

# Optimization Techniques for Green Layout Design in Manufacturing Industries: A Meta-Heuristic Analysis

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Many research papers and much legislation has been published in recent years to control or reduce factory pollution. However, only a few articles have discussed pollution from manufacturing facilities, specifically shop floors, even though this a specific single objective problem. In this research framework, a new variant technique of the jelly fish concept adaptive salp swarm optimization (ASSO) with a familiar Lagrangian relaxation model for lowering Total Material Handling Costs (TMHC) and carbon dioxide (CO<sub>2</sub>) emissions is presented. Using the Mat Lab software and the improved ASSO, the dragon fly optimization (DFO) algorithm technique, experimental simulations of the existing and recognized design of the studied industry were performed. The simulation results were validated and compared to those of other optimization techniques such as ant bee colony (ABC), simulated annealing (SA), and genetic algorithm (GA). It was determined that the proposed methodology, ASSO, was the most efficient, resulting in 40 % reduction compared to ABC, 38 % DFO, 50 % SA, and 40 % GA in the lowest TMHC, as well as an average 20 % reduction of emission rate in green layout design. These techniques could be combined into a hybrid format for further reduction of the emission rate up to 80 %.

**Keywords:** adaptive salp swarm optimization, bi-objective function, emission, evolutionary computation, layout design, and total handling costs

## Highlights

- This study will improve the efficiency of workflow within the workplace allowing workers and equipment being more productive.
- A new variant technique of the jelly fish concept - adaptive salp swarm optimization and dragon fly optimization techniques were introduced for design optimization.
- Lowering total material handling costs and CO<sub>2</sub> emissions a Lagrangian relaxation model equation derived.
- The experimental results are compared with five different optimization techniques with specified algorithm of programs.

## 0 INTRODUCTION

The logistic network dilemma (LNDP) has received much attention recently. This problem is divided into two parts: (i) a location problem, which involves deciding where logistics nodes (such as logistics parks, distribution centres, and logistics terminals) should be located, and (ii) an allocation problem, which involves routing the flow of goods from origin to destination [1]. One of the most important strategic considerations for logistics companies is where to establish logistics facilities and which ones should service which customers. Environmental considerations are increasingly being considered in classic capacitated facility site problems in response to the introduction of sustainable supply chain management. The logistics process aims to reduce transportation-related costs, such as distance travelled, time, route flexibility, and reliability. Furthermore, based on present trends in fuel consumption and carbon dioxide (CO<sub>2</sub>) emissions, these are expected to rise by approximately 50 % by 2030 and by 80 % by 2050 [2]. As a result, transportation businesses and governments are beginning to explicitly include

emission reduction goals in the development of their work plans [3].

Converting existing logistics systems to be more environmentally friendly can save money while still allowing them to meet traditional logistical goals in some cases [4]. Furthermore, the green transportation system might be completed by defining emission characteristics and measuring vehicle emissions by integrating them into logistics system networks [5]. In view of current environmental concerns and high levels of entrepreneurship, enterprises [6] should benefit from using bi-objective optimization (BOO) improvement tactics when developing distribution networks [7], allowing them to satisfy multiple primary objectives at the same time.

Optimization methodologies [8], such as BOO and vehicle carbon tax legislation, can help reduce CO<sub>2</sub> emissions. As a result, the salp swarm model has been taken bi-objective problems into account while modelling and optimizing the logistics centre location and allocation problems for better reliability [9]. The intelligence of natural swarms, herds, schools, or flocks of animals is the basis for swarm intelligence techniques. The primary foundation

of these algorithms is derived from the collective behaviour of a group of organisms [10]. Scientific research on this organism remains in its early stages due to the difficulty of accessing their natural habitats and keeping them in laboratory surroundings. A numerical example in which the impacts of fuzziness on issue optimization are measured and a comparison between the CO<sub>2</sub> emission optimization approaches were made. An improved multi-objective algorithm has been developed for optimization of supply chain management in natural gas handling industries [11] and this model is to minimize economic and environmental costs. Similarly, a closed loop [12] supply chain logistics model was implemented in manufacturing industries for the reduction of handling costs.

A fuzzy multi-objective optimization model was developed [13] for a network design including the design of both forward and reverse supply chain for reduction of total handling costs and CO<sub>2</sub> emission rates [14]. The optimization module is used to minimize the following constraints: raw material, semi-finished, finished product flows, and outsourcing decisions [15].

