CHAPTER 6

B2CS ALGORITHM FOR MULTI-PERIOD D-T-O

The previous chapter (Chapter 5) proposed an artificial bee colony algorithm for the optimal scheduling and selection of E-O-L products. The previous strategy provided better performance in terms of time and cost spend for the E-O-L reverse logistics. But the convergence rate of ABC algorithm used in the previous strategy is not good, so in this chapter a hybrid Meta heuristics algorithm to improve the convergence rate. This chapter proposed a strategy based on hybrid bee colony cuckoo search algorithm for the optimal scheduling and product selection. The proposed strategy can provide better performance in terms of time, cost and convergence rate.

Most recent advances rise step by step, which drives the producer to create new items inside a brief period. Also, it is a sort of misfortune for the maker, so in later days the parts are extricated from the end of life items or the old items to satisfy the element prerequisite. In this sense, many specialists have exhibited systems for the end of life (E-O-L) piece dismantling. However, the benefit acquired from this procedure is not satisfactory in light of its great misfortune. Subsequently, our work needs to build up a superior strategy for the multi-period dismantling in reverse logistics, in our first work, an adaptive genetic algorithm (AGA) based approach created for the ideal item chose for the disassemble to structure the (DTO) prepare. In the second work a simulated honey bee province (ABC) based booking methodology is produced for the time minimization in E-O-L reverse logistics. In this thesis, a hybrid bee colony and cuckoo search (B2CS) approach introduced for the multi-period dismantling in reverse logistics, and its execution contrasted and the traditional methods. The proposed approach gives better performance regarding time and cost, and it is recommended to use in the real-time reverse logistic arranging.

In the current age, innovation maybe the most vital asset to any country. Mechanical advancements, in the field of item and procedure of advances, are occurring at a quick pace (Ram Ganeshan and Terry P. Harrison, 1995). Shortening of life expectancy of the part, advancement of developments and creations and increment in item requests is the markers to the quick changing manufacturing situation. Hence the cover up and augmentation of these improvement patterns is the quickly changing innovative condition (M. Xiangru, 2008). The development of these models can contend with developing innovation and shortening of item life cycles, have made association presented to ruin with no time in the wiped out (D. S. Rogers and R.S. Tibben-Lembke, 2011).

Organisations need to work consistently to build up more ideas and thoughts which are shabby and upgraded of their rivals, will make long haul upper hands (F. Ciliberti, et al. 2008). As the associations around the globe are confronted with element conditions, the innovation overhauling is the primary variable for the survival of the organisation and swelling on long haul premise (Q. Zhu, et al. 2008; L.Q. Dat, et al. 2012).

There are two alternatives of redesigning: Initially, the innovation breaks down for a reason, and the innovative association work actualizes it. Next stride is it can accumulate information from independent sources in the nation or abroad (M.A. Ilgin, and S. M. Gupta, 2010). In the meantime, the associations confronted with the coercive condition and the item. The life expectancy of innovation decreased, and the analysts left with short response time for utilizing massive speculation for the execution of R&D operations inside the association (A. Mutha, and S. Pokharel; 2009; A. Gungor and S. M. Gupta, 1999).

Obsolete items frequently named as end-of-life (EOL) products. The transfer could create additional abatements in the quantity of landfill, which perilous to wellbeing and Eco framework unless it dealt with by lawfully. It is an appreciated sign that an extended cut of the EOL items in the association can support a possible pattern in the opposition which is exceedingly attractive to adventure them by either

reprocessed which prompts to the perceived economy in material obtaining and the interest in item execution (C. Prahinski and C. Kocabasoglu, 2006).

In the earlier decades, deep-rooted return systematization done in the developed nations. The corporates to effectively administer the whole existence of the item and in such manner customers assume a prominent part in the advancement of business to expect responsibility of the dumping of their items (D. S. Rogers and R.S. Tibben-Lembke, 2011). A noteworthy lump of the supply investigation concentrated on the upward heading and reclamation of the materials from the provider's stream brings down through the end customers and control the change uses on the bullwhip impact. In any case, the retrogressive procedure stream of items from the customers on a more elevated amount of business has not revealed any tremendous energy (E. Grenchus et al. 1997).

A compelling supervision on the item enhances client benefit quality and prompts to customer churn. As taking care of profits requires a particular course of action and information following instruments and reverse logistics temporary workers have come to be acknowledged as the necessary ones (V.D.R. Guide et al. 1997). The continuation of benchmarks and the view purpose of the assertion tend to scale up the multifaceted nature of the determination (Bloemhof-Ruwaard et al. 1995).

Dismantling is the way toward withdrawing the segments from EOL items for re-devouring and reprocess. These items were sent to the organization for the dissecting procedure at different condition. It is undigested to think about the dismantling of the material meet requests on parts. The dismantling methodology closes with the unclear process. This strategy is one of the analytical strategy for the managing of work on the heuristic procedure for resolving decided to terrorize (L.Moyer and S. M. Gupta, 1997).

A portion of the current research identified with the finish of life reverse logistic are; Luu Quoc Dat et al. (2012) have subjectively thought of a scientific demonstrating which recreate by programming model which can abbreviate the

general preparing costs of the various endless division of destruction in jolting items (WEEPs). The business highlights considered in the model grasp the costs for the choice, control, and transport together with the resulting benefit consult with different variables of traded items.

Chunguang Bai and Joseph Sarkis, (2013) have charmingly got attention adjusted inversion system design which is part up into agent execution and vital adaptabilities. Mahdi Mahmoudzadeh et al. (2013) have extraordinarily propelled a creative strategy for depicting the suitable assumptions regarding unmistakable circumstance due to date to life authorization in Iran to oblige the issue as an outsider reverse logistics organize.

The strategy is made by means of MILP to quantify the ideal areas of scrap yards over the nation together with their regular assignments and material streams. Sónia R. Cardoso et al. (2013) have deliberately offered an original blended whole number straight programming (MILP) method is expected for the outline and arranging of supply chains within reverse streams in augmentation to the correspondent valuation of manufacturing, appropriation and reverse logistics capacities.

