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VEHICLE ROUTING PROBLEM CONSIDERING GREEN CRITERIA

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Abstract- **The vehicle routing problem is a critical issue as it relates to the cost of transport, vehicleemissions, trafficcongestions.This paper addresses the issues related to green criteria as environment sustainability has become the need of the houroptimization of cost, and green criteria are taken as objectives in the paper. Multi-objective formulation is done, and a suitable metaheuristic is applied to solve the problem.**

Keywords:- VRP, greencriteria, traffic, heuristic

I. INTRODUCTION

The distribution effectiveness of remanufactured products becomes a critical focal point as the selling price is lesser (Ferrer &Swaminathan 2010) than the original price. Minimization of cost &management of vehicle route is a very important step to make remanufactured products cost-effective. A vehicle routing problem (VRP) is projected with a view of dispensing the products. Newonce & remanufactured products at the same time in different marketingplaces, taking into account the minimization of emitted pollution limits.

The model alsoviews that the end spots are the customer destinations for new and remanufactured products & returned productsassortmentcenters.Some of the factors like statutory regulation, traffic condition, timesense, fuelcosts, greensustainability factors make the decision-making process complex for reducing the transportation cost. Thus, VRP is categorized as NP-Hard problems (Lenstra and Kan 1981) and needs sound knowledge of mathematicsfor solving.

Secondhand products and residuals of a primary product are treated as essentialsupply sources for remanufacturing/repair activity. The efficient remanufacturing activityhas numerousgains for the people who use/manufacture and increase of consumption cycle of the product in use,like a reduction of the cost of the raw materials, low manpower cost and discardingadvantages.Many organaisationsare moving towards multiple layers of recycling and remanufacturing/repairing of the products for better utilization as the natural resources are turning into scarce.This necessitates todiscovernew way outs for best pickup and dispatch ofall types of products during vehicle routing problems.

Effective VRP is possible for remanufactured products only when green sustainability activities such as vehicular emissions, fuel economy etc are considered, (Michaud and Llerena 2011). (Kara et al. 2007) mentioned minimizationof the fuel consumption is one of the social responsibilities. The lack of pollution containment issuesin the green logistics is absent inanalysisof studies conducted on vrpofBraekers et al.2016 ,Montoya-Torres et al. 2015.

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Static versus Dynamic Vehicle Routing

The traditional vehicle static routing issues are differentfrom dynamic vehicle routing as per Psaraftis [36], [37]
a) Timefactor isindispensable. The time schedule is not anessential factor in the static vehicle routing problem. In dynamic routing, itis a must.
b) Theprocess may beopen-ended. Theroutes begin and stop at the depot.The static routing is time bounded and close in nature.Dynamic vehicle routing,the timing may be unbounded.
c)Future information may not be precise or not known in advance in the dynamic routing problem, the upcomingevent isnever known with accuracy, whereas in static routing case, it is contrary.
d) Near-term significant events, an event has the same priority as the other event in a static routing problem. In dynamic routing near term, events carry priority over future events
e)Information update mechanisms areessential. Information renews mechanisms are pertinentin the dynamic context. Immaterialwithin a static context.
f) reassigning decisioncommon.In dynamic situations, new requirements arise; hence assignment decisions have to be reviewed and

II. DIFFERENT OBJECTIVE FUNCTION

*Time constraints may be different.*Time constraints like pickup times tend to be adaptive in a dynamic routing problem
*3.vehicle fleet size changes***.**in dynamicscheduling, timelyavailability of backup vehicle is minimum
*Considerations ofqueuing***.** The algorithms produce meaningless results whenthe customer demand rate goes over a certain thresholdlimit. The algorithms will become crammed Psaraftis [37] also proposes terminology used for attributes to be used for the vrp.
4.Evolution of information. The timing and customer information will unfold as time progress in dynamic settings

- informationquality. Inputs could beeither;
- (1) deterministic, 2) uncertainty (forecasts) or3) (probabilistic).
- Availability of information. Information sharing with the advent of technology instant/remote etc.
- Information Processing. The central unit collects information and processes it ina *centralized* system. A distributed system does the information collection and processing in decentralization.