A hybrid algorithm introduced by Peng et al. [16] to define various neighbourhood operations and the vehicle operations at full workload conditions. Asghari et al. [17] proposed a classification scheme based on its variants considered in three major and applicable streams, including internal combustion engine vehicles, alternative-fuel-powered vehicles, and hybrid electric vehicles, to reduce CO<sub>2</sub> emission [18].

In variations of green vehicle route problem (GVRPs), it has been suggested that multi-objective optimization models be considered, as well as to establish a green vehicle route [19] offer a branch and price (BAP) improved algorithm for solving the heterogeneous fleet green car routing problem with time frames with precision. Xu et al. [20] introduced a genetic algorithm, an excess rectangle fill algorithm, which frames a specific type of inner structure and is incorporated into the model to distribute facilities to many blocks.

To minimize the total costs, which includes both investment and running expenditures, a quantitative method for assigning facilities is provided. Coral reefs optimization is a recently developed evolutionary-type technique to tackle numerous complex optimization issues [21].

Pourhassan and Raissi [22] has provided an approach to address the dynamic facility layout problem because material handling and related

expenses can be minimized mathematically, and a modified non-dominated sorting genetic algorithm (NSGA-II) is projected to discover the best layout that meets the two important objective functions. The model for facility layout problem anticipated [23] is discussed. To implement the heuristic technique for updating layout design, a modified multi-objective particle swarm optimization algorithm is given.

Latifi et al. [24] present an integrated solution to the problem of process plant layout that takes into account both profitability and protection considerations. A new mathematical model is constructed for a facility layout that accounts for potential fire and explosion scenarios as well as the danger of a fatal toxic leak. D'Antonio et al. [25] introduced a mathematical model for defining a hybrid product-process architecture employing hybrid facility layout mathematical modelling and based on a genetic algorithm (GA).

## 1 PROBLEM FORMULATION

The primary focus of this research is to develop and evaluate search heuristics to find nearer-to-optimal solutions to the facility layout problems related to manufacturing industries. In this research work, a mathematical model will be formulated to address the major current issues of unequal area facility layout problems considering block layout, detailed facility layout issues like inter department layout, input/output (I/O) locations, and flow path (for materials) layout design and to cover the wide range of layout problems.

The integrated layout design issue of poorly balanced facilities and sites considering procurement and management and pickup, and the circulation networks are all addressed in this article. A medical equipment producer with small batch production of complex medical vital systems is the driving force behind it. Emissions from handling operations between divisions are analysed in order to develop a computational formula for vehicle CO<sub>2</sub> emissions on the plant floor. In this paper, two major issues are addressed: CO<sub>2</sub> emissions and the machine's total handling costs in terms of materials. The performance of vehicle carbon tax regulation in lowering vehicle CO<sub>2</sub> emissions in the logistics network is based on evidence of the benchmark, i.e., Pareto solutions [26], supplied by BOO in a numerical instance [27].

The vehicle CO<sub>2</sub> emissions of the final block arrangement, as expressed by the optimization problem: the basic data must be structured before the block layout can be built. The initial step is to create

a partial block layout of the departments with the greatest  $E_{ij}$  value, then gradually add the rest to finish the final plant layout as

$$\sum E_{ij}(q, d) = d_{ij} \times \left( \frac{q_{f1} - q_{f2}}{Q} \right) p_{ij} + q_{ei}. \quad (1)$$

Eq. (1) represents  $E_{ij}(q, d)$  is the CO<sub>2</sub> emissions from a vehicle [kg/km] with the variable of load  $q$  [10<sup>3</sup> kg] and  $d$  in [km].  $q_{f1}$  and  $q_{f2}$  is CO<sub>2</sub> emissions of a fully loaded and the CO<sub>2</sub> emissions of an empty vehicle.  $Q$  is the volume capacity of a vehicle.  $E_i \leftrightarrow E_j, \forall, j \in [1, n]$ . The second sub-problem is the rule-based approach to the “block layout” design [28].

### 1.1 Constraints with Scheduling Model

To locate a delivery route that satisfies the requirements of distribution points and obtains the shortest travelled expenses and the least amount of emitted CO<sub>2</sub> while visiting each customer with respect to vehicle’s capacity constraints, see Eq. (2)

$$\sum \sum \sum \text{cost}_{ij} \times x_{ij}. \quad (2)$$

### 1.2 Research Gap Findings

The following research gap findings were observed:

- Solutions have been derived as single objective optimization techniques only.
- In manufacturing layout, inter-cell department production material movements (number of times) and distance moved are not taken into account.
- Emission control systems (CO<sub>2</sub>), material handling vehicles travelled in and between productions departments are not highlighted.
- Energy consumption of machines, material handling systems, and workmen density are not accounted.
- Multi-objective function solutions are minimal and detailed layout-design study is more required.