Harold Krikke et al. (2013), have offered general lively information on the assessment of current return works out. They have made the examination proposals on the mentors, amount and estimation of coach returns for the duration of the life cycle displaying the insufficiency in late practices brought about esteem decrease as opposed to the advanced appreciation develop and close reverse practices in changed fields and businesses.

6.1 Cuckoo Search Algorithm

Credit goes to Xin-she Yang and Suash Deb for their astounding accomplishment in considering the magnetic Cuckoo search (CS) as an improvement algorithm in the epic year 2009. It was, truth be told, activated by the commit brood parasitism displayed by certain cuckoo species with an extraordinary nature of laying

their eggs in the homes of differing host winged creatures having a place with different animal varieties. All the while, single host flying creatures dive into straight battle with the meddling cuckoos (Luu Quoc Dat et al. 2012).

6.1.1 Cuckoo Behavior

Cuckoos, as a gathering, by and large welcome our excited consideration and profound respect as a standout amongst the most attractive species, enriched with the God-spend endowment of musical sounds combined with the remarkable generation methodology. In such manner, certain species like the Ani and Guira cuckoos show the way of laying their eggs in homes, but their disposition now and again to dispose of eggs of different species with an ultimate intention of venturing up the bring forth the prospect of their eggs. Likewise, a plenty of species draws out their brood parasitic conduct by tending to lay their eggs in the homes of different host winged animals (Chunguang Bai and Joseph Sarkis, 2013).

By chance, the brood parasitism doing the rounds among the cuckoo species can extensively classify into three principal sorts, for example, transpacific brood parasitism, co-agent reproducing. Individual host winged animals indicate dynamic characteristics in their character by going into constant battle with the meddling cuckoos.

Further, certain special category of cuckoo species like the New World brood-parasitic Tapera so fashion their life-style that female parasitic cuckoos get habitually proficient in the imitation in the color model of the eggs of a handful of selected host species. With the result, considerable cutback in the probability of their re-productivity is on the cards. Fig 6.1 speaks to the cuckoo reproducing conduct.
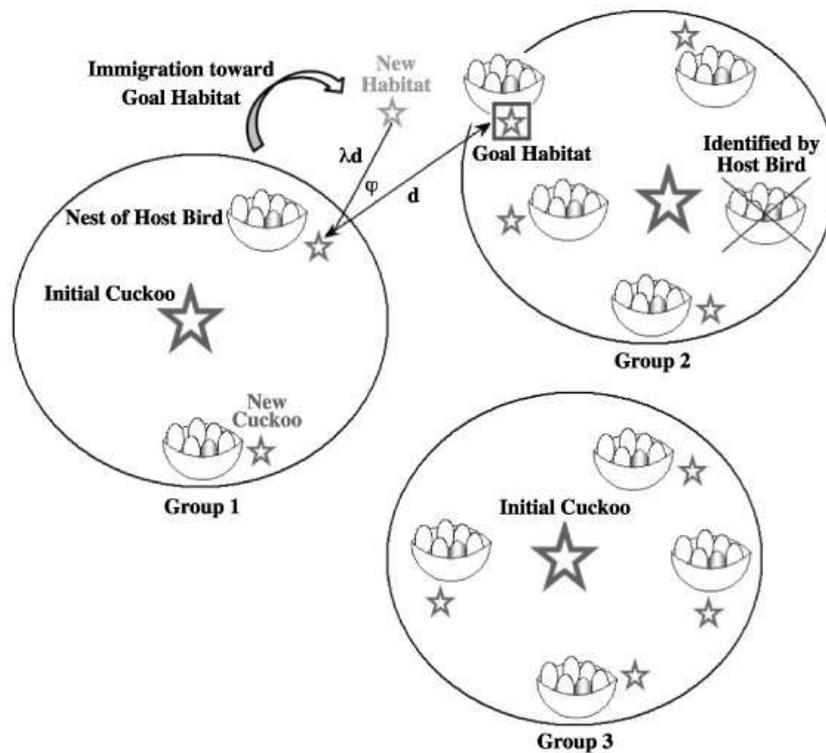
Figure 6.1. Cuckoo Breeding Behavior

6.1.2 Levy Flights

Collect flights can likewise determine for the reason that Levy movements, which remain in the class associated with non-Gaussian haphazard work whose standing developments, for the most part, are designated by any Levy secure syndication before all else arranged by the method for This particular dialect mathematician Robert Pierre Levy. Exact, reliable controls more often than not are significant on a couple of key properties. These are by and large,

(i) Like the Gaussian enactments, levy secure directions from the bowl associated with the request concerning entireties related to arbitrary specifics. This detail comes after from secure controls, by which any summed up focal decrease hypothesis wins concerning specifics alongside separating deviation haphazardly. The Gaussian syndication can found on the outskirts with the bowl associated with attraction related to secure controls;

(ii) probability thickness works associated with Levy safe enactments consumption inside asymptotic power-law shape alongside wandering deviation and

in this manner appear by regular means from the data of the numerous change capacities alongside for the most part disseminating reviews seen as blasts and additionally critical anomalies;

(iii) Levy flights in the main are self-relative, land giving to the data associated with arbitrarily fractal capacities. Require tight controls appear for the reason that actual data for any broad class related to functions inside real, substance, natural, geophysical financial settings, among others.

It is typical in nature for different creatures to be vigilant for nourishment in a self-assertive or semi-arbitrary way. As a general rule, the scavenging pathway of an animal constitutes a discretionary stroll selectively. As the resulting activity is reliant on the present day area/circumstance and the advancement prospect to the ensuing territory (Chattopadhyay R., 1971).

