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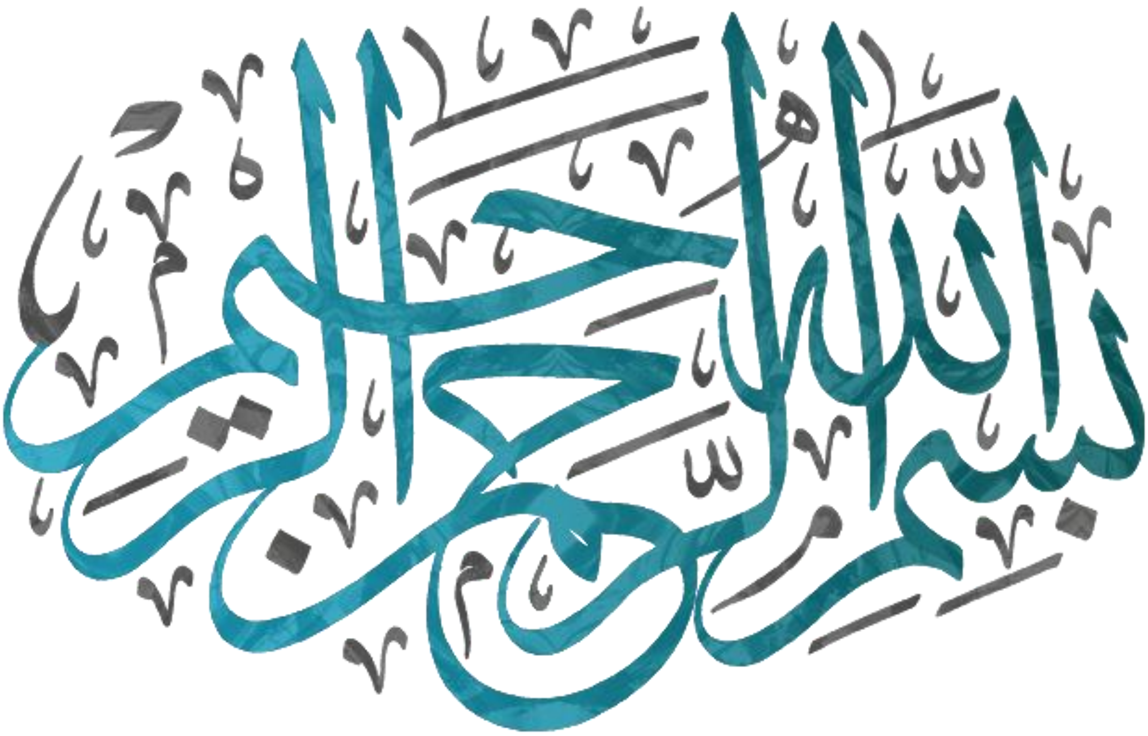
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كلمة العدد

كلمة العدد: رحلة جديدة في آفاق المعرفة التطبيقية

بسم الله الرحمن الرحيم

يسرنا في الأكاديمية الأمريكية الدولية للتعليم العالي والتدريب أن نقدم لكم بفخر واعتزاز **العدد الرابع من المجلة الأمريكية الدولية للعلوم التطبيقية والصرفة** .هذا العدد ليس مجرد إصدار جديد، بل هو محطة أخرى في مسيرتنا المتواصلة لدعم البحث العلمي ونشر المعرفة الرصينة التي تسهم في تقدم البشرية.

إن ما يميز هذا العدد بشكل خاص هو أنه يمثل ثمرة جهود علمية مكثفة، حيث يضم مجموعة مختارة من الأبحاث المتميزة التي شاركفيها مجموعة من الباحثين . .لقد كانت المجلة، ولا تزال، منصة حيوية لتبادل الأفكار والرؤى بين نخبة من الباحثين والعلماء من مختلف أنحاء العالم، ونجحت في استقطاب دراسات مبتكرة تعالج قضايا معاصرة في صميم العلوم التطبيقية والصرفة.

لقد تناولت البحوث المنشورة نقاشات علمية عميقة، عكست التطورات المتسارعة في ميادين مثل **الذكاء الاصطناعي، والطاقة المتجددة، والعلوم البيئية، وعلوم المواد، والرياضيات التطبيقية، والفيزياء، والكيمياء**، وغيرها من التخصصات الحيوية. الأبحاث المنشورة في هذا العدد تعكس هذا التنوع والعمق، وتوفر لقرائنا نافذة على أحدث الابتكارات والنتائج البحثية التي تشكل ملامح مستقبلنا.

إننا نؤمن بأن العلوم التطبيقية والصرفة هي المحرك الأساسي للتقدم التكنولوجي والاقتصادي والاجتماعي. فمنها تنبع الحلول لمواجهة التحديات العالمية، كالتغير المناخي، والأمن الغذائي والمائي، وتطوير الرعاية الصحية. ومن هنا، تأتي أهمية المجلة كمنصة لنشر هذه الحلول والرؤى، وتشجيع المزيد من البحث والتعاون.

أود أن أتوجه بخالص الشكر والتقدير لكل من ساهم في إثراء هذا العدد:

- وخاصة للفريق التحريري المتميز على عمله الدؤوب لإخراج هذا العدد بالشكل الذي يليق بمكانته العلمية.