## 2 METHODOLOGY- SOLUTION FOR PROBLEM FINDING

Some objectives are suggested to enhance efficiency and material consumption, such as total material handling cost (TMHC) and decreasing CO<sub>2</sub> total emission ( $E$ ) from various equipment during production time. Apart from CO<sub>2</sub> emissions, the main goal of this bi-objective problem to cost criteria is to address highly significant aspects in the location

process. Then CO<sub>2</sub> emissions for industrial companies are not only a legal need, but also a production process for corporations to compete. The output regularity is closely related to the suggested plant layout design; however, the interdepartmental flow values and functional annotation are very important variables to consider in the cell process [29].

The energy consumption of a commonly used material handling vehicle [30] on an industrial floor shop is primarily determined by the number of hours and shifts that it has been utilized. The Gas Technology Institute (GTI) projected yearly runtimes in various industries ranging from 500 hours to 3500 hours for battery-powered material handling vehicles and 1800 hours to 1900 hours for internal combustion engine-powered vehicles in 1995 [30]. The first agency’s centre length is calculated first, and then the other agencies’ centres are measured, resulting in the centre-to-centre length between each section. Measurements were taken, and the distance between each division was recorded; in total, 15 systems can be considered, as in Fig.1.

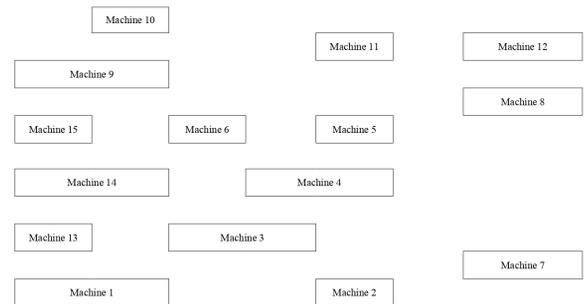


Fig. 1. Existing layout

### 2.1 Objectives of Proposed Model

The following objectives of proposed model were observed:

- The goal of our research is to develop route and transport strategies that provide the optimal balance of TMHC travel and CO<sub>2</sub> emissions.
- To create the best layout while taking into account of the distance between departments for manufacturing materials management among terminals
- The focus is to reduce the overall CO<sub>2</sub> emissions using an Adaptive Salp Swarm Optimization (ASSO), i.e., Meta heuristic optimization technique.
- To compare the outcomes of the ASSO models with those of other methods, such as ant bee

colony (ABC), dragon fly optimization (DFO), simulated annealing (SA), and genetic algorithm (GA), in terms of the goals.

## 2.2 Mathematical Modelling for the Optimization Technique

The BOO approach, as a result, produces a transaction situation in which the responsible party has the ability to visualize the design along with adequate options to meet all of the primary objectives. The final layout design aims to lower the total CO<sub>2</sub> emissions from the workstation. The proposed optimization technique, ASSO, has a positive correlation with the reduction of overall flow and energy consumption at the various department positions. The resulting operating plans must then be as cost-effective as possible while also reducing CO<sub>2</sub> emissions. These two goals are not always in sync; in some situations, they are in direct opposition to one another.

a) Total Material Handling Cost (TMHC). Materials management costs are an important part of a manufacturer's profit calculation. If these are disregarded while assessing production costs, the company's potential profit will be overestimated. Analysing material costs also aids the organization in devising strategies to cut future costs. Costs differ depending on the industry and location [30]. To reduce handling costs and maximize available space, the functional areas should be organized close together but not in conflict with one another. This is described below in Eq. (3) and Eq. (4).

$$TMHC = \sum T_{ij} \cdot M_{ij} \cdot D_{ij}, \quad (3)$$

$$\min(E) = \text{weight}(TMHC), \quad (4)$$

here,  $T_{ij}$  are the cost for the material transport between the machines,  $M_{ij}$  materials flow between the machines and  $D_{ij}$  distance between machines. If a corporation distributes multiple products at once, it must divide handling costs among them to acquire an accurate estimate of each product's actual cost [30].