6.1.3 Cuckoo Search

Cuckoo Search (CS) is truly a novel metaheuristic criterion. It employed for managing design. The real identity of the criteria could be the first family parasitism lead of various cuckoo species consolidated with the Levy Airfare direct of various gulls notwithstanding natural products dances.

In detail about our inventive Cuckoo Search, ready to go to articulate the three following idealized controls:

➢ Each cuckoo should lay only one egg at once which dumped into a self-assertively chose to settle.

➢ The best homes with superlative nature of eggs presented to the succeeding eras.

➢ The quantity of offered host homes is perpetual, and the egg laid by a cuckoo is situated by the host feathered creature with a likelihood communicated by the accompanying expression:

$$P_a \in [0.1] \tag{6.1}$$

It is related to note here that the host winged creature appreciates the twin alternatives of either leave the egg in a faraway place or then again, exit the home and start to offer shape to an altogether new home. For illustration, the third discount shelled above, can be approximated by the fraction P_a of n *number* of nests which are substituted by new nests.

On account of expansion issue, the quality or wellness of an answer regarded as straightforwardly about the estimation of the goal work. Indistinguishable versions of welfare capacity plentifully stopped in genetic algorithms (K. Deb, 1995; Melissen, FW and De Ron AJ 1999). For ease, turn to the work of positive direct portrayals: Each egg in a home distinguishes an answer, while a cuckoo egg describes another arrangement. When producing new solutions $x^{(t+1)}$ for, say, a Cuckoo *i,* a Levy flight invariably carried out.

$$x_i^{(t+1)} = x_i^t + \alpha \oplus Levy(\lambda) \tag{6.2}$$

Where, $\alpha > 0$ is the step dimension which has a correlation with the scales of the issue of concern? In a significant chunk of instances, at liberty to use $\alpha = 1$. The product $\oplus$ stands for entry wise multiplications. And, this entry wise product, in turn, is analogous to those employed in PSO strategy.

The Levy flight, truly, imagines an arbitrary walk while the variable stride length is assembled from a Levy appropriation outfitted underneath:

$$Levy\ u = t^{-\lambda}\ , (1 < \lambda \le 3) \tag{6.3}$$

It is to be note that this circulation has a limitless difference with an interminable mean. Collect stroll around the best arrangement accomplished till now, goes far in rushing the nearby chase. The procedure stream of the preservationist cuckoo look algorithm is perfectly attracted Fig 6.2.

The roadmap for the operation of conservative cuckoo search.

Step 1: Go through the system data which is home to fuel cost coefficients, minimum and maximum power limits of all producing units, power demand and B coefficients.

Step 2: Activate the constraints and constants of Cuckoo Algorithm such as "none", P_a, beta and $iter_{max}$.

Step 3: Produce non number of nests in a discrete range between λ_{min} and λ_{max}.

Step 4: Lay down iteration count to 1.

Step 5: Estimate the fitness value analogous to "non" number of cuckoos.

Step 6: Achieve the best fitness value G_{best} by analysing and contrasting all the fitness values along with the best nests matching the best fitness value G_{best}.
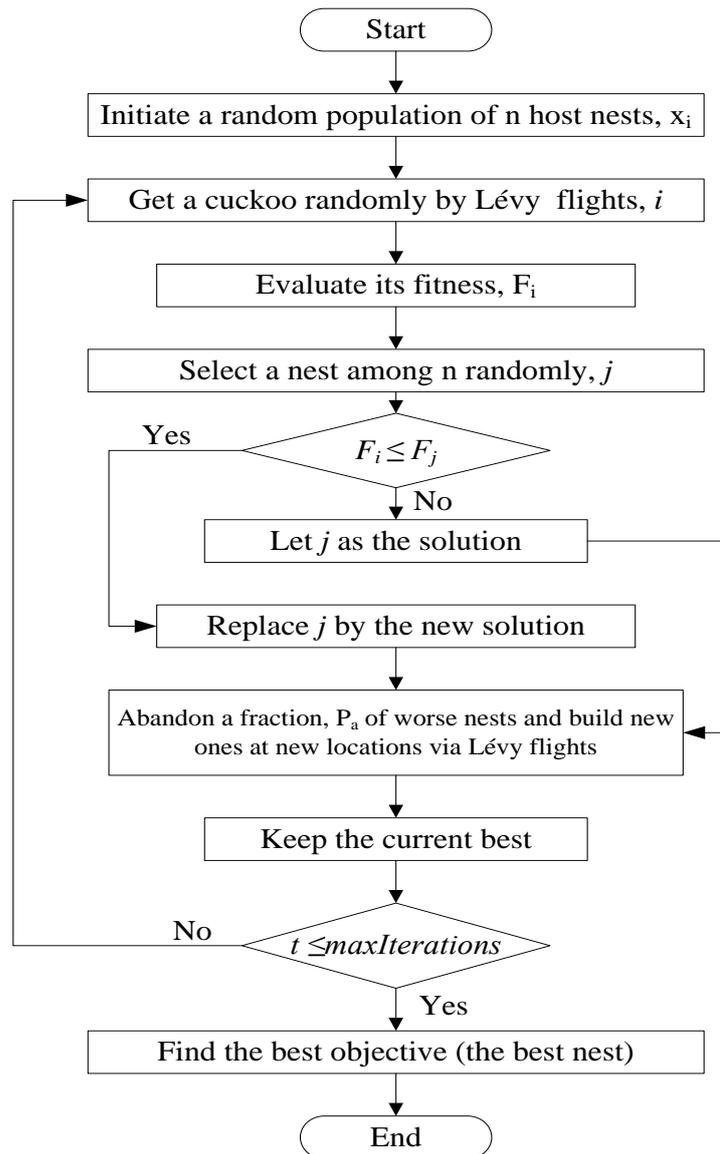
```
                        ┌─────────────┐
                        │    Start    │
                        └─────────────┘
                               │
        ┌──────────────────────────────────────────────┐
        │ Initiate a random population of n host nests, xᵢ │
        └──────────────────────────────────────────────┘
```