نأمل أن يجد القراء في هذا العدد مادة علمية ثرية وملهمة، تدفعهم نحو المزيد من البحث والتفكير النقدي. ونتطلع إلى استمرار دعمكم ومشاركاتكم في أعدادنا ومؤتمراتنا القادمة، لتبقى المجلة الأمريكية الدولية للعلوم التطبيقية والصرفة منارة للمعرفة والإبداع.

والله ولي التوفيق.

فهرس الموضوعات

The Adoption of Hybrid Swarm Intelligence Algorithm in The Optimal Allocation of Physical Cloud Manufacturing Resources

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Abstract

There is a close relationship between the cloud manufacturing environment (CMfg) and the optimal Allocation of resources for this manufacturing, because resources represent the largest nerve of industrial companies, so it has become an important requirement to focus work on the Allocation of those resources. These resources are related to products in the manufacturing lines of industrial companies, that is, the optimal Allocation of machines and workers, reducing Time and cost, improving the quality of Service provided to the customer and load balancing for manufacturing operations. In addition, swarm intelligence algorithms have proven their relevance and efficiency in solving complex optimization problems, especially the problem of optimal Allocation of cloud manufacturing resources (CMfg). Therefore, In this study, a hybrid algorithm consisting of the particle swarm algorithm(PSO) and the ant colony optimization algorithm(ACO) was proposed to reach the optimal Allocation of cloud manufacturing resources (CMfg) for the torrent sealing product (TOS) by placing the optimal solution obtained from the particle swarm algorithm and placing it back into the ant colony algorithm by adding pheromones to obtain the hybrid algorithm(AC-PSO) that gives the optimal solutions. The objective function here consists of four goals that represent the optimal Allocation of resources by reducing Time and cost, load balancing and the quality of the Service provided. The results obtained showed the effectiveness and efficiency of allocating cloud manufacturing resources using the three algorithms and the hybrid algorithm (AC-PSO) in particular. Where the optimal technical path of manufacturing the transformer has been reached, reducing the Time from (560) to (310), the cost from (9352000) to (5177000) ID, the load balance from (82%) to (70%), the quality of Service from (90%) to (70%) and Salary average of Worker from (6800000) to (6000000) ID.

Keywords: Cloud Manufacturing, Optimisation, Resource Allocation in CMfg, Hybrid Algorithm, Quality of Service (QoS).

اعتماد خوارزمية ذكاء السرب الهجينة في التخصيص الأمثل لموارد التصنيع السحابي المادية

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الملخص

هناك علاقة وثيقة بين بيئة التصنيع السحابي (CMfg) والتخصيص الأمثل للموارد في هذا المجال؛ نظراً لأن الموارد تمثل العصب الأساسي للشركات الصناعية، فقد أصبح التركيز على تخصيص هذه الموارد متطلباً مهماً. ترتبط هذه الموارد بالمنتجات في خطوط التصنيع للشركات الصناعية، مما يعني التخصيص الأمثل للآلات والعمال، وتقليل الوقت والتكلفة، وتحسين جودة الخدمة (QoS)المقدمة للعميل، وموازنة الحمل لعمليات التصنيع. بالإضافة إلى ذلك، أثبتت خوارزميات ذكاء السرب فاعليتها وكفاءتها في حل مشكلات التحسين المعقدة، لا سيما مشكلة التخصيص الأمثل لموارد التصنيع السحابي. بناءً على ذلك، تقترح هذه الدراسة خوارزمية هجينة تتكون من خوارزمية تحسين ازدحام الجسيمات (PSO) وخوارزمية تحسين مستعمرة النمل (ACO) للوصول إلى التخصيص الأمثل لموارد التصنيع السحابي (CMfg) لمنتج المحولات(Transformer) ، وذلك من خلال توظيف الحل الأمثل الذي تم الحصول عليه من خوارزمية ازدحام الجسيمات (PSO) وإعادة إدخاله في خوارزمية مستعمرة النمل بإضافة الفيرومونات؛ للحصول على الخوارزمية الهجينة (AC-PSO) التي تقدم الحلول المثلى. تتكون دالة الهدف في هذه الدراسة من أربعة أهداف تمثل التخصيص الأمثل للموارد من خلال تقليل الوقت والتكلفة، وموازنة الحمل، وجودة الخدمة المقدمة. أظهرت النتائج التي تم التوصل إليها فاعلية وكفاءة تخصيص موارد التصنيع السحابي باستخدام الخوارزميات الثلاث، والخوارزمية الهجينة (AC-PSO) على وجه الخصوص. حيث تم التوصل إلى المسار التقني الأمثل لتصنيع المحولات، مما أدى إلى تقليل الوقت من (560) إلى (310)، وخفض التكلفة من (9,352,000) إلى (5,177,000) دينار عراقي، وتحسين موازنة الحمل من (82%) إلى (70%)، وجودة الخدمة من (90%) إلى (70%)، ومتوسط أجور العمال من (6,800,000) إلى (6,000,000) دينار عراقي.

الكلمات المفتاحية: التصنيع السحابي، التحسين (الاستمثال)، تخصيص الموارد في التصنيع السحابي، الخوارزمية الهجينة، جودة الخدمة.(QoS)

1. Introduction

Encourage electronics manufacturers to use their resources effectively to meet dynamic customer demand. As decision makers determine the required level of resources by evaluating the technical requirements of products, one of the most common issues that arises is that the demands and desires of customers are changing quickly, which has led to the need to work towards reducing production cycle times in many industries, including the electronics industry. Because the scope of customer use of these industries' products has expanded rapidly in all human activities, the efficient use of resources will have a significant impact on the efficiency of manufacturing processes. Decision-makers calculate the quantity of various machine kinds required to evaluate the technical requirements for the electronic devices or parts, such as the complexity of the product and the number of components, and relying on human experience, which may cause bias easily and production performance cannot guaranteed as estimates vary from one decision maker to another, and therefore requires the Allocation of sufficient material resources for production optimally, and in interest of the current study in the electronics industry, there are no systematic methods to determine the percentage of waste for different resources, and therefore the need to rearrange them for determining a sufficient amount of resources, especially production resources [1,2,3,4,5,6,].

