sea routes to the seaports of petroleum crude/refined petrochemical storage locality. The combinatorial problem "What is the optimal set of routes for a fleet of vehicles to traverse in order to deliver cargo to a given set of customers?" is a research topic. By the way, the problem generalizes travelling salesman problem. One of the objectives of the VRP is to minimize the total route cost.

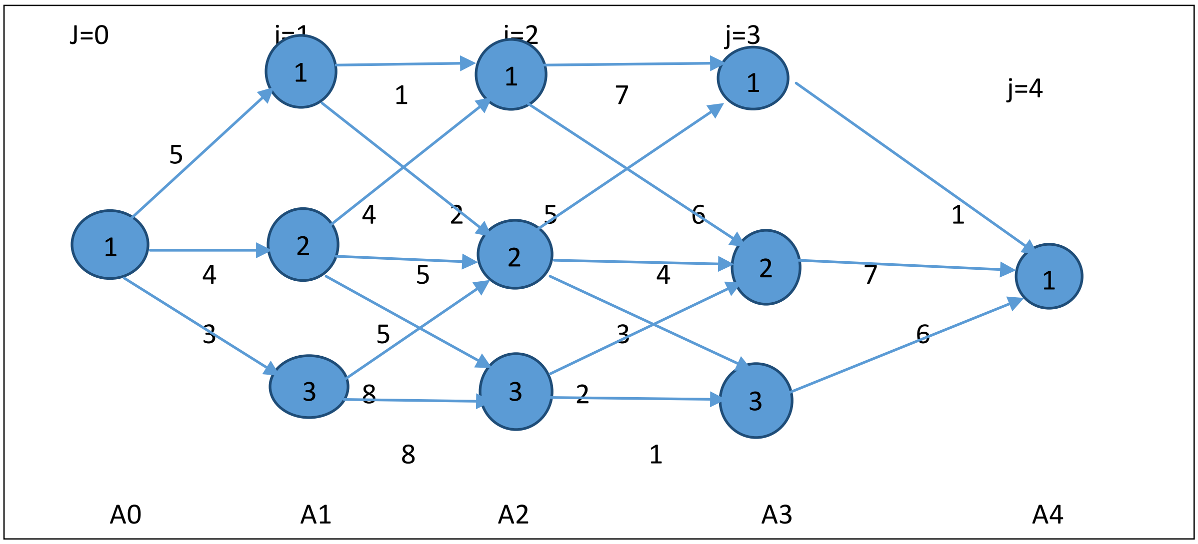
The network supports vessel routing can be represented paths from the vertex A_0 to the vertex A_n along directed arcs joining the effective vertices in the intermediary stages representing indexes $j = 1, 2, \ldots, (n-1)$. Each intermediary stage has at most $n-2$ states or vertices. Thus the vehicle routes through the vertices in the n stages. For convenience, we denote subscript j is the index of node vertices and edge arcs. The initial stage $j = 0$ is attached to stage $j = 1$ which has $n-2$ states of vertices and sequentially connects the final stage $j = n$ with arc links.

On each move the vessel routes from stage j to stage $j+1$. In the way vessel passes any one vertex in stage j to one vertex in stage $j+1$. The possible alternative paths from one stage to the next stage are decided by comparing the arc variable values w_j.

The assignment problem is one of the combinatorial optimization problems. In reference to the VehicleRouting problem the route set assignments can be modified for assigning a number of fleets to specific seaports routes and it is similar to the assigning number of tasks to a number of agents. If the number of seaports equal to the number of fleet vessels, any sea port storage facility is greater or equal to contained material of fleet vessels, the concerned seaport can be assigned to specific fleet vessels. Assignment cost optimality is decided with the application of Hungarian algorithm [3].

II. MULTISTAGE LEAST COST PATH DETERMINING MODEL

The Petrochemical oil refinery seaports in India are Koyali, Mumbai, Mangalore, Kochi, Chennai, Tatipaka, Vizag, Paradip, and Haldia. These port authorities and oil companies (list is enclosed in the Appendix -B) import crude or refined petroleum through fleet vessels transport systems. The second routing problem consists with the container train assignment from seaports to distant refineries in India. The list of refinery companies and location map location name refinery capacity are mentioned in the web. But this list does not contain all the planned petrochemical storage locations in India.