b) CO<sub>2</sub> Emission Level. The rate of CO<sub>2</sub> emission provides a clear picture of an industrial organization's international environmental approach. Pollution from the engine can be calculated using the quantity of gas consumed. Forklifts generally utilize conventional diesel, and since they are off-road vehicles, they are not subject to road fees. The total amount of CO<sub>2</sub> produced per ton of vehicle is determined

by the number of vehicles, the average distance travelled, and the amount of fuel consumed in vehicles, as well as the unpredictable impacts of climate change. This is written in the equation Eq. (5).

$$E_{total} = E_{start} + E_{hot} + E_{Evaporative}, \quad (5)$$

here  $E_{total}$  is the total emission,  $E_{hot}$  it denotes emission during hot engine conditions,  $E_{start}$  denotes emission during the start of the engine,  $E_{evaporative}$  denotes emission due to evaporation. Whenever an engine motor is restarted at a lower-than-normal operating temperature, typically, the criteria utilized to construct a matrix of length, duration, and price between all distribution centres and the depots are separation, time, and cost. The goal now is to develop routes that emit the least amount of CO<sub>2</sub> into the atmosphere; to accomplish this, a vehicle with CO<sub>2</sub> emission matrix based on the estimated CO<sub>2</sub> emitted between every link must be created [31].

## 2.3 Procedure of Salp Swarm Optimization

Salps play a role in the reconciling process; it includes a swarm. Their cells are remarkably similar to those of jellyfish. It travels in the same way that jellyfish do, with liquid pumped through the body as an impetus to move forward. Normally, the swarm's goal is to take the most space from a food supply. Going with the scenario is suggested to inform the present status, as well as a flow diagram shown in Fig. 2.

(i) Initialization: The system structure weights are relegated as the initial solution when using the salps. The number of assignments is decided by the additional sub term occurrences [31], in the material depicting the machine and the function represented in condition mentioned in Eq. (6).

$$\mathbf{R} = \begin{bmatrix} R_{11} & R_{12} & \dots & R_{1n} \\ R_{21} & R_{22} & \dots & R_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ R_{n1} & R_{n2} & \dots & R_{nn} \end{bmatrix}. \quad (6)$$

The vector terms in the  $R$  direction of cypher to minimize the optimization problem via a benchmarking problem are derived from constraints Eq. (6).

(ii) Objective Function for Condition Evaluation. This trend is important for both information cost and emissions in any situation where the cost and emission rate must be kept to a minimal. Its fitness appears to be in good shape Eq. (7).

$$\min \sum \sum \text{TMHC and emission cost.} \quad (7)$$

(iii) **New solution Updating Procedure:** The first vector is the leading salp. It will, to some extent, migrate towards food as the leader to fulfil its leadership role. Normally, the swarm's purpose is to obtain food from the hunt space, which is seen in Fig. 3, the following condition Eq. (3) to Eq. (5) is proposed to update the leader's situation:

$$\text{Swarm } (New)_j^i = \begin{cases} T_j + Q_1 [(H_j - L_j)Q_2 + L_j], & Q_3 \geq 0 \\ T_j - Q_1 [(H_j - L_j)Q_2 + L_j], & Q_3 < 0 \end{cases}, \quad (8)$$

$$Q_{1...3} = 2e^{(-4t/L)}, \quad (9)$$

$$\text{weight}_j^i = \frac{1}{2} [w_j^i + w_j^{i-1}]. \quad (10)$$

where  $T_j^1$  signifies the position of the first part (leader) in  $j^{\text{th}}$  cell. The position of the machines in  $j^{\text{th}}$  cell is symbolized as  $T_j$ ; the upper bound and lower bound is indicated as  $H_j$  and  $L_j$ ;  $Q_1$ ,  $Q_2$  and  $Q_3$  indicates a random number randomly generated in the interval of [0,1].