The literature that dealt with the concept of resource allocation confirmed that this topic concerns getting the ideal compatibility for allocating available resources to the required tasks by maximizing or minimizing a certain measure of allocation efficiency for several Indivisible goals, such as maximizing profits or reducing costs. The basic elements of resource allocation are the amount of those resources, the type, and where they are placed. According to this perception, the Allocation of resources is selecting and assigning the ones strategically to a task to support the business objectives, and thus deals with the appointment or assignment of individuals to the business according to their skills, experience and qualifications in a timely manner, in addition, this orientation considered as its appropriate Allocation of activities or tasks in order to get the optimal solution economically, and can improve the effectiveness of that Allocation in terms of productivity, efficiency and effective exploitation of limited ones while avoiding delaying the deadline for product delivery, therefore, manufacturers are trying to achieve effective exploitation of resources to acquire the ability to competitiveness in their industries [7,8,9,10,11,12,13,14,15].

Because of the changes taking place in the markets today, the effective Allocation of resources has become of great importance, especially in the electronics and electrical appliances industry, and the pressure caused by the trend of designs and models of products (product and Service), as well as there is an urgent need for the success of this industry to shorten the lead times for obtaining new products, and although the effective Allocation of resources is one of the important criteria for responding to these market changes, but in reality it is a complex task, as electronics manufacturing involves different machines, a skilled workforce and thousands of packages of parts and components to produce different products simultaneously, and because traditional decision-making in these Industries involve resource allocation that is highly dependent on human expertise, and therefore takes a long time in an industry that is sensitive to Time, cost, quality and load balance. Therefore, any delay in deciding will prolong the entire product cycle time and cause the company to lose its competitiveness [16,17,18,19,20,21,22,23]. In this study, the swarm intelligence algorithms of ants (ACO), particle swarm (PSO), and hybrids of both (AC-PSO) will be used to reach the optimal Allocation of cloud manufacturing resources for the seal torrent product and compare the three algorithms used and determine which is the best in reaching the optimal solution.

2. Statement Description

The key to the success of cloud manufacturing is the optimal Allocation of its resources, as this Allocation helps to achieve efficiency and make maximum use of virtual, physical and production resources. It contributes to the delivery and development of products and services more efficiently and easily with the least Time and cost, optimal quality of Service, load balancing and efficient use of resources. The problem of allocating cloud manufacturing resources begins with the first step of the cloud manufacturing platform when the customer begins to post his request for a (product/service), after which the request is transferred to the factories related to the request to carry out the task, and before producing the order, manufacturing resources must first be allocated optimally through artificial intelligence, specifically swarm intelligence algorithms, to ensure the operation and continuation of the product manufacturing process easily and efficiently and delivered to the customer within the specified delivery time [24,25,26,27,28]. In this work, having studied the seal torrent product, suppose that there are four parts to the Process, and each of these parts has its associated resources. These resources must be allocated to optimally process the torrent seal product, which ensures on-time delivery of the order by reducing the Time, cost, load balance and quality of molecular Service for each processing and then for the entire manufacturing process. The process task is split into several subtasks [Oc1, Oc2, Oc3, Oc4] in Table 1 and Figure 1. Then, prepare resources based on the task requirement and the characteristics of the resources.

Table 1. Initial Matrix of Manufacturing Task Before Allocation

it	*process*	*No. of. machine*	*No. of. worker*	*Time(m)*	*Cost(m)*	*QoS%*	*LB%*
1	Oc1	4	5	20	3340	0.9	0.8
2	Oc2	6	8	16	2672	0.9	0.7
3	Oc3	1	2	8	1336	0.9	0.9
4	Oc4	0	2	12	2004	0.9	0.9

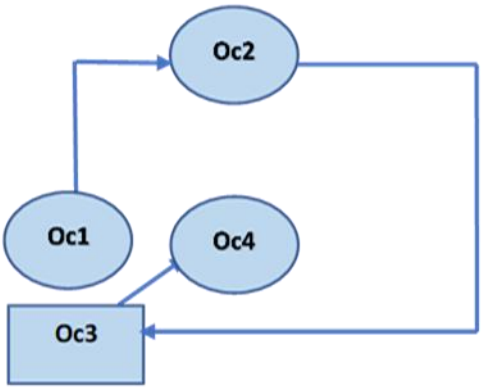


Figure.1 The Technical Route for Torrent Seal Manufacturing Task

3. Methodology

3.1. The Parameters

The parameters of the proposed model represent the objective function of the problem of optimal Allocation of resources and the functions of allocation goals, that is, the objectives of the objective function, namely the functions of Time, cost, quality of Service, load balancing in below., which the current study seeks to reduce these goals by reaching the optimal solution in allocating the resources of the seal torrent product. (Raqeyah & Adel,2024)