The seaport authority India planned to establish a refined oil storage at seaport Dhamara location 60km east to Paradip. In the above network graph we assume the nodes represent the formal location of the seaports. The arcs are transition paths connecting node to node. The number levels to arc consists of costs in lakhs. The problem is to select a sequence of nodes in such a way that minimize the costs

There are nine seaports in India having facilities for Crude/refined petroleum storage. The above graph has five stages of nodes. Excluding the starting node the remaining nodes represent more than one seaport for material transactions. From the graph w_4 is the variable weight assigned to stage four or A4 and can have numeric values $w_4 = 1$ or 7 or 6. Then the prior nodes are $x_3 = 1$, 2 or 3.

$$Thus\ F_4(x_4) = F_4(1) = \left[1 + F_3(1),\ 7 + F_3(2),\ 6 + F_3(3)\right]\ ;\ = [w_4 + F_3(x_3)]$$

Where $F_3(x_3)$ has three possible options, $F_3(1)$, $F_3(2)$ and $F_3(3)$, depending on the values of w_4. Moreover, $F_3(1) = [7 + F_2(1),\ 5 + F_2(2)]$

$$F_3(2) = [6 + F_2(1),\ 4 + F_2(2),\ 2 + F_2(3)]$$

$$F_3(3) = [3 + F_2(2),\ 1 + F_2(3)]$$

The above expressions can be written in the form $F_3(x_3) = [w_3 + F_2(x_2)]$

The three values of $F_3(x_3)$ are calculated with possible values of w_3 and possible values of $F_2(x_2)$ depending on w_3.

In a similar manner particular values of $F_2(1)$, $F_2(2)$, $F_2(3)$ can be calculated with the following relations.

$$F_2(1) = [1 + F_1(1),\ 4 + F_1(2)]$$

$$F_2(2) = [2 + F_1(1),\ 5 + F_1(2),\ 8 + F_1(3)]$$

$$F_2(3) = [5 + F_1(2),\ 8 + F_1(3)]$$

In general form, the expressions can be written as $F_2(x_2) = [w_2 + F_1(x_1)]$.

Finally $F_1(1)=5,\ F_1(2)=4,\ F_1(3)=3$; in general $F_1(x_1)=\ w_1$ and derived with the general recursion formula

$$F_j\left(x_j\right) = [w_j + F_{j-1}\left(x_j - 1\right)] \text{ for } j = 4, 3,\ 2 \text{ with } F_1(x_1) = w_1$$

This can be summarized to determine $F_4(x_4)$ recursively as follows

$$F_1(1)=5,\ F_1(2)=4,\ F_1(3)=3$$

$$F_2(1)=(6,\ 8)=6\ ,\ F_2(2)=(7,\ 9,\ 11)=7 \text{ and } F_2(3)=(9,\ 11)\ =9$$

$$F_3(1)=(13,\ \ 12)=12\ ,\ F_3(2)=(12,\ 11,\ 13)=11\ \ ,\ F_3(3)=(10,\ 10)=10$$

$F_4(1)=(13,\ 18,\ 16)=13.$ Which is the least cost path.

The significant feature of the procedure is that once the minimum $F_j\left(x_j\right)$ for a particular value of x_j or a particular value of jth stage is computed, in subsequent computations of paths to x_{j+1} through the value of x_j, only the minimum path to it is already computed and needs to be taken into consideration. Other alternative paths to x_j may be ignored. This is similar to Bellman's principles of optimality [4].

The principles essentially state that in a multistage process without feedback, whatever the previous states and decisions are, The subsequent decisions must form the optimal policy with respect to the current state. A Process without feedback means subsequent decisions do not affect the states arising from decisions previously taken.

III. CONCLUSION

The import costs mentioned in the form of network arc levels are tentative and not actual costs. The actual costs are available to the refinery companies, seaport authority and oil importing companies. The statements made in the multistage least cost path determining model is synthesized in the form of graph network and algebraic form of solvation process. If the graph is more complicated with the larger number of vertices and arcs, a geometrical representation is hardly convenient and a numerical approach with computer application software can solve the new-port inclusion problem. By the way a new port in the form of a vertex and connective route cost in the form of arc labels are included in the array. Therefore the data in the tabular version of the problem description and problem solving procedure, which involves purely numerical computation starting and iterating tables are needed. Some of the examples such as transit node and arc value, state transformations, recursive operation pre and post operation numeric representation are also found in the standard Operations Research book. The tabular numerical data description is also useful for writing Computer programs for solving the Combinatorial Optimization and refinery operations resource problem.

International newspapers and Electronic media informs Indian Petrochemical refinery located at Indian seaports collect petroleum filled vessels from Kuwait, Oman, and Saudi Arab through the India western sea route and the ship engine fitted petroleum filled vessels reach at Indian seaports from western coast to South Indian coast and South Indian coast to East Indian coast, within a definite time period. The receiver seaport authority maintains Indian custom duty and alerts shipyard for downloading the petroleum, diesel and Kerosene oils within a definite time. The ship's sea route schedule is found from Merchant navy India web site to the registered petrochemical trader ships that are built under the Registrar shipyard supervision or Indian seaport authority.