Start

Initiate a random population of n host nests, x_i

Get a cuckoo randomly by Lévy flights, *i*

Evaluate its fitness, F_i

Select a nest among n randomly, *j*

$F_i \leq F_j$ Yes

No

Let *j* as the solution

Replace *j* by the new solution

Abandon a fraction, P_a of worse nests and build new ones at new locations via Lévy flights

Keep the current best

$t \leq maxIterations$ No

Yes

Find the best objective (the best nest)

End

Figure 6.2. Flowchart for the cuckoo search algorithm

Step 7: Calculate sigma value with the help of the equation given below:

$$\sigma_u = \left\{ \frac{\Gamma(1+\beta)\sin(\pi\beta/2)}{\Gamma * [(1+\beta)/2]\beta * 2^{(\beta-1)/2}} \right\}^{1/\beta} \qquad (6.4)$$

Step 8: Estimate new nest by employing step dimension between the λ_{min} and λ_{max} limits.

Step 9: Arrive at the fitness value, if **t_fitness > fitness** value, then forward the nest values to new nest. Subsequent keep G_best updated by analyzing and contrasting fitness values.

begin

Objective function $f(x)$, $x = (x_1,.........,x_d)^T$

Generate initial population of

n host nest x_i $(i = 1,2,..............,n)$

while$(t < MaxGeneration)$ or $(Stop criterion)$

Get a cuckoo randomly by Levy flights

evaluate its quality / fitness Fi

Choose a nest among n (say, j) randomly

if $(Fi > Fj)$,

replace j by the new solution;

end

A fraction (Pa) of worse nests are abandoned and new ones are built;

Keep the best solutions (or nests with quality solutions);

Rank the solutions and find the current best

end while

Post process results and visualization

end

Algorithm 6.1. Pseudo code of the Cuckoo Search Algorithm

Step 10: New solution by Random Walk. Here, if random value > pa then ascertain the step dimension any two nests. Thereafter, proceed to arrive at the newnest1, where newnesst1 = nest + stepsize1, the newnest1 will definitely be well within the limits. Repeat the process of keeping the Gbest updated by analyzing and contrasting fitness values. If the stipulation is not met, then proceed to step 5 and execute the process once again.

Step 11: At last, G_best furnishes the optimal solution of the Economic Load Dispatch issue and the outcomes are put in black and white. The pseudo code for the conservative cuckoo search algorithm is shown in the Algorithm 6.1.

6.2   ABC Algorithm

Artificial Bee Colony (ABC) is just about the almost all crisply clarified algorithms basically by Dervis Karaboga all through 2005, irritated on account of the

insightful conduct with respect to infant honey bees. It's since inconvenience free since Particle Swarm Optimization (PSO) and Differential Advancement (DE) algorithms, and works by utilizing exclusively normal control rules, for example, settle measuring and most noteworthy cycle amount.

ABC being an advancement apparatus uncovers any populace based query prepare by which individuals known as nourishments parts typically are specially crafted as a result of the produced honey bees before long and furthermore the honey bee's point is dependable to discover the regions in regards to sustenance arrangements with high nectar amount and at last the one while utilizing most astounding nectar. With ABC prepare, made honey bees go about in an exceptionally multidimensional query living space and a few (employed and passerby honey bees) pick nourishments arrangements relying upon the data about freely and the home buddies/amigos, and adjust the parts.

A few (scouts) travel and discover the sustenance arrangements at arbitrary, without utilizing handy information. On the off chance that your nectar amount of a fresh out of the plastic new supply is more noteworthy than in which with the previous 1 of their slam, they retain the most up to date position and your venture past 1. Along these lines, ABC handle incorporates provincial query methods, finished mostly by as of now employed and spectator honey bees, with overall query systems, oversaw basically by observers and scouts, needing to the feeling of adjusting pursuit and abuse prepare.
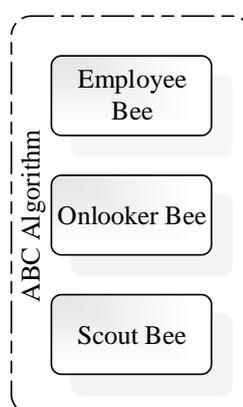
Figure 6.3. ABC Algorithm

Used Bee Phase: Convey the employed honey bees to the dinners assets given for them. Make sense of the volume of nectar (wellness esteem) inside supper's source notwithstanding gauge the probability worth relating to dinners assets.

Onlooker Bee Phase: Choose dinner's assets found just by worker dependent on quality. Get the outskirt dinners source notwithstanding ascertain it is nectar whole. Think about the two dinners assets and select their nourishment source together with better physical wellness.

Scout Bee Phase: Settle on dinner assets self-assertively notwithstanding change the left behind supper source together with entirely new source. Retain the best source.

The specific well-ordered strategy from the ABC equation talked about in chapter 4 of this thesis.

6.3   Proposed B2CS Methodology for Product Selection in D-T-O

The Disassembly-to-Order is one of the real procedures toward the finish-of-life reverse logistic, also it a mind-boggling errand. Henceforth in the late period, numerous counterfeit consciousness based methodologies have been exhibited by the analysts for the D-T-O procedure of E-O-L items. At first, an adaptive genetic algorithm (T.Sathish and J. Jayaprakash, 2015) is built for the ideal determination of some reclaim E-O-L items, so that the total cost required for dismantling procedure can lessen. The second strategy focused on both cost and time needed for the dismantling of the E-O-L items, so that the artificial bee colony (ABC) algorithm based system was created (Sathish T. and Jaya Prakash, 2016).

In this chapter to further upgrade the execution as far as both cost and time required in D-T-O prepare, a new half and half counterfeit honey bee colony and cuckoo search (B2CS) are proposed. The proposed mixture procedure thinks both cost and time of D-T-O handle, while the enhancement so that the execution of the proposed system prompt to a peak.