Objective Function

$$F = min\{w_1C + w_2T + w_3Q + w_4B\} \quad \dots \dots .. (1)$$

Cost(C)

$$min\ C = \sum_{i=1}^{n} C_i \quad \dots \dots \dots (2)$$

Constraint for Cost

$$\sum_{j=1}^{i} C_{ij\,xij} = Ci \qquad \ldots\ldots\ldots(2-1)$$

Time(T)

$$min\ T = \sum_{i=1}^{n} T_i \qquad \ldots\ldots\ldots(3)$$

Constraint for Time

$$\sum_{j=1}^{i} T_{ij\,xij} = Ti \qquad \ldots\ldots\ldots(3-1)$$

Quality of Service(Q)

$$min\ Q = \sum_{i=1}^{n} Q_i \qquad \ldots\ldots\ldots(4)$$

Constraint for QoS

$$\sum_{j=1}^{i} Q_{ij\,xij} = Qi \qquad \ldots\ldots\ldots(4-1)$$

Load Balance(B)

$$min\ B = \sum_{i=1}^{n} B_i \qquad \ldots\ldots\ldots(5)$$

Constraint for Balance

$$\sum_{j=1}^{i} B_{ij\,xij} = Bi \qquad \ldots\ldots\ldots(5-1)$$

Conditions: The probability condition for a decision variable is: $xij \in (0,1)$. That is, it takes a value equal to (1) in the case of verification and a value equal to (0) in the case of non-verification.
Where: F is the target function, n is the number of instances, and ij is the Time between nodes (resources).
Xij is the value of the decision variable (0,1), which is either equal to zero or one.

3.2. ACO Algorithm

1. The initial information matrix is represented by Table .1, which describes the manufacturing processes of the seal torrent product with Time, cost, quality of

Service, load balancing, for each processing, which represents the initial community and this step also represents the distance between ants and various resources, as well as the configuration of the number of ants, the initial value of the pheromone rate, the number of repetitions, and other factors. It is by relying on this initial matrix of the product that a number of paths are generated.

2. Finding the Fitness Value

This step represents the movement where the ants will move between different resources according to their personal decisions and the effect of the accumulated pheromone, so the fitness value(trade-off) is found for each product path according to the equation of the target function(1), the equations of Time(2), cost(3), quality of Service(4), Load Balancing(5) in Table 2., mentioned above to generate paths that represent possible solutions and then search for the best path for each product and with the least Time, cost, quality of Service, load balancing.

3. Finding the probabilistic values of the allocation goals for participation and for all tracks in the primary community.

In this step, the probabilistic values of each resource are found for the objectives (cost, Time, quality of Service, load balancing) by adopting a trade-off in the assessment aimed at reduction, i.e. preference for routes that have the lowest probabilistic values. The available resources are selected based on the probabilistic values of each resource (for each manufacturing process).

4. Update

After selecting the best paths in the previous(third) step, the pheromone matrix is updated in this step by updating the matrix of various resources based on the efficiency of their use.

5. Iteration

The second, third and fourth steps are repeated for a number of cycles until the termination Criteria are reached, represented by the following:

- Reach the maximum frequency.
- Reaching the perfect solution.
- To take into account the priorities and sequence of production stages for each product, while accepting the new, stronger tracks and retaining the highest quality of them.

6. Solution Analysis

In this step, the solutions reached after the execution of the algorithm are analyzed in all its steps, with a number of cycles (100) and an execution time of 35.4 seconds. That is, these steps are repeated until the ants move towards the optimal solution to the problem of resource allocation, and this behaviour is characterized by the ability to pass obstacles and discover new paths gradually, ultimately leading to a balance between new solutions and the exploitation of good solutions that have already been discovered [29,30].

STEP 0: Initialize:
a) Set iteration counter t=0.
b) Set pheromone level on all edges to τ_0.

STEP 1: Construct solutions for each ant γ (i.e., for $\gamma=1$ to Υ):
Generate a tour by adding an edge from $tabu^{\gamma}$ using the following:
a) With probability q, the node with the maximum pheromone level.
b) With probability d, a discrete probability distribution with edge probability $\Pr^{\gamma}_{(i,k),(r,s)}(t)$.
c) With probability r, random selection.

STEP 2: Local search (Optional)

STEP 3: Evaluate the fitness of each solution.

STEP 4: Keep the best solutions in a list. If not optimal (i.e., ARPI is not zero) and t < MaxIterationCount, then update the pheromone levels on the network via evaporation and incremental pheromone update processes.

STEP 5: Set $t=t+1$. Go to Step 1.

Figure .2 Pseudocode for ACO Algorithm

3.3. PSO Algorithm

This algorithm aims to optimise candidate solutions by modifying and optimising the positions of a group of birds in the search space. Its steps are as follows:

1. Initialisation

In it, the number of particles(birds) in the search space is configured, as each bird represents a potential solution, the size of the flock, the initial distance matrix, i.e. the time matrix, cost, quality of Service, load balancing, for each product.

2. Movement and Improvement

Calculation of fitness value

- Particle positions are updated based on their previous movement and improved.
- The movement of each particle is determined based on the direction of movement of the preference (the particle with the best performance so far) and the direction of the personal particle (its subjective preference).

3. Update

- The information on the personal preferences of each gross and the general preference of the group is updated.
- The preference value is used to determine the direction of Future Movement.

4. Iteration

The algorithm is repeated for a certain number of cycles, with a number of (100) cycles and with a time of (35.4) seconds, or until the Stop condition is met.