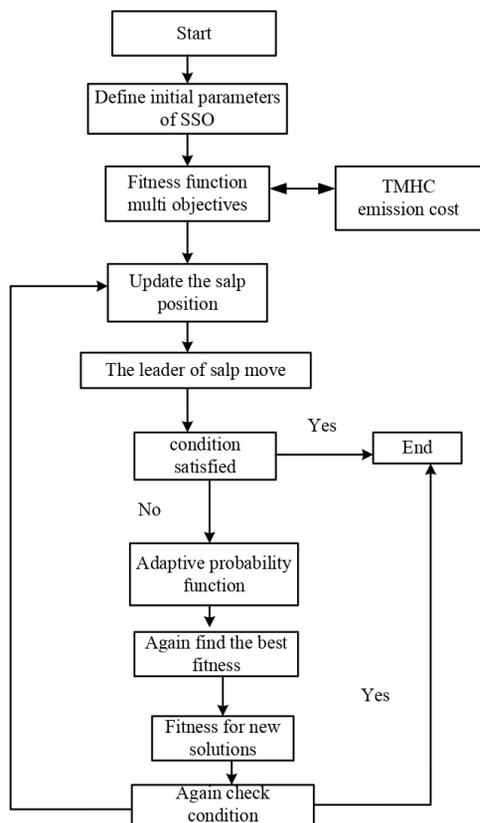


Fig. 2. Flow chart for ASSO

The coefficient is the most essential parameter in SSO since it affects the exploration and exploitation shown in Eq. (10), as well as the next step: weight discovery. The food supply will be refreshed during optimization, as the salp chain is known for exploring and exploiting the space around it in pursuit of a better solution.

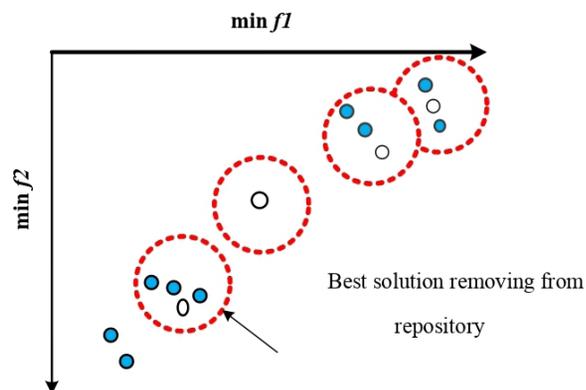


Fig. 3. Repository update

(iv) **Adaptive function.** To find a new solution for perfect fitness, use the coefficient vector acquired from the flexible probability function. The best features include less parameter dependence, the elimination of the need to describe the initial parameter, and the ability to change step size or position towards an ideal solution based on its functional fitness value through iteration, in order to discover the coefficient vector received by the flexible probability function.

$$y \Rightarrow \text{Probability} = \begin{cases} \frac{C_1(f_{\max} - f_x)}{(f_{\max} - F_{\text{avg}})}, & f_x \geq F_{\text{avg}} \\ C_3, & f_x \leq f_{\text{avg}} \end{cases}, \quad (11)$$

where  $f_{\min}$  and  $f_{\max}$  as greatest and least fitness functions, and  $C_1$  and  $C_3$  range between (0, 1). Throughout the iteration, the position toward an ideal solution adapts as indicated by its functional fitness value. As a result, when meta-heuristic algorithms are combined with adaptive systems, less computing time is required to find an optimal solution, nearby minimum avoidance is avoided, and convergence is faster.

The method for dealing with the green logistics problem is as follows:

- The location of each salp is obtained by initialising the salp population.

- The objective function is used to calculate the fitness for each salp position (TMHC and emission cost).
- Sort through all of the fitness and choose the best one to use as a food source.
- The first half of the people were picked as leaders, while the rest were chosen as followers.
- Update the salp leader’s position using an equation, as well as the salp followers’ positions.
- Use the salp’s global optimum position as a new feeding source.

### 3 RESULTS AND DISCUSSION OF SIMULATION ANALYSIS

The test issue is supplied in the division using this input data and the mathematical model created in MATLAB 2020a with an Intel core i5 and 4GB RAM system setup. The efficiency of an answer in terms of minimizing travel lengths is compared using our method in contrast to other meta-heuristics such as ABC, DFO, SA, and GA, as shown in Table 1.

**Table 1.** Simulation parameters for modelling

Parameters	Values
Population size	120
Number of iterations	300
Fix handling cost	2151829
Number of machine shops	15