In the proposed work, the total accessible E-O-L reclaim items are kept in a gathering point, then the required amount of items is taken for the D-T-O prepare. The removed amount of items for reclaim storage must satisfy the part prerequisite and give most extreme benefit by the minimization of cost and time of dismantling. The procedure required in the proposed framework is as per the following;

Step 1: Candidate Representation

The underlying hopeful arrangement or food source or the underlying incentive to enhance are introduced given the proposed objective. The real goal of this work is to decide the appropriate blend of taking back products and legitimately plan the products while dismantling so that the general cost and time for E-O-L reverse logistic get diminish. In this work three parameters like, procurement cost (pc), cost of taking back products (bc) and the cost of arranging the products are taken as the beginning qualities. The underlying populace organization is given in Fig 6.4.
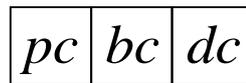
$$\boxed{pc \mid bc \mid dc}$$

Figure 6.4. Initial Population Format

Step 2: Employee bee phase

In this stage to look at changed arrangements, wellness (or cost) assessment of every hopeful arrangement is settled. It is finished up by the breaking the strings and the assessment of the target work eqn. (6.5) For every arrangement. In this way to fulfil the essential wellness work for the assessment, the accompanying strides are executed for every hopeful arrangement.

$$Fit = \min\{T_{DTO} \times T_{COST}\} \tag{6.5}$$

Where; 'T_{DTO}' is the total time required for the D-T-O process, 'T_{COST}' is the total cost required for the D-T-O process. The formula to obtain T_{DTO} and T_{COST} are given in eqn. (6.6) and eqn. (6.7) respectively.

$$T_{DTO} = \sum_i \left(EP_i \cdot \left(T_{Di} + T_{Ni} \right) \right) \tag{6.6}$$

$$T_{COST} = \sum_i (EP_i \cdot bc_i) + \sum_j (pc_j \cdot PC_j) + \sum_j (dc_j \cdot DC_j) \qquad (6.7)$$

Where; 'PC_j' total no of Procured Components in unit; 'DC_j' Total no of Disposed Component in unit; 'bc_i' unit take-back cost for product i (Rs/unit); 'pc_j' unit procurement cost for component type j (Rs/unit); 'dc_j' unit disposing cost for component type j (Rs/unit); 'EP_i' i type total E-O-L products in unit; 'T_{Di}' is time required for disassembling of ith destructive component (sec); 'T_{Ni}' is time required for disassembling of ith Non-destructive component (sec) and the corresponding expressions are given in the below equations.

$$T_{Di} = \sum_i \left((EP_i - NDY_i) \times t_{DM\_j} \right) \qquad (6.8)$$

$$T_{Ni} = \sum_i \left((NDY_i) \times t_{NM\_i} \right) \qquad (6.9)$$

$$PC_j = RUD_j - \sum_i (EP_i \cdot NDY_j) \qquad (6.10)$$

$$DC_j = \sum_i (EP_i \cdot NDY_j) - RUD_j \qquad (6.11)$$

Where; 't_{DM_j}' is average time taken by machine j for disassembling of a destructive component ($\sec$); 't_{NM_j}' is average time taken by machine j for disassembling of a non-destructive component ($\sec$); 'EP_i' is total E-O-L products in unit; and 'NDY_i' is Non-destructive disassembly yield in %; 'RUD_j' j^{th} type Reuse component demand in unit; 'EP_i' i type total E-O-L products in unit; 'NDY_j' Non-destructive disassembly yield in %.

Step 3: Onlooker bee phase

This stage is to pick the first class nourishment sources of the obliged ideal area of DG and upgrades the sustenance sources. The spectator honey bee step achieves the first class arrangements of the reasonable area at low power misfortune and high voltage profile, which improve the speed of the populaces by utilizing eqn. (6.12).

$$V_{i,j} = x_{i,j} + \Phi_{i,j}(x_{i,j} - x_{k,j}) \qquad (6.12)$$

Where, k is the solution the neighborhood of i and Φ is a random number in the limit [-1, 1], $V_{i,j}$ is the neighborhood solution of $M_{i,j}$.

Step 4: Selection

The choice procedure is employed to acknowledge ideal wellness of the upgraded arrangement notwithstanding choose this possibility. The likelihood capacity could be clarified in searching after eqn. (6.13).

$$probability = \frac{\Phi}{\sum\limits_{i=1}^{n} \Phi} \qquad (6.13)$$

Step 5: CS based Scout bee phase

At the point when the spectator honey bee step has not refined far superior alternatives, withdraw from the specific choices and make the arbitrary number of scout bee arrangement while utilizing the Cuckoo Search Optimization.

Initialization: The input parameters are explained in the initial step. These parameters consist of the number of nests 'n', the step size parameter 'α', discovering probability 'P_a' and the maximum number of generation as termination criteria.

Generate Initial Nests or Eggs of Host Birds: The underlying areas of the homes are determined by the arrangement of irregular qualities allocated to every variable as:

$$D_{i,j}^{(0)} = Round\left(x_{j,\min} + rand\left(x_{j,\max} - x_{j,\min}\right)\right) \qquad (6.14)$$

Where, '$D_{i,j}^{(0)}$' is the initial value of the jth variable for the ith nest; '$x_{j,\min}$' and '$x_{j,\max}$' are the minimum and the maximum allowable values for the jth variable; '$rand$' is a random number in the interval [0, 1]. The Round function is accomplished due to the discrete nature of the problem.