A model is dynamic if it explicitly incorporates the interaction of activities over time. Here one should distinguish between deterministic dynamic models and stochastic models.
Vehicles are designed for a certain capacity,but always they are specified to operate at a load lesser than designed. Hence it is prudent to operate a little bit higher than the specified load.At the same time, we should not operate at much lower than the specified load as it is not economical. Such over and under load limits can be called fuzzy limits specified and follow the triangular membership function.The objective of the paper is on the distribution and delivery of new &remanufactured products along with picking up used products

III. LITERATUREREVIEW

Dantzig and Ramser dealtthe truck dispatching problem to minimize the distances traveled (1959). Clarke and Wright (1964) applied first time a linear optimization problem for vrpproblem.Malandraki and Daskin (1992) addressed vrp models, which considered step speed within time windows.
Bektas (2006) considered the multiple traveling salesman problem (TSP), Hashimotoet al. (2010), Kok et al. (2012), Kritzinger et al. (2012) were instrumental in contributing in solving to the routing problems with time windows . Soler et al. (2009) reviewed time- dependent VRP with precisionSbihi and Eglese (2007), Pokharel and Mutha (2009), and Govindan et al. (2015) reviewsdealt on the soft &hard windows, the effect of traffic congestion in VRP.
Bektaş and Laporte (2011) described the idea of pollution-path problem considering factors such as vehicle load, speed andcost. Xiao et al. (2012) conducted a research on minimizing cost of vehicles and improving the efficiency of the GVRP issues. Cruz et al. (2012) solvedVRP pickup and delivery issues through heuristic algorithmco2 emission were included in the a study conducted by Jabir et al (2015), KazemianandAref (2015) projected a green view on capacitated time-dependent VRP with timewindows. Technology is progressing very fast. Semiconductors are playing a vital role in the technology. Semiconductors, electronic components are manufactured throughout the globe. Supply chain of these items shall be optimized to minimize the cost. Madankumar and Rajendran (2016) suggested a case of VRP in this field.Xiao and Konak (2016) studied the

GVRP with time scheduling. the greenhouse gases expelled fromvehicles causing enormous harm to the environment.

Vrp problems focus on minimizing these effluents in green logistics.mixed integer linear programming methods were applied in solving these issues.Cherkesly et al. (2016) Ting et al. (2017introduced models using the multi-stack approach and models for the delivery andpickup VRP with time windows. Turkensteen and Hasle (2017) studied carbon releases effect on trucks. The study disclosed that savings on account of reduction in flue discharges areconsiderable when small automobiles are set for delivery and pickup locations that are somewhatin distance from each other. Alvarez and Munari (2017)formulated arouting model with time windows and many deliverymen and solved with a branch-price-and-cut algorithm.

Finally, Toro et al. (2017) formulated a model for capacitated locationroutingproblem including environmentaleffectof the distribution system of vehicles.Based on a bi-objective MILP, authors argue thatdeployment of addedvehicles reasonably yields greater fuel reductions in the long run, and thus lowering fuel emission volumes a bi-objective MILP.

The literature review has a given lot of insight on VRP. VRP hasaddressed to embrace the sustainability issues on costs,the environmental implications of transportation & logistics activities (Lin et al.,2014). The possibility theory suggested by Dubois and Prade in 1988 has become relavant in decision making fieldsPossibilistic Linear Programming (PLP) problem is a linear programming with vague coefficients limited by possibilistic distribution. The possibilistic linear programming pioneered by Negoita et al. [14]