5. Termination Criteria

The Stop conditions are determined when an acceptable solution is reached or after a certain number of cycles, that is, the maximum repetition (100) is reached, taking into account the precedents and the sequence of stages of the manufacturing process of the product as a whole.

6. Solution Analysis

The solutions reached are analysed after the completion of the research process [31,32].

step 1. Initialize Optimization.

step 1.1 Initialize algorithm constants, t_{max}, P.

step 1.2 Initialize randomly all particles positions x_t^i and velocities v_t^i.

step 1.3 Evaluate objective function value as $f(x_t^i)$ in equation (1).

step 1.4 Assign best positions $p_t^i = x_t^i$ with $f(p_t^i) = f(x_t^i)$, $i = 1, \dots, P$.

step 1.5 Find $f_t^{best}(p_t^{best}) = \min\{f(p_t^1) \dots, f(p_t^i) \dots, f(p_t^P)\}$ and initialize $p_t^g = p_t^{best}$ and $f(p_t^g) = f^{best}(p_t^{best})$.

step 2. Perform Optimization

while $(t \leq t_{max})$

step 2.1 Update particle velocity v_t^i and position x_t^i, according to equation (2) and equation (3) of all P particles.

step 2.2 Evaluate objective function value as $f(x_t^i)$ in equation (1).

step 2.3 Update particle best position if $f(p_t^i) > f(x_t^i)$ then $p_t^i = x_t^i$ with $f(p_t^i) = f(x_t^i)$.

step 2.4 Find $f_t^{best}(p_t^{best}) = \min\{f(p_t^1) \dots, f(p_t^i) \dots, f(p_t^P)\}$; if $f(p_t^g) > f(p_t^{best})$ then $p_t^g = p_t^{best}$ and $f(p_t^g) = f^{best}(p_t^{best})$.

step 2.5 Increment iteration count $t = t + 1$.

end while

step 3. Report best solution p^g of the swarm with objective function value $f(p^g)$.

Figure 3. Pseudocode for PSO Algorithm

3.4. The AC-PSO Hybrid Algorithm

A hybrid algorithm consisting of the ant colony algorithm(ACO) and the bird swarm algorithm(PSO) can be used by applying the concept of communication and interaction between the behavior of organisms inspired by both ants and birds, so that ants can benefit from the ability of birds to find the best place to fly and communicate with the rest of the swarm, while birds can benefit from the ability of ants to detect and determine the best path for the distribution of resources, this hybrid helps in the optimal Allocation of resources through a balance between performance, cost, Time, quality of Service, load balancing, in a manufacturing environment the cloud is the area of interest of the current study and its goal is to use these two algorithms together[33,34,35,36].

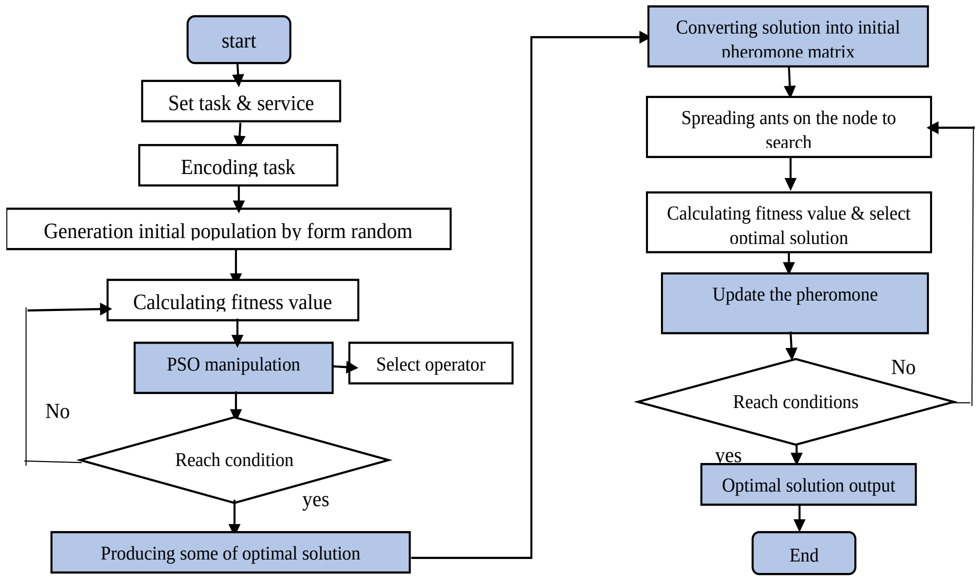


Figure 4. Flow chart of (AC-PSO) Hybrid Algorithm

step 1. Initialize Optimization.

step 1.1 Initialize constants for PSO and ACO processes, P, t_{max}.

step 1.2 Initialize randomly all particles positions x_t^i and velocities v_t^i.

step 1.3 Evaluate objective function value as $f(x_t^i)$ in equation (1).

step 1.4 Assign best positions $p_t^i = x_t^i$ with $f(p_t^i) = f(x_t^i)$, $i = 1,\ldots,P$.

step 1.5 Find $f_t^{best}(p_t^{best}) = \min\{f(p_t^1),\ldots,f(p_t^i),\ldots,f(p_t^P)\}$ and initialize $p_t^g = p_t^{best}$ and $f(p_t^g) = f^{best}(p_t^{best})$.

step 2. Perform Optimization

while ($t \le t_{max}$)

step 2.1 Update particle velocity v_t^i and position x_t^i, according to equation (2) and equation (3) of all P particles.