Step size evaluation: In this progression, the progression sizes for individual parent weights acquired in step 3 are assessed. The accompanying expressions are employed to discover the progression measure.

$$S_z = \alpha\, S\left(D^t - D_{best}^t\right) \cdot r \tag{6.15}$$

Where 'S_z' is the Step size, 'α' is Step size parameter ($\alpha = 0.01$), 'D^t' is the current originate weight, 'D_{best}^t' is the current originate the best solution, 'r' is a random number from a standard normal distribution [0,1] and 'S' is the step. The step S is found out by using the Mantegna's algorithm, shown in the below equation.

$$S = \frac{u}{|v|^{1/\beta}} \tag{6.16}$$

Where, 'β' is a parameter arising in the interval [1, 2] which choose in our system as 1.5 (i.e. $\beta = \frac{3}{2}$) and u and v are normal distributions, which are estimated as follows.

$$u \sim N(0, \sigma_u^2),\ v \sim N(0, \sigma_v^2) \tag{6.17}$$

$$\sigma_u = \left\{ \frac{\Gamma(1+\beta)Sin\left(\frac{\pi\beta}{2}\right)}{\Gamma\left[\frac{(1+\beta)}{2}\right]\beta \cdot 2^{(\beta-1)/2}} \right\}^{1/\beta}, \ \sigma_v = 1 \tag{6.18}$$

Generation of New Solution: In this progression, the new enhanced arrangements or weights are created for the comparing guardian weights in view of the CS algorithm (Levy Flight). The new weights are produced by utilizing the progression estimate values got in the progression 3. The new weights are created by utilizing the expression given beneath.

$$D^{(t+1)} = D^t + S_z \tag{6.19}$$

Where, '$D^{(t+1)}$' is the new weight, 'S_z' is step size and 'D^t' is the current parent weight. From this step another set of optimized weights are obtained.

Ending of CS process: The end criteria is tried in this stage, if the procedure meets end foundation it ended, else Step estimate assessment step is begun for next iteration.

Step 6: Termination Criteria

The procedure is rehashed till to achieve the most extreme number of emphasis. In the event that the quantity of emphasis is most extreme the procedures is stopped and keep the present best arrangement. At that point the DG is put in that fitting area. The proposed framework for the ideal multi period dismantling to arrange in the reverse logistic utilizing B2CS is portrayed up until this point and the procedure stream outline. At first the case information is instated, then the irregular mix of take back item will create, in the B2CS.

```
Initialization: Generate the initial population zi=1,2,...,SN
Evalute the fitness (fi) of the population
cycle=1;
Repeat
        For each employed bee {
                Produce new solution, then calculate the value fi and Apply greedy
        selection process }
        Calculate the probability values pi for the solutions zi
        FOR each onlooker bee {
                Select a solution zi depending on pi, Produce new solution, then
                Calculate fi, and Apply greedy selection }
        IF an abandoned solution for the scout exists,
        THEN replace it with a new solution based on cuckoo
        FOR each scout bee {
                Initialize Population
                Generate N random solutions and insert into Population
                FOR (i=1 to MaxGenerations) {
                        Generate ChildPopulation using Cuckoo Search
                        Non-dominated-sort
                        FOR each individual in CurrentPopulation do {
                                Generate sets of non-dominated vectors along PF known.
                                Loop (inside) by adding solutions to next generation
                                starting from the best front.
                                until N solutions found and determine crowding distance
                                between point on each front. } }
                Present results }
        Memorize the best solution so for
cycle++;
UNTIL cycle=MCN
```

Algorithm 6.2: Hybrid ABC Cuckoo Search Algorithm

The wellness esteem for the relating arbitrary mix is computed in worker honey bee stage and in light of this spectator honey bees select a few answers for further preparing. At that point scout honey bee stage in view of CS is handled to

locate the ideal blend and number of products, which takes less time in minimal effort of operation. The execution and execution approval is done in the following area. Pseudo code for the proposed half and half algorithm is given in Algorithm 6.2.

6.4   Results and Discussion

The proposed procedure for the ideal D-T-O in E-O-L reverse logistic in light of the novel B2CS method is investigated and actualized by MATLAB 2014a, with the framework setup; Intel Core i5 processor, 8GB RAM and windows 8.1 working framework. In this reproduction, thinking about 100 item and every item contain most extreme of 9 parts. The sort of item considered in our work is (pc) and their parts are numbered in the vicinity of 1 and 9. The parts detail and relating procurement and transfer cost is portrayed in Table 4.1.

The Table 4.1 gives the bill of material (BOM), which incorporates the part detail alongside the sort of dismantling. In like manner the E-O-L products does exclude all parts; at least one segments may miss. Those missed parts are characterized by number '0'. The insight about the products are alluded in the Table 4.2 and the total information employed for our usage is given in the addendum segment.

The case considered in this thesis for the trial execution is to make 20 new products from the accessible 100 E-O-L products. So as to fabricate 20 new products require 180 segments. The quantity of 20 segment sort is required to fulfill the necessity. In this manner most extreme of 55 E-O-L products (estimated) is taken. To choose the most helpful compound which diminish the general cost and dismantling time proposed B2CS algorithm is employed.

The accomplishment of the normal approach is contrasted and past procedures like adaptive genetic algorithm (AGA), and simulated honey bee state algorithm (ABC) based planning. In the past chapter thought to diminish the dismantling time of the E-O-L products, so that an ideal planning structure in view of ABC algorithm is proposed. This chapter, focused both choice and planning of E-O-L products so

that the general profit get increment. By and large the normal time taken by the different machines is given in the Table 5.1.

The Table 5.1 demonstrates that the dismantling machine required more opportunity for dismantling non-destructive machine than the destructive machine. Since non-destructive dismantling need to stay away from harm of parts. The most extreme normal time required for the dismantling of the non-destructive part is 40seconds and least required time is 33 seconds for the given products. Then again for the dismantling of the destructive segment machine required most extreme of 14 seconds and least of 9 seconds. Keeping in mind the end goal to approve the viability of the proposed framework the proposed framework is contrasted and the AGA and ABC based systems regarding dismantling. The dismantling time examination is given in Table 6.1.