IV. PROBLEM

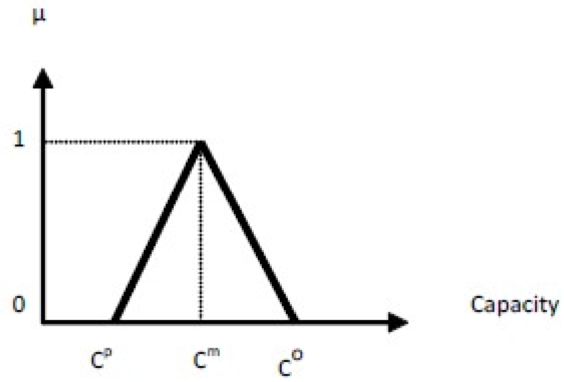
4.1 formulation ofa problem

Thecenterdistributes the new products and gathers the damaged products from the market to repair/remanufacture. Later again, the new products and repaired products are delivered to the market.

The assumptions

- The vehicles shouldcome back to the depot where they start once goods delivered
- The customer demand and flow for the new and remanufactured goods are decided and related together with a positive association.
- One visit of a vehicle Satisfies the demand of each customer &multiple sourcing not required.
- Double experts are considered Traveling to increase payments and decrease the possibility of accidents and time-saving.
- Traffic time consideredis a uniformly distributed random variable. Violation of time window causesan increase inperishability
- demands of Customer change in different seasons and has exponential distribution the model deals a multi-depot and multi-product situation

There are two types of production with preset spoilage possibility which can be decreased by using better transportvehicles



Indices

I Product $(1 \le i \le I)$

D Centre$(1 \le d \le D)$

c,cDemand points $(1 \le c \le C)$

v Vehicle $(1 \le v \le V)$

$(capa\_a_{id}^{dist-s}, capa\_m_{id}^{dist-s}, capa\_m_{id}^{dist-s})$ distribution center supply product capacities fuzzy values

$(capa\_a_{id}^{dist-r}, capa\_m_{id}^{dist-r}, capa\_b_{id}^{dist-r})$ distribution center capacity returned products capacity

$(capa_{a_v^{veh}}, capa_{m_v^{veh}} capa\_b_v^{veh},) =$ **fuzzy vehicle capacity**

$cost_v^{veh}$ vehicle v cost

$cost_d^{dist}$ distribution center d setup cost

$deli_{ic}$ Deliverd quantity of product i to point c

$pick_{ic}$ The collected product i(returned) from point c

fu_vspcific fuel consumption rate of vehiclev

$cost^{fuel}$unit fue lcost

)the rate green house gas emissions per each unit of fuel

$biggm \sim \infty$ **largenumber**

ψ= satisfation level

$Wag_{cc'}$ = wage payment per unit distancefrom center c to c’

Variables

$$X_d^{dist} \begin{cases} 1 & \text{Ifdistributioncenterdexists} \\ 0 & \text{else} \end{cases}$$

$$X_v^{veh} \begin{cases} 1 & \text{Ifvvehicletravels} \\ 0 & \text{else} \end{cases}$$

$$X_{vcc} \begin{cases} 1 & \text{Ifvehiclevtravelsfromdemandpointctodemandpoint} \quad c \\ 0 & \text{else} \end{cases}$$

$$\beta_{vd} \begin{cases} 1 & \text{Ifvehicle v isassignedtodistributioncenterd} \\ 0 & \text{else} \end{cases}$$

αi_{ivc}^{del} Integer $\mathbf{Thenumberofproductsiinvehiclevdeliverabletodemandpoints}$ $\mathbf{theservicingtothedemandpointc}$

αi_{ivc}^{pic} Integer $\mathbf{Theno.ofproductsiinvehiclevcollectedfromdemandpointsafter}$ $\mathbf{servicingdemandpointc}$

Objective function

$$\mathbf{minimize}\ Z^1 = \xi \times \left(\sum\nolimits_{v,\hat{c}>1,c} f_v \times dis_{\hat{c}c}^{cus} \times X_{v\hat{c}c} + \sum\nolimits_{v,c>1,d} f_v \times (X_{v1c} + X_{vc1}) \times dis_{dc} + \beta_{vd}\right) \quad (1)$$