step 2.2 Evaluate objective function value as $f(x_t^i)$ in equation (1).

step 2.3 Generate P solutions z_t^i using equation (5).

step 2.4 Evaluate objective function value as $f(z_t^i)$ in equation (1) and if $f(z_t^i) < f(x_t^i)$ then $f(x_t^i) = f(z_t^i)$ and $x_t^i = z_t^i$.

step 2.5 Update particle best position if $f(p_t^i) > f(x_t^i)$ then $f(p_t^i) = f(x_t^i)$ and $p_t^i = x_t^i$.

step 2.6 Find $f_t^{best}(p_t^{best}) = \min\{f(p_t^1),\ldots,f(p_t^i),\ldots,f(p_t^P)\}$; if $f(p_t^g) > f(p_t^{best})$ then $f(p_t^g) = f^{best}(p_t^{best})$ and $p_t^g = p_t^{best}$.

step 2.7 Increment iteration count $t = t + 1$;

end while

step 3. Report best solution p^g of the swarm with objective function value $f(p^g)$.

Figure 5. Pseudocode for the AC-PSO Algorithm

To develop optimal solutions in this work were used, MATLAB2021 programming to calculate Experimental parameter setting for ACO algorithm: the population sample size is 60, the number of iterations is 100, $\alpha = 1$, $\beta = 6$, $\rho = 0.1$, Process divided to (4) task as follow, the parameters that were prepared and used for the PSO algorithm are as follows: (community size=60, maximum frequency=100, C1=1.49, C2=1.49), and The weight values of the four objective time T, cost C, quality of Service Qos, load balance LB are [w1, w2, w3, w4] = [0.3, 0.3, 0.2, 0.2]=1.

4. Results and Discussion

Table 2. Results of Manufacturing Task Resources Allocation by ACO

it	*Process*	*No. of. machine*	*No. of. worker*	*Time/m*	*Cost/ID*	*QoS%*	*LB%*
1	Oc1	4	5	18	3006	0.8	0.8
2	Oc2	6	8	15	2505	0.8	0.7
3	Oc3	1	2	6	1002	0.9	0.9
4	Oc4	0	2	10	1670	0.8	0.8

This optimal Allocation and savings in Time, cost, quality of Service, load balancing was reached as shown in Table (2) using the ACO algorithm and the optimal Allocation of internal processor resources Oc1, Oc2) and reached the optimal Allocation of these processors through the Allocation and optimal arrangement of the resources of these processors (machines and workers) together as shown in Table (3).

Table 3. Resources Allocation for Process (Oc1,Oc2)by ACO

Process	**Oc1**				**Oc2**					
Sub task	1	2	3	4	1	2	3	4	5	6
Machine Allocation	M3	M1	M4	M2	M5	M3	M1	M6	M2	M4
Worker Allocation	2	1	1	1	2	1	2	1	1	1

Table 4. Results of Manufacturing Task Resources Allocation by PSO

it	***Process***	***No. of. machine***	***No. of. worker***	***Time/m***	***Cost/ID***	***QoS%***	***LB%***
1	Oc1	4	5	16	2672	0.7	0.7
2	Oc2	6	8	14	2338	0.8	0.7
3	Oc3	1	2	5	835	0.8	0.8
4	Oc4	0	2	8	1336	0.7	0.7

This optimal Allocation and savings in Time, cost, quality of Service, and load balancing were achieved as shown in Table 4, based on the bird swarm algorithm (PSO) and the Process of optimal Allocation of internal processor resources (Oc1, Oc2) machines with workers as shown in Table 5.

Table 5. Resources Allocation for Process (Oc1,Oc2) by PSO

Process	**Oc1**				**Oc2**					
Sub task	1	2	3	4	1	2	3	4	5	6
Machine Allocation	M4	M3	M2	M1	M3	M1	M6	M2	M4	M5
Worker Allocation	1	1	1	2	2	1	1	2	1	1

Table6. Results of Manufacturing Task Resources Allocation by AC-PSO

it	*Process*	*No. of. machine*	*No. of. worker*	*Time/m*	*Cost/ID*	*QoS%*	*LB%*
1	Oc1	4	5	12	2004	0.7	0.7
2	Oc2	6	6	10	1670	0.7	0.7
3	Oc3	1	2	3	501	0.7	0.7
4	Oc4	0	2	6	1002	0.7	0.7

This optimal Allocation and savings in Time, cost, quality of Service, and load balancing (as shown in Table 6) were achieved by adopting the hybrid algorithm (AC-PSO) and the Process of optimal Allocation of internal processor resources (Oc1, Oc2) as shown in Table 7.

Table 7. Resources Allocation for Process (Oc1,Oc2)by AC-PSO

Process	**Oc1**				**Oc2**					
Sub task	1	2	3	4	1	2	3	4	5	6
Machine Allocation	M2	M4	M1	M3	M6	M4	M2	M5	M1	M3
Worker Allocation	1	1	2	1	2	1	1	1	1	2

The results of the optimal Allocation for the technical path of the torrent seal product were as shown in Table 8.

Table 8: The Optimal Resource Allocation

Optimal Allocation	**Average no.of.it**
Oc1-Oc2- Oc3-Oc4	100

Table 9 shows the comparison of the three algorithms in terms of fitness values for each product in the hybrid algorithm and the iterations at which the optimal solution was reached.