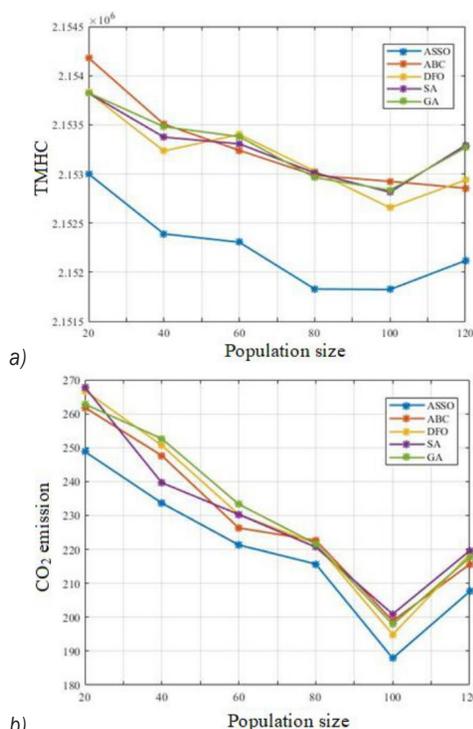
An assessment of the resolution quality in terms of minimizing travel lengths is made by comparing this improved technique with other methodologies that have not been attempted or for which a feasible solution has not been found in the literature. One goal of the comparison is to reduce the routing cost to the lowest level possible [32]. With respect to the number of iterations, our suggested optimizing technique delivers a minimum emission rate and TMHC with populations of 60 and 120 in Table 2.

**Table 2.** Bi- objectives results of ASSO model

Iteration	Population size= 60		Population size= 120	
	TMHC	Emission rate	TMHC	Emission rate
100	2153000	248.82	2151278	244.2
150	2152390	233.64	2151193	236.6
200	2152305	221.3	2151013	179.25
250	2151829	215.68	2150923	162.16
300	2151824	187.9	2150834	134.6

Fig. 4 depicts the convergence graph as population size changes, including ABC, DFO, SA, and GA with

proposed optimization issues for TMHC comparison. While traditional single-objective vehicle routing algorithms are unable to investigate the conflicting behaviour of objectives, the ASSO algorithm is capable of doing so for a bi-objective vehicle routing problem. In addition, inventory management emissions are decreased by reducing cycle time, which reduces the quantity of replenishment items and, as a result, reduces energy consumption. Considering the relationship between energy consumption and emission in various logistics activities [19], the appropriate cycle time for an efficient solution must be short enough to minimize total energy consumption while still being long enough to avoid too frequent replenishing.



**Fig. 4.** Convergence graph respect to population size; a) TMHC, and b) CO<sub>2</sub> emission

Total cost and total emission rate estimations include transportation, inventory management, and material-handling processes [33]. Material-handling operations include loading and unloading the utilized vehicle with products for refilling the goals. The utilized vehicle is restocked at the design constraint (DC) before being dispatched to resupply each sub-tour on each cycle trip. The final layout design’s purpose is to lower the total CO<sub>2</sub> emissions from the workstation [1]. The reduction of total flow and energy consumption in proportion to population size

is strongly correlated with the locations of various departments in ASSO. One goal of the comparison is to reduce the routing cost to the lowest level possible. In terms of solution quality, the suggested model has proven to be economical with the finest available approaches. Fig. 5 shows the emission of TMHC as a function of iteration from 100 to 300, with the curve decreasing as the iteration level increases. Similarly to emission parameters, the difference between iteration level and objective function is 0.13 % to 0.25 %.

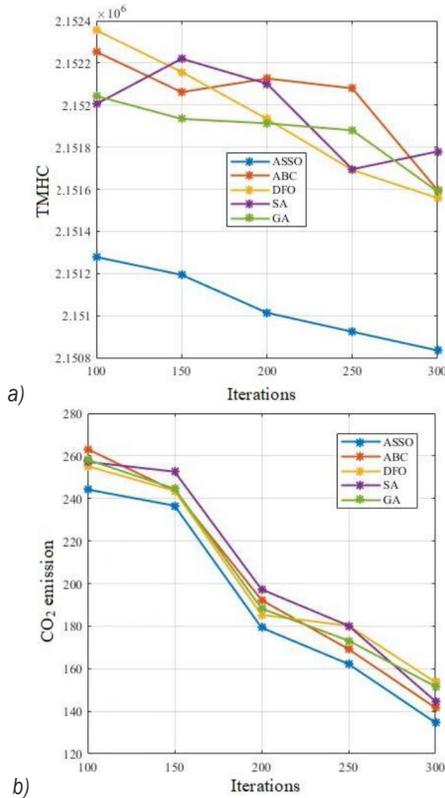


Fig. 5. Convergence respect to number of iterations: a) TMHC, and b) CO<sub>2</sub> emission

The bi-objective function of the green logistics issue is shown in Fig. 6. Because customer demands are unpredictable, the following operations are repeated multiple times for each entire trip, with the average utilized to calculate the total travel cost [35]. The reason for this is that if there are too few customer queries for a certain route, truck capacity may be wasted, raising the overall cost of the route. The values of all objective functions are shown in this table as a function of population size. The difference between TMHC in ASSO and ABC is 10 %, while DFO's other algorithm is 12 %, 19 %, and emission parameters are similar.