The first goal, minimization of the greenhouse gas discharged by fuel consumption reduction

$$\mathbf{minimise}\ Z^2 = Cost^{fuel} \times \left(\sum\nolimits_{v,\hat{c}>1,c} f_v \times dist_{\hat{c}c}^{cus} \times X_{v\hat{c}c} + \sum\nolimits_{v,c>1,d} f_v \times (X_{v1c} + X_{vc1}) \times dist_{dc} \times \beta_{vd}\right) + \sum\nolimits_d cost_d^{dist} \times X_d^{dist} + \sum\nolimits_v cost_v^{veh} \times X_v^{veh} + \sum\nolimits_{c\acute{c}} dist_{\hat{c}c}^{cus} \times Wag\,c\,\hat{c} * X_{v\hat{c}c}$$
(2)

The second aim, minimization the fuel cost, set up cost of distribution centers and the cost of the vehicles

constraints

$$\sum_{v,c} \alpha i_{ivc}^{del} \times \beta_{vd} \leq capa_{id}^{dist-s} \forall i,d \qquad (3)$$

$$capa_{id}^{dist-s} \leq (capa_{a}{}_{id}^{dist-s} + capa_{m}{}_{id}^{dist-s}) * \frac{1}{2} * \psi + (1-\psi) * (capa_{b}{}_{id}^{dist-s} + capa_{m}{}_{id}^{dist-s}) * 1/2 \qquad \forall i,d \qquad (4)$$

Capacity of distribution center shall match with the vehicle capacity for the product I to be delivered in vehicles

$$\sum_{v,c} \alpha i_{ivc}^{pic} \times \beta_{vd} \leq capa_{id}^{dist-r} \qquad \forall i,d \qquad (5)$$

$$capa_{id}^{dist-r} = (capa\_a_{id}^{dist-r} + capa\_m_{id}^{dist-r}) * \frac{1}{2} * \psi + (1-\psi) * (capa_{b}{}_{id}^{dist-r} + capa_{m}{}_{id}^{dist-r}) * 1/2 \qquad \forall i,d \qquad (6)$$

Capacity of distribution center shall match with the vehicle capacity for the product I to be collected in vehicles

$$\sum_{v,c} \alpha i_{ivc}^{del} \leq biggm \times \sum_{d} \beta_{vd} \qquad \forall i,v \qquad (7)$$

Ensures vehicle loading or emptiness when it is allotted to distribution center

$$\sum_{v,c} \alpha i_{ivc}^{pic} \leq biggm \times \sum_{d} \beta_{vd} \qquad \forall i,v \qquad (8)$$

Ensures vehicle loading or emptiness for second hand products when it is allotted to distribution center

$$\sum_{d} \beta_{vd} \leq 1 \qquad \forall i \qquad (9)$$

$$\sum_{v} \beta_{vd} \leq biggm \times X_{d}^{dist} \qquad \forall d \qquad (10)$$

distribution setup cost is ensured if vehicle is allotted.

$$\sum_{\hat{c}} X_{v\hat{c}c} \leq 1 \qquad \forall v, c \qquad (11)$$

Ensures travel of vehicle between two center.

$$\sum_{\hat{c}} X_{v\hat{c}c} = \sum_{\hat{c}} X_{v\hat{c}c} \qquad \forall v, c \qquad (12)$$

Ensures vehicle movement in one direction only

$$\alpha i_{ivc}^{del} \leq biggm \times \sum_{\hat{c}} X_{v\hat{c}c} \qquad \forall iv, c \qquad (13)$$

Ensures no idle travel between two centers

$$\alpha i_{ivc}^{pic} \leq biggm \times \sum_{\hat{c}} X_{v\hat{c}c} \qquad \forall iv, c \qquad (14)$$