Table 6.1: Comparison on disassembly time for the 47 products

No of E-O-L Products	Disassembly time (sec)			
	Hybrid Algorithm	*ABC*	*GA*	*EP*
47	179	223	247	280

Table 6.2: Comparison on total cost for the 47 products

No of E-O-L Products	Total Cost ($)				
	Hybrid Algorithm	*ABC*	*AGA*	*GA*	*EP*
47	465	498	525	591	614

The dismantling time of the different system for the D-T-O of 47 products got from the past work is given in Table 6.1. The total time required for the dismantling of 47 products by the proposed B2CS procedure is 179 seconds and by utilizing alternate strategies like ABC, GA and EP is 223, 247 and 280. It is unmistakably demonstrating that the proposed strategy system can be a superior choice for the dismantling of E-O-L products in brief time.

In Table 6.2 the total cost required for the D-T-O of 47 products is given. The total cost required for the dismantling of 47 products is 614, 591, 525, 498 and 465 by utilizing EP, GA, AGA, ABC and B2CS. The Table 6.1 and 6.2 demonstrates that

the utilization of time and cost for the dismantling of 47 products is better and low by utilizing the proposed B2CS system. So as to demonstrate the planning execution of the proposed structure, it is contrasted and the other booking algorithm by changing the quantity of E-O-L products and is given in Table 6.3. The Table 6.3 gives the examination of different algorithm as far as dismantling time by shifting the quantity of products.

Table 6.3: Comparison in terms of disassembly time

No of E-O-L Products	Disassembly time (sec)			
	Hybrid Algorithm	*ABC*	*GA*	*EP*
30	125	196	215	249
40	167	202	221	266
50	196	237	261	298
70	223	256	289	320
100	255	310	345	382

Table 6.4: Comparison in terms of total cost

No of E-O-L Products	Total Cost ($)				
	Hybrid Algorithm	*ABC*	*AGA*	*GA*	*EP*
30	421	448	475	516	563
40	452	487	502	578	597
50	485	505	533	602	620
70	498	536	558	645	656
100	532	585	591	689	702

The time required for the dismantling of the 30, 40, 50, 70 and 100 products is 125, 167, 196, 223, and 255 individually by proposed strategy, 196, 202, 237, 256, and 310 separately by ABC strategy, 215, 221, 261, 289, and 345 individually by GA and 249, 266, 298, 320, and 382 individually by EP algorithm. In Table 6.4 the different algorithm as far as total cost is analyzed the relative investigation unmistakably demonstrates that the total cost required by proposed algorithm is lower than that of alternate past and existing algorithms. The graphical portrayal of correlation as far as both dismantling time and total cost is given in Fig 6.6 and 6.7 separately.

The Fig 6.6 the dismantling time examination of different procedures at various no. of E-O-L products is given. It plainly demonstrates that the time required by the proposed strategy is lower than alternate strategies.

The execution examination diagrams given in Fig 6.5 and 6.6 unmistakably demonstrates the adequacy of the proposed system for the E-O-L item in the reverse logistic operation. The adequacy of streamlining algorithm is appeared by the merging it is given in the Fig 6.7.
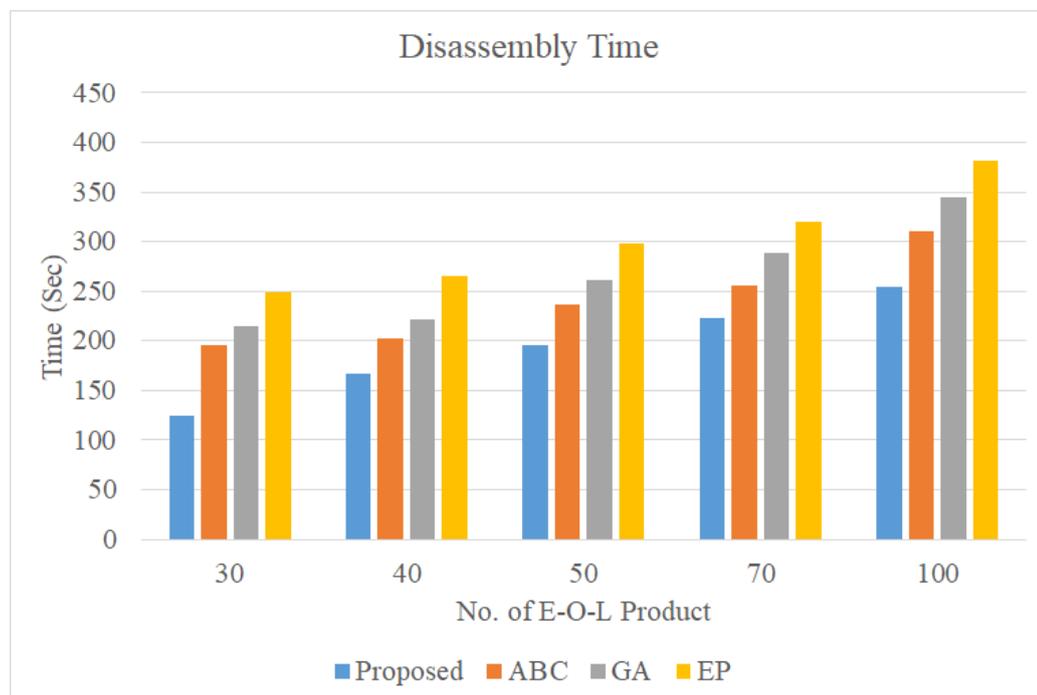