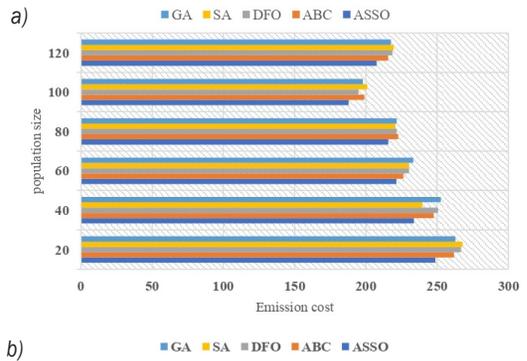
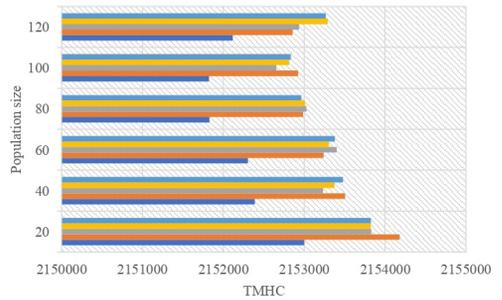


Fig. 6. Comparative analysis for bi-objective function (iteration = 300); a) TMHC, and b) CO<sub>2</sub> emission

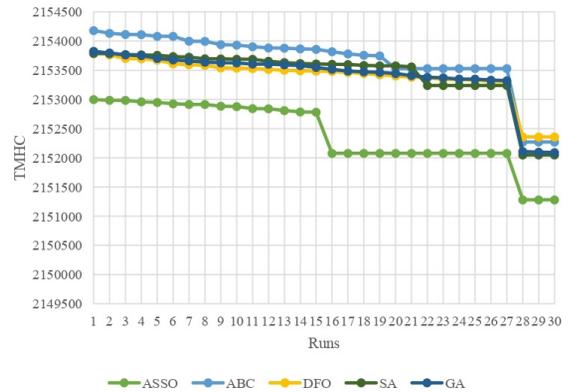


Fig. 7. Number of runs based results for TMHC (population size = 90, iteration = 300)

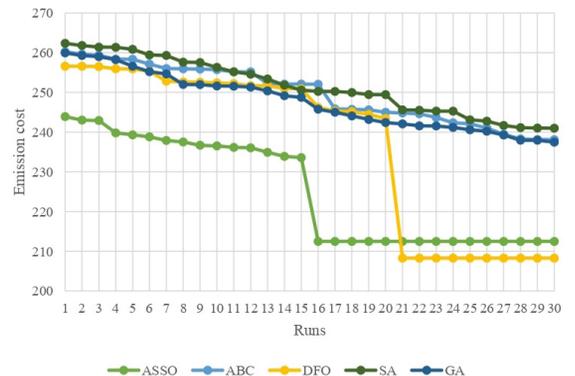


Fig. 8. Number of runs based results for CO<sub>2</sub> emission (population size = 90, iteration = 300)

Figs. 7 and 8 depict the several runs of the objective function in the carrying-out section, which is one of the membrane framework’s key strengths. In ASSO, communication is between the control subsystem and the two operating systems [34], where the control subsystem applies a guiding approach to speed up convergence and improve solution quality. It can be seen that ASSO outperforms other optimization methods in terms of identifying solutions with lower overall costs shows in Fig. 6; this advantage is especially apparent when optimizing the total cost goal, and Fig. 7 shows the reduced emission rate.