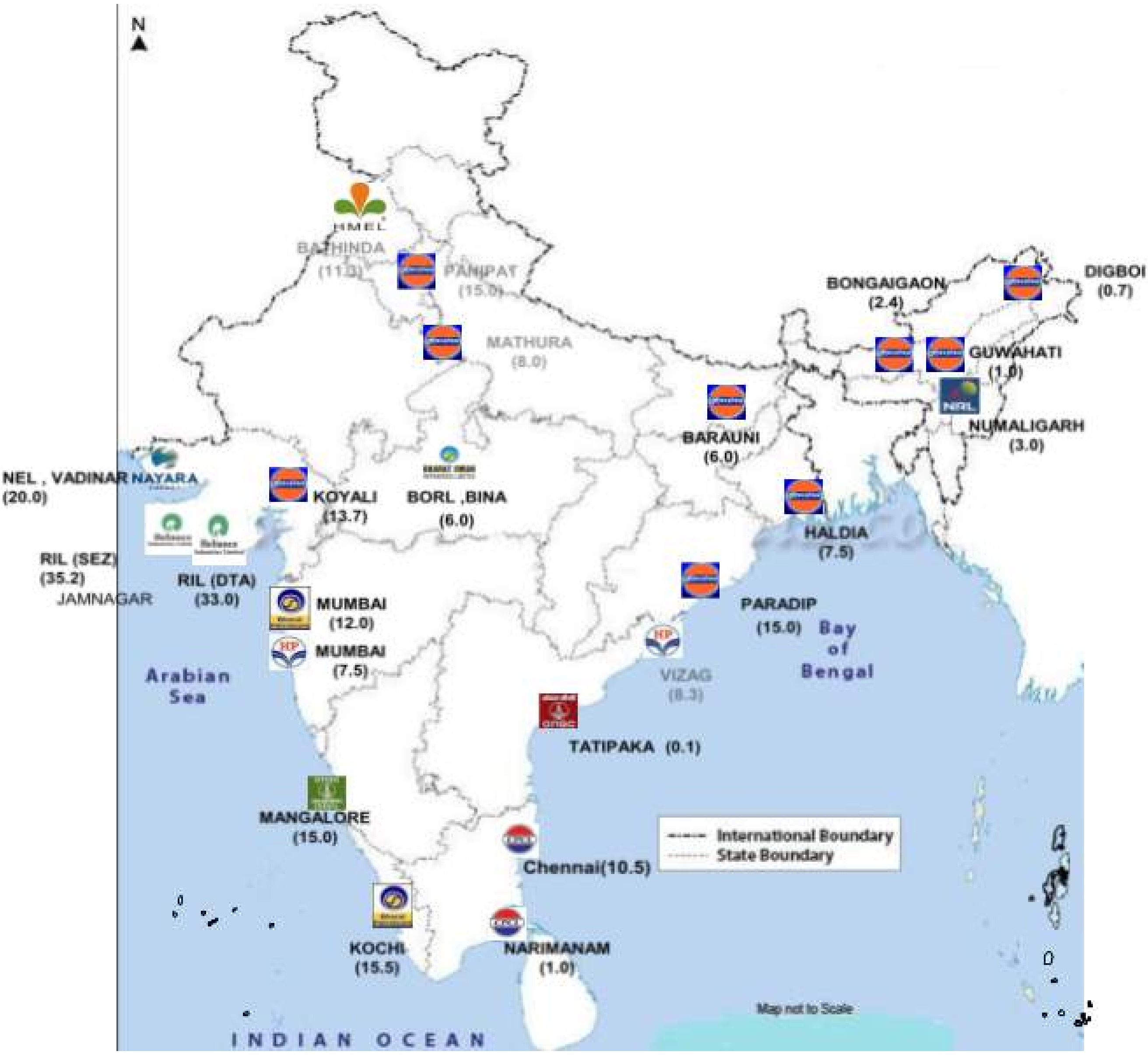
Mineral oil traders with Indian Government makes Legislation regulating Auto-Fuel trader's license and it is used to import refined mineral oil and it is an agreement between refinery oil merchant, oil seller and buyer industry to utilize the oil for healthcare industry product production.