Ensures non collection of goods if vehicle does not travel

$$\alpha i_{ivc}^{del} - \alpha i_{iv\hat{c}}^{del} + capa_{v}^{veh} \times X_{v\hat{c}c} + \left(capa_{v}^{veh} - deli_{i\hat{c}} - deli_{ic}\right) \times X_{v\hat{c}c} \leq cap_{v}^{aveh} - del_{i\hat{c}} \qquad \forall i, \hat{c}, v, c \qquad (15)$$

Ensures deliverablegoods capacity

$$\alpha_{iivc}^{pic} - \alpha i_{iv\hat{c}}^{pic} + capa_{v}^{veh} \times X_{v\hat{c}c} + \left(capa_{v}^{veh} - pikc_{i\hat{c}} - pic_{kic}\right) \times X_{v\hat{c}c} \leq capa_{v}^{veh} - pic_{i\hat{c}} \qquad \forall i, \hat{c}, v, c \qquad (16)$$

Ensures pickup of secondary goods.

$$\sum_{i} \alpha i_{ivc}^{del} + \sum_{i} \alpha i_{ivc}^{pic} - \sum_{i} deli_{ic} \leq capa_{v}^{veh} \qquad \forall i, v, c \qquad (17)$$

Ensures all the products capacity shall confirm to vehicle capacity

$$\alpha_{iv\hat{c}}^{del} \geq del_{ii\hat{c}} + \textstyle\sum_{i} deli_{ic} \times X_{v\hat{c}c} \qquad \forall i, v, c \qquad (18)$$

the deliverable goods tothe customer should not be in shortage

$$\alpha_{ivc}^{pic} \geq pic_{i\hat{c}} + \textstyle\sum_{i} pick_{i\hat{c}} \times X_{v\hat{c}c} \qquad \forall i, v, c \qquad (19)$$

$$capa_{v}^{veh} = \left(capa\_a_{v}^{veh} + capa\_m_{v}^{veh}\right) * 0.5 * \psi + (1 - \psi) * 0.5 * \left(capa\_b_{v}^{veh} + capa\_m_{v}^{veh}\right)$$

(20)

Ensures collected goods meet the requirement the problem is nonlinear (NLP)one. By analogy to Karaoglan et al.

(2012) that sub tour removal was illustrated in above equations, was based on using integer variables. The equations are linearised as mentioned below

$$X\beta_{ivdc}^{del} \begin{cases} 1 & \mathbf{1ifvehicle}\boldsymbol{v}\mathbf{ofdistributioncentredmoves} \\ 0 & \mathbf{fwithproductitocenterc,else0} \end{cases}$$

$$\beta p_{ivdc}^{del}\,\mathbf{Integer}\,\begin{matrix}\mathbf{Thenumberofproduct}\boldsymbol{i}\mathbf{assignedtovehicle}\boldsymbol{v}\mathbf{from} \\ \mathbf{distributioncenter}\boldsymbol{d}\mathbf{todemandpoint}\boldsymbol{c}\mathbf{.}\end{matrix}$$

$$\beta p_{ivdc}^{pic} = \begin{matrix}\mathbf{Thenumberofcollectedproducts}\boldsymbol{i}\mathbf{fromdemandpointc} \\ \mathbf{byvehicle}\boldsymbol{v}\mathbf{fromdistributioncenterd.}\end{matrix}$$

$$\mathbf{min}\ Z^1 = \Upsilon \times \left(\textstyle\sum_{v,\hat{c}>1,c} f_v \times dis_{\hat{c}c}^{cus} \times X_{v\hat{c}c} + \sum_{v,c>1,d} f_v \times (X_{v1c} + X_{vc1}) \times dis_{dc} + \beta_{vd}\right)\mathbf{Firstobjectivefunctionnon-linear}$$

.