Table 9: Fitness values & iteration of the three algorithms

Algorithm	Fitness values	NO. of. Iteration at the optimal solution
AC-PSO	155	25
PSO	215	30
ACO	245	38

Table 9) and Figure.6 show the Process of searching the three algorithms for the seal torrent product in reaching the optimal solution through the fitness and repetition value at which the optimal solution was reached. In the ACO algorithm, the optimal solution was reached with a fitness value equal to (245) and at repetition (38). In the (PSO) algorithm, the optimal solution was reached with a fitness value equal to (215) at iteration (30), and in the (AC-PSO) hybrid algorithm, the optimal solution was reached with a fitness value equal to (155) at iteration (25).

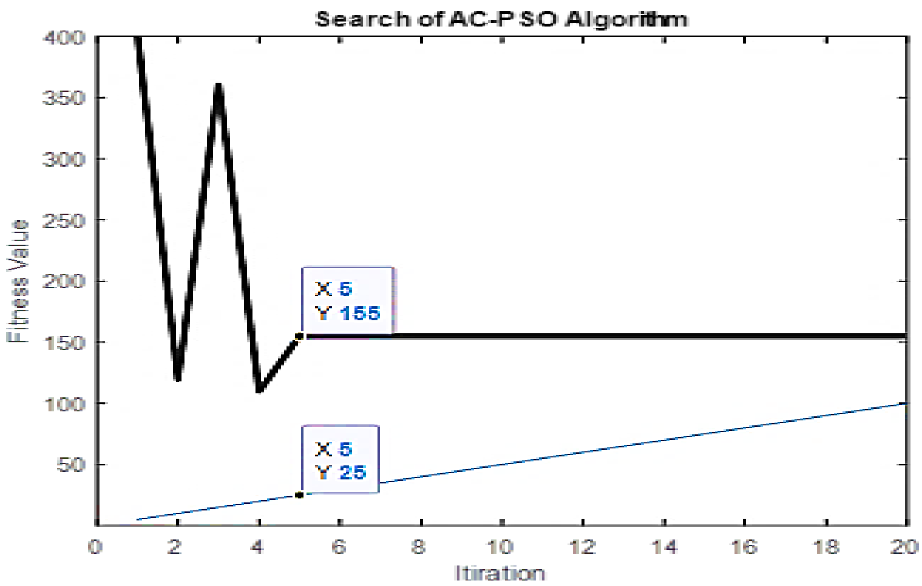
Table.10 Differences before and after the optimal Allocation of converter resources using the hybrid algorithm (AC-PSO)

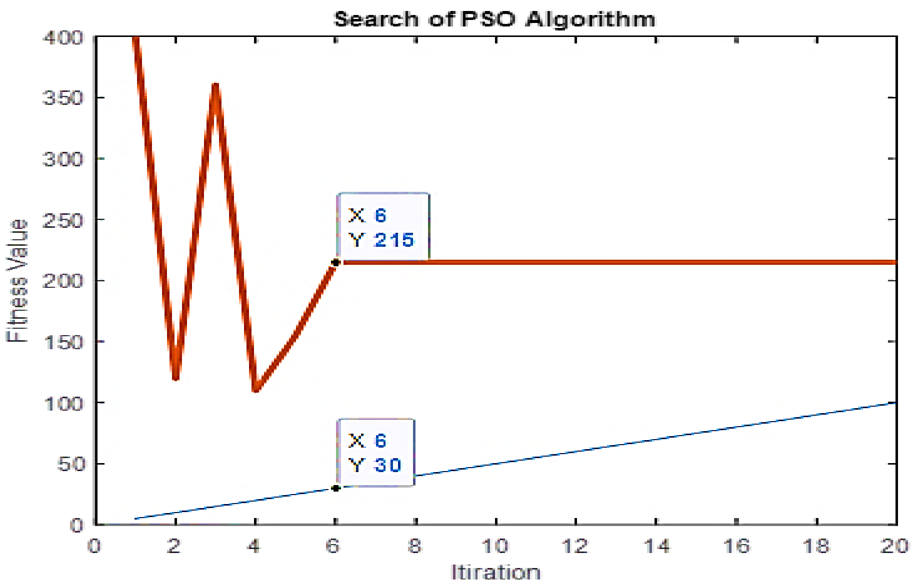
Information	***Before Allocation***			***After Allocation***	
		ACO	PSO	AC-PSO	Gap
Product code	TOS	TOS	TOS	TOS	TOS
Number of Tasks	4	4	4	4	-
Number of Machines	11	11	11	11	-
Number of Workers	17	17	17	15	2
Total time(m)	560	490	430	310	250
Total cos t(ID)	9352000	8183000	7181000	5177000	4175000
QoS%	90%	83%	75%	70%	20%
LB%	82%	80%	73%	70%	12%
Salary average of Worker (ID)	6800000	6800000	6800000	6000000	800000

It can be concluded from Table 10 that the following:

- The cost of one unit of the original seal is 9352 dinars. Note that the selling price is (10000) dinars.

- The cost of one unit of seal torrent in the ACO algorithm=8183 dinars with a difference of (1169) dinars.
- The cost of one converter in the algorithm (PSO)=7181 dinars, with a difference of 2171 dinars.
- The cost of one converter in the algorithm (AC-PSO) = 5177 dinars, with a difference of 4175 dinars.
- The completion time of one unit of the original seal is 0.56 minutes.
- The completion time of one unit of the seal torrent in the ACO algorithm is 0.49 minutes, with a difference of (0.07) minutes.
- The completion time of one unit of the seal torrent in the algorithm (PSO)=0.43 minutes, with a difference of 0.13 minutes.
- The completion time of one unit of the seal torrent in the algorithm (AC-PSO) =0.31 minutes, i.e. with a difference of (0.25).