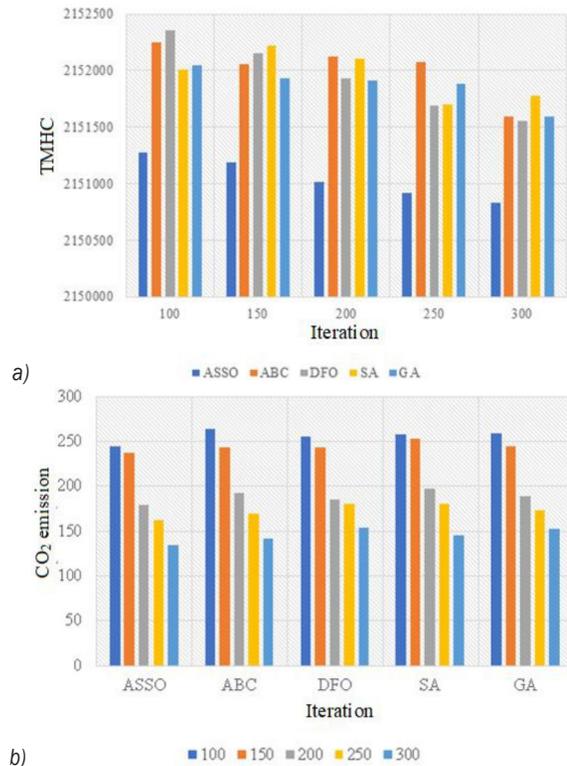


Fig. 9. Comparative analysis; a) TMHC, and b) CO<sub>2</sub> emission

Fig. 9 depicts a comparison of the objective function TMHC and the emission cost, with one goal in mind: minimizing the route cost over the viable options. In terms of solution quality, the suggested algorithm has demonstrated the best available solutions. Fig. 9a depicts the optimization technique’s TMHC values. It will be a nonlinear graph. Fig. 9b shows the emission rate comparison values for various optimization procedures, as well as the emission cost and emission rate that are close the best solutions. The best facility layout [35] can be selected after running simulation results for different iterations and temperature conditions, as per set Table 1 parameters,

and final layout after simulation runs, as shown in Fig. 10.

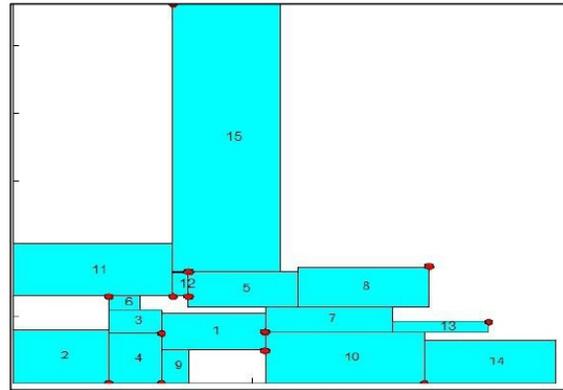


Fig. 10. Best shop floor layout

The new variant ASSO optimization technique has demonstrated significant cost savings in terms of material handling, with savings averaging 50 % when compared to other chosen techniques, according to this comparative analysis. Additionally, graphs of comparative emission rates for lower emission levels are shown. This implementation methodology can be effective in lowering emission rates and is very helpful for setting up new plant layouts prior to the installation of equipment. The main flaw in this methodology is that it necessitates complete layout design constraints for algorithm setup and development. In a select few instances, it will create intricate plant layout arrangements while taking into account all available resources [36].

#### 4 CONCLUSION

The goal is to create workspaces that reduce vehicle emissions. This study looked at three major sources of CO<sub>2</sub> emissions in industries: TMHC associated with interdepartmental traffic, and emissions with gas consumption and electric consumption [37]. The target function in the proposed optimization ASSO model reflects a mix of the above three variables to make a green layout with as optimal vehicle emission rates as possible.

- The ASSO method uses a string of customer identities to signal the delivery sequence that a vehicle should cover throughout its route, functioning as a separator between two alternative swarm paths. Several experiments were conducted in order to exhibit the efficiency of the projected measures. The search history,

trajectory, average fitness, and closure curve were used as the first qualitative metrics.

- The proposed method was reasonably sufficient in comparison to the best available marks and the standard ASSO compared to ABC, DFO, SA, and GA performances were adequate, according to the results. This green layout design, 50 % TMHC and 25 % minimal emission rate were compared to other optimization techniques.

## 5 FUTURE SCOPE

Different hybrid optimization techniques will be used in the future to address the objective function in green logistics problems. Furthermore, the methods used to estimate the optimal adjustments can converge at the local optimal points [38], as this will result in a useful plant layout.

## 6 NOMENCLATURE

$E$	total emission from a vehicle, [kg/min]
$q$	load, [kg]
$d$	path way/distance travelled, [km]
$Q$	volume capacity at full load, [kg]
$R$	random matrix variable selection from constraints,
$y$	probability function.

## 7 ACKNOWLEDGEMENTS

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