$$\mathbf{min}\ Z^{1n} = \Upsilon \times \left(\sum_{v,\hat{c}>1,c} f_v \times dis_{\hat{c}c}^{cus} \times X_{v\hat{c}c} + \sum_{v,c>1,d} f_v \times (x\beta_{vd1c} + x\beta_{vdc1}) \times dis_{dc} + \beta_{vd}\right)\mathbf{Linearequivalent(21)}$$

$$x\beta_{vd\hat{c}c} \leq x_{v\hat{c}c} + (1 - \beta_{vd}) \times Biggm \qquad (22)$$

$$x\beta_{vd\hat{c}c} \leq \beta_{vd} + (1 - x_{v\hat{c}c}) \times Biggm \qquad (23)$$

$$x\beta_{vd\hat{c}c} \geq 1 + (x_{v\hat{c}c} + \beta_{vd} - 2) \times Biggm \qquad (24)$$

$$x\beta_{vd\hat{c}c} \leq (x_{v\hat{c}c} + \beta_{vd}) \times Biggm \qquad (25)$$

$$\mathbf{min}\ Z^2 = Cost^{fuel} \times \left(\textstyle\sum_{v,\hat{c}>1,c} f_v \times dist_{\hat{c}c}^{cus} \times X_{v\hat{c}c} + \sum_{v,c>1,d} f_v \times (X_{v1c} + X_{vc1}) \times dist_{dc} + \beta_{vd}\right) + \textstyle\sum_d cost_d^{dist} \times X_d^{dist} + \sum_v cost_v^{veh} \times X_v^{veh} + \sum_{cc'} dist_{\hat{c}c}^{cus} * \mathrm{Wagcc'} * X_{v\hat{c}c}\, sec0nd\, obectivefunctionnon-linearexpansion\ )$$

$$\mathbf{min}\ Z^2 = Cost^{fuel} \times \left(\sum_{v,\hat{c}>1,c} f_v \times dist_{\hat{c}c}^{cus} \times X_{v\hat{c}c} + \sum_{v,c>1,d} f_v \times (\beta X_{vd1c} + \beta X_{vdc1}) \times dis_{dc} \times \beta p_{vd}\right) + \sum_d cost_d^{dist} \times X_d^{dist} + \sum_v cost_v^{veh} \times X_v^{veh} + \sum_{cc'} dist_{\hat{c}c}^{cus} * \mathrm{Wagcc'} * X_{v\hat{c}c}\, secpndobectivefunctionnon-linearexpansion \qquad (26)$$

$$\sum_{v,c} \alpha b_{ivc}^{del} \times \beta_{vd} \leq capa_{id}^{dist-s} \times Biggm \quad \forall iv,c \quad Nonlinearexpresion$$

$$\sum_{v,c} \alpha\beta_{ivdc}^{del} \leq cap_{id}^{dist-s} \times Bigm \qquad \forall iv,c \qquad (27)$$

$$x\beta_{ivdc}^{del} \geq \alpha_{ivc}^{del} - (1 - \beta_{vd}) \times BigmLinearequvalent \qquad (28)$$

$$x\beta_{ivdc}^{del} \geq \alpha_{ivc}^{del} \qquad (29)$$

$$x\beta_{ivdc}^{del} \geq Biggm \times \beta_{vd} \qquad (30)$$

$$\sum_{v,c} \alpha_{ivc}^{pic} \times \beta_{vd} \leq cap_{id}^{dist-r} \qquad \forall i,d \qquad Nonlinearexpression \qquad (31)$$

$$\sum_{v,c} \alpha_{ivc}^{pic} \leq capa_{aid}^{dist-r} \qquad \forall i,d \qquad (32)$$

$$x\beta_{ivdc}^{del} \geq \alpha_{ivc}^{del} - (1 - \beta_{vd}) \times BigmLinearequvalent \qquad (33)$$

$$x\beta_{ivdc}^{del} \geq \alpha_{ivc}^{del} \qquad (34)$$

$$x\beta_{ivdc}^{del} \geq Bigm \times \beta_{vd} \qquad (35)$$

4.2. Dynamic vehicle routing

Entire demand information from all the potential customers may not be obtainable from the beginning of the vehicle routing plan. Initial vehicle routing is planned based on the partial information available at that point oftime. As time passes, some more customers may join with demand.By that time, some customers who were planned previously for service might not have been served. Hence a need arises to make a suitable vehicle routing plan to incorporate new customers without compromising costs. Such a policy is called dynamic policy without time windows. While making a revised route plan, one should not forget the customers served and their requirements. All the things are added in the formulation suitably.