The mineral oil trader license scaling process is a list of actions usually practiced in oil refill procedures for an unmanned gas station server pump task actuation logistic analytic. When a buyer refills fuels at an unmanned fuel station certain mechanical tasks operations such as holding pump gasket nozzles before, during and after refill at a fuel container engine tanker closed lid open and shut are performed. Container gas measure procedure such as the gas pressure pipe stretching jet nozzle on/off actuation after receipt signal from the electronic device, computing quantity force pressure to be put at pump end edges and cost price billing is also printed after fill the oil into the engine tanker. If the fuel is liquid, and one end of the pump fitted pipe is subjected to the engine tanker open lid, the pipe's other end is merged to the reservoir, and another pipe is fitted to the reservoir tanker for air pressure actuation and balancing. The mathematical fuzzy measure is the volume of oil transformed from a reservoir tanker layer transported into the engine oil tank through the pipe internal space. Either the volumetric difference in oil reservoir tanker, or the oil inflow and outflow at pipe end jet pressure or the engine oil tank filled space volume quantity is to be computed for bill purpose. But an easier way of oil measure is inner pipe space measure and multiplied with quantity time oil transported through the pipe at a normal air temperature and oil bottom layer pressure.

If the fuel is compressed gas, the mass of the gas is computed for receipt bill documentation,

Appendix A displays the map of petroleum refineries in India and Appendix B mentions the list of Petroleum refinery companies operating in India.

Appendix-A


N
HMEL
BATHINDA
(11.3)
PANIPAT
(15.0)
MATHURA
(8.0)
BONGAIGAON
(2.4)
DIGBOI
(0.7)
GUWAHATI
(1.0)
NUMALIGARH
(3.0)
BARAUNI
(6.0)
NEL , VADINAR NAYARA
(20.0)
KOYALI
(13.7)
BORL ,BINA
(6.0)
HALDIA
(7.5)
RIL (SEZ)
(35.2)
JAMNAGAR
RIL (DTA)
(33.0)
MUMBAI
(12.0)
MUMBAI
(7.5)
PARADIP
(15.0)
Bay of Bengal
Arabian Sea
VIZAG
(8.3)
TATIPAKA (0.1)
MANGALORE
(15.0)
International Boundary
State Boundary
Chennai(10.5)
KOCHI
(15.5)
NARIMANAM
(1.0)
Map not to Scale
INDIAN OCEAN

S. No.	NAME OF THE OIL COMPANY	STATE	LOCATION OF REFINERY	CAPACITY (MMTPA)
1	INDIAN OIL CORPORATION LIMITED (IOCL)	BIHAR	BARAUNI	6.0
2		GUJARAT	KOYALI	13.7
3		WEST BENGAL	HALDIA	7.5
4		UTTAR PRADESH	MATHURA	8.0
5		HARYANA	PANIPAT	15.0
6		ASSAM	GUWAHATI	1.0
7		ASSAM	DIGBOI	0.7
8		ASSAM	BONGAIGAON	2.4
9		ODISHA	PARADIP	15.0
		IOCL TOTAL		**69.2**
10	USTAN PETROLEUM CORPORATION LIMITED (HPCL)	MAHARASTRA	MUMBAI	7.5
11		ANDHRA PRADESH	VISAKH	8.3
12	HPCL-HINDUSTAN MITTAL ENERGY LIMITED (HMEL) (JV)	PUNJAB	BATHINDA	11.3
		HPCL-TOTAL		**27.1**
13	BHARAT PETROLEUM CORPORATION LIMITED (BPCL)	MAHARASTRA	MUMBAI	12.0
14		KERALA	KOCHI	15.5
15	BPCL-BHARAT OMAN REFINERIES LIMITED (BORL) (JV)	MADHYA PRADESH	BINA	6.0
		BPCL-TOTAL		33.5
16	CHENNAI PETROLEUM CORPORATION LIMITED (CPCL)	TAMIL NADU	MANALI	10.5
17		TAMIL NADU	CAUVERY BASIN	1.0
		CPCL-TOTAL		11.5
18	NUMALIGARH REFINERIES LIMITED (NRL)	ASSAM	NUMALIGARH	3.0
19	OIL & NATURAL GAS CORPORATION LIMITED (ONGC)	ANDHRA PRADESH	TATIPAKA	0.1
20	ONGC-MANGALORE REFINERIES & PETROCHEMICALS LIMITED (MRPL)	KARNATAKA	MANGALORE	15.0
		ONGC TOTAL		15.1
		PSU/ JV Total		159.4
21	RELIANCE INDUSTRIES LIMITED (RIL)	GUJARAT	JAMNAGAR (DTA)	33.0
22		GUJARAT	JAMNAGAR (SEZ)	35.2
23	NAYARA ENERGY LIMITED (NEL)	GUJARAT	VADINAR	20.0
		PVT Total		88.2
ALL INDIA				247.6

Appendix-B

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