Figure 6.5. Comparison of disassembly time at variable no. of E-O-L products

The joining diagram given in the Fig 6.7 demonstrates that the proposed enhancement algorithm for the D-T-O process is merged well contrasting with alternate strategies like ABC, AGA, GA and EP. The test results and execution investigation talked about up until now, demonstrates that the proposed structure for the D-T-O of E-O-L item in reverse logistic (RL) can turn into an appropriate system to upgrade the speed of RL process, so that the greatest profit can accomplished by using the proposed strategy.
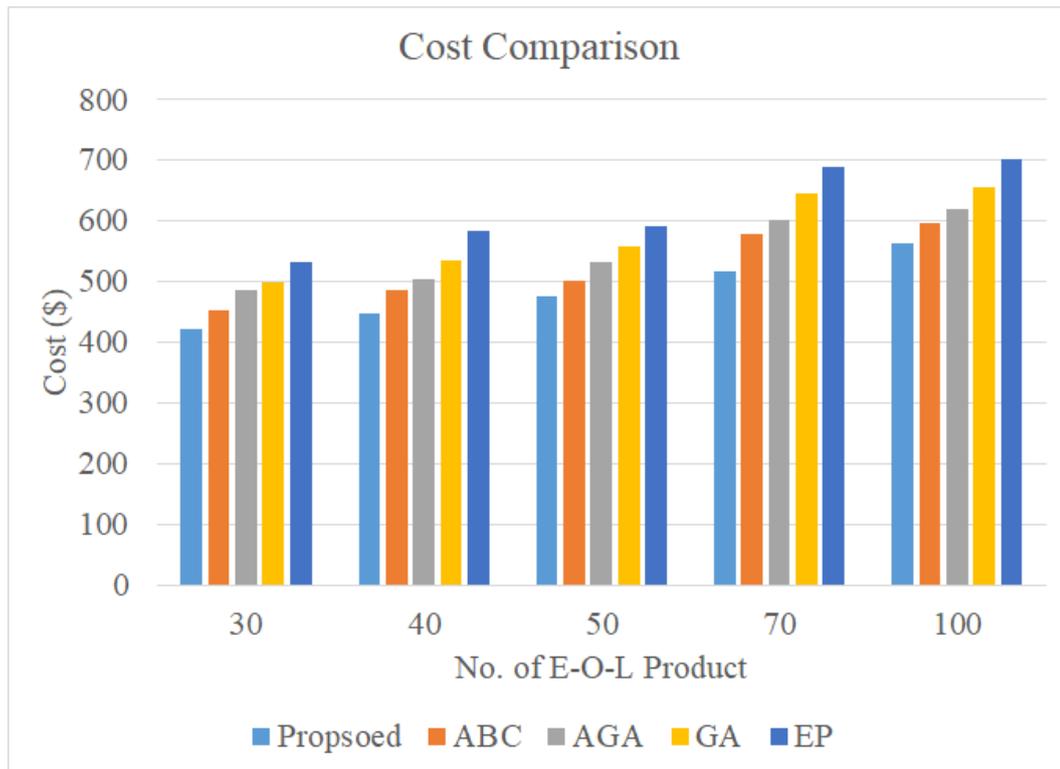
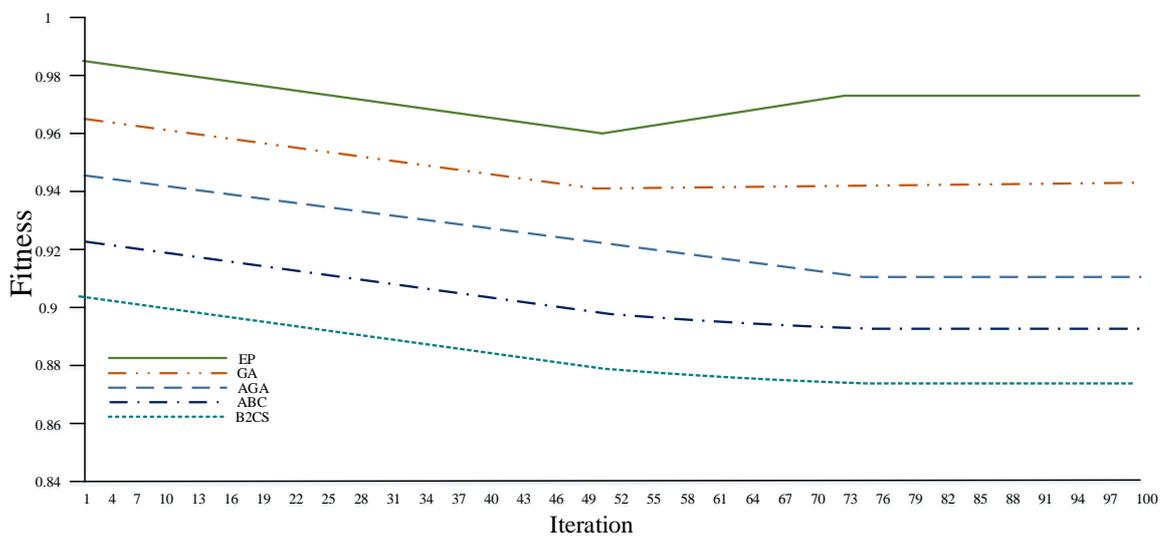Figure 6.6. Comparison of total cost at variable no. of E-O-L products

Figure 6.7. Convergence

The crossover approach B2CS is proposed for the multi period dismantling in reverse logistic of end of life products. The proposed strategy joined the honey bee province algorithm and cuckoo scan algorithm for the better advancement. The goal of the proposed work is to locate the appropriate mix of products, so that it's

dismantling cost and time taken will be lessened by preparing D-T-O. The normal procedure strategy is tried utilizing a case test information, and the execution is assessed the execution assessment was done and the correlation demonstrates the viability of the proposed B2CS approach in the reverse logistic. Henceforth from the investigation and execution correlation recommend that the proposed approach will get to be distinctly one of the appropriate method for the constant usage toward the finish of life reverse logistic.

In this chapter a hybrid B2CS strategy is proposed for the optimal scheduling and selection of E-O-L products in disassembly. The performance analysis proves that the proposed strategy provided better performance based on the time and cost spend for the E-O-L reverse logistics process and provided better convergence than the ABC based strategy. But the update rule of cuckoo more complex, which can fluctuate the convergence rate. Hence in the next chapter (chapter 7) a novel hybrid bee colony bat optimization based strategy is proposed to obtain stable convergence in scheduling and product selection.