4.3 Dynamic vehicle routing algorithm considered

step 1. static vehicle routing. move to step 2
step 2. Formulate multi-objective nonlinear model
step 3. convertnonlinear into linear model
step 4. convert the model into a single objective model
step 5. finding feasible plan
step 6.if some more customers added, perform step7, else end
step 7: identify served customers and demand. Add new customers demand togo to step 1.

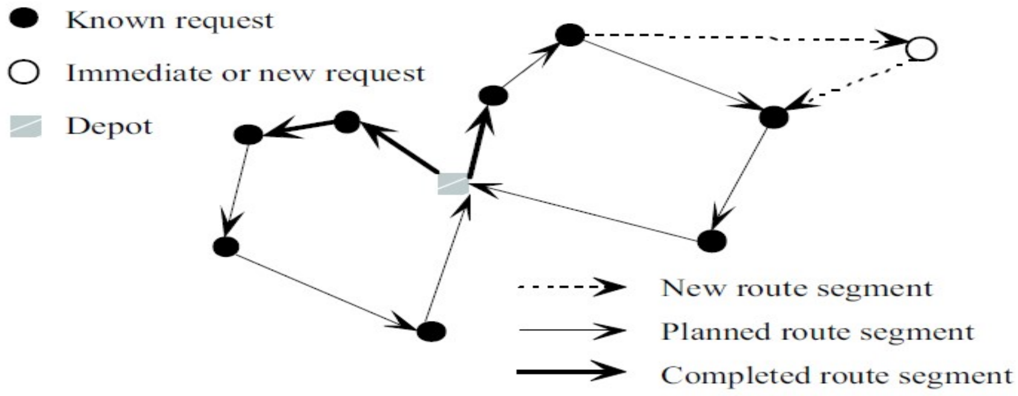


Fig2: Dynamic vehicle routing

V. NUMERICAL RESULTS

The parameters of the problem are shown below. The proposed model is in bi-objective type, using the techniqueoffered by Zimmerman (1978)converted as a single-objective model.

$Max\ \lambda$

Subject to:

$\lambda \leq \mu_{z_k} \min(x)$

$\lambda \leq \mu_l \max(x)$

$$\mu_{z_k} \text{minimize}(x) = \begin{cases} 1 & z_k(x) > z_k^{positive} \\ 0 & z_k(x) < z_k^{negative} \\ f\mu_{z_k} min = \frac{z_k^{positive} - z_k(x)}{z_k^{positive} - z_k^{negative}}, & z_k^{negative} \leq z_k(x) \leq z_k^{positive} \end{cases} \quad (36)$$

$$\mu_{z_l} \text{minimize}(x) = \begin{cases} 1 & z_l(x) > z_l^{positive} \\ 0 & z_l(x) < z_l^{negative} \\ f\mu_{z_l} max = \frac{z_l(x) - z_l^{negative}}{z_l^{positive} - z_l^{negative}}, & z_l^{negative} \leq z_l(x) \leq z_l^{positive} \end{cases} \quad (37)$$

In which $z_k^{negative}$ and $z_l^{negative}$ are the lower limits, $z_k^{positive}$ and $z_l^{positive}$ are the higher limits and $\mu_{z_k} \min(x)$ and $\mu_{z_l} \min(x)$ are the lower limits (minimization values), respectively.

The objective function while applying weights

$$Max\ \lambda = \sum w_i \times \lambda_i \quad (38)$$

subject to:

$$\lambda \leq \mu_l(x) \quad (39)$$

$$\sum w_i = 1 \quad (40)$$

for weights of w1=0.5, w2=0.5), the obtained results arepresented in Table 3 FOR ALL $\psi = 0.5$:

Table 3. Values of the objective function and running time

TABLE 1 : DATA CONSIDERED FOR INDICES

Indices	Number in Districts
I	1
D	2
C	10
V	3

TABLE 2: DATA CONSIDERED FOR PARAMETERS

Parameter	values
cap_{id}^{dist-s}, $capa\_m_{id}^{dist-s}$, $capa\_m_{id}^{dist-s}$	4500, 5000, 5500
Wage cost per distance km	Varies between rs (20 ..25)
$capa_{a_v^{veh}}$, $capa_{m_v^{veh}}$ $capa\_b_v^{veh}$	1950, 2000, 2050
$capa_{id}^{dist-r}$, $capa_{id}^{dist-r}$, $capa_{id}^{dist-r}$	5900, 6000 , 6100
ψ	0.5
$dist_{ic}^{cus}$	Euclidian distance
$cost_{id}^{dist}$	600000
$deli_k$	100000
$deli_k$	200
$capa_v^{veh}$	200000
$pick_k$	20
$cost^{fuel}$	100
$bigm \sim \propto$	300000
ξ	0.00015
fu_v	8KMS/LT

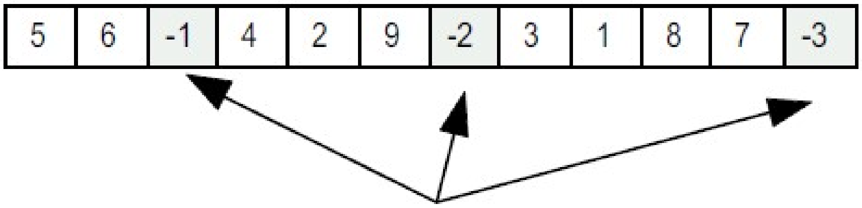
TABLE 3: ANALYSIS OF OBJECTIVE FUNCTION RESULT

	WEIGHT OF OBJECTIVE FUNCTION FIRST	WEIGHT OF OBJECTIVE FUNCTION SECOND	VALUE OF OBJECTIVE FUNCTION FIRST	VALUE OF OBJECTIVE FUNCTION SECOND
PROPOSED APPROACH 1	0.5	0.5	215	4100000
PROPOSED APPROACH 2	0.4	0.6	210	4200000

Table 4: COMPARASION TABLE

	WEIGHT OF OBJECTIVE FUNCTION FIRST	WEIGHT OF OBJECTIVE FUNCTION SECOND	VALUE OF OBJECTIVE FUNCTION FIRST	VALUE OF OBJECTIVE FUNCTION SECOND
PROPOSED APPROACH	0.5	0.5	215	4100000
NORMAL	0.5	0.5	245	4600000

The proposed model is solved as a normal genetic algorithm with PMX cross over and for 500 iterations for a moderate size and found that the run time is shorter than themilpmodel. Thechromosome considered a permutation type.



Chromosome representation

The customers are represented with positive number vertices(nodes).negative integers represent the group where customers already visited. Whenever new customers are added, integer number will increase .when the chromosome is decoded; old groups will be added with new customers if a vehicle has capacity.

VI. CONCLUSION

The paper is presented for vehicle routing considering pickup and delivery of products. Equations are formulated considering fuzziness in criteria for multi objectives. Small-sized problems can be solved using milp methods. In a dynamic situation, new requirements arise with new customers., the same can be solved by considering previous customers already allotted to vehicles. The new requirement is added to already running vehicles if the capacity of vehicle permits, or altogether new route from the depo. The problem is solved using GA. It is applied to a small-sized problem. Result found effective. The software used Python &R

VII.FUTURE STUDY

Several gaps of research are found and directions for further studies are mentioned here.
which are

1) stochastic parameter are to be considered for more compatibility with the real distribution systems.
2) Using Data envelop analysis for the product distribution search
3) Finally, applicationsof graphtheory in this type of problems and realtimeschedules is highly suggested for future research.

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