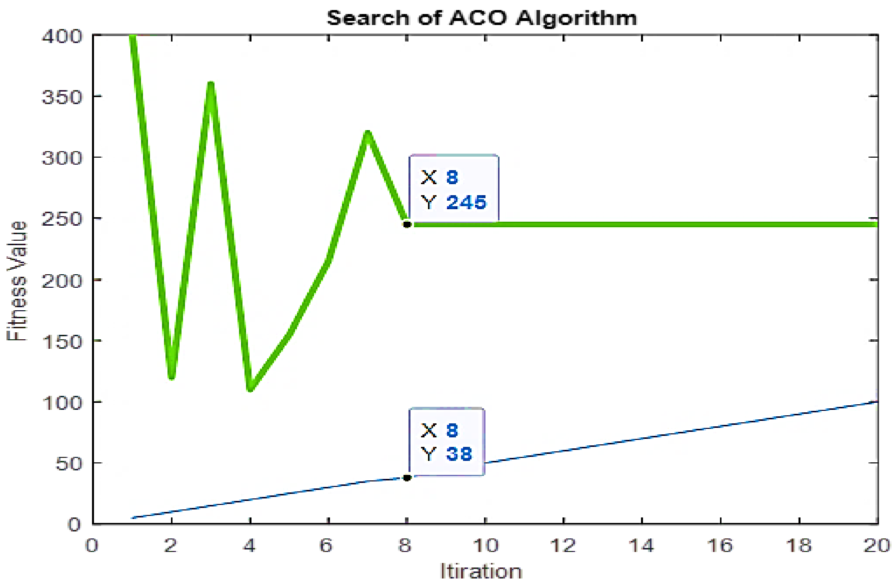


Figure 6. The search by three algorithms

It can see from Figure (6) that searching the three algorithms for the seal torrent product in reaching the optimal solution through the fitness value and the frequency at which the optimal solution reached in the algorithm (ACO) the optimal solution reached with a fitness value equal to (245) and at repetition (38), while in the algorithm (PSO) the optimal solution reached with a fitness value equal to (215) at repetition (30), and in the hybrid algorithm (AC-PSO) the optimal solution was reached with a fitness value equal to (215) at repetition (30), and in the hybrid algorithm (AC-PSO) the optimal solution was reached with a fitness value is equal to (155) when repeating (25).

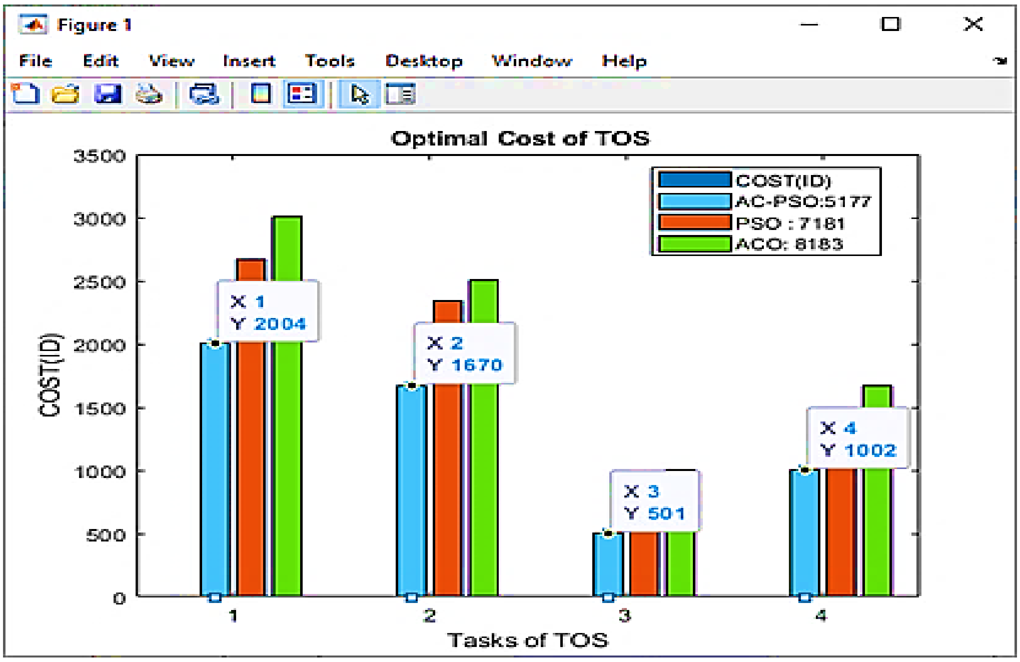


Figure.7 Optimal Cost of TOS

It is shown in this study that the two algorithms (ACO)&(PSO) were selected for comparison with the hybrid algorithm (AC-PSO) of both. The search process in Figure .6 shows the results of comparing the three algorithms, and as in Table .9, the performance of optimization algorithms is mainly reflected by factors such as algorithm approximation, speed and optimization accuracy, the accuracy and efficiency of optimization of the algorithm is reflected by the fitness value(trade-off), and the effectiveness of algorithm convergence is reflected by the number of iterations at which we reach the optimal Allocation of resources. Therefore, this study compares the fitness value (trade-off) with the number of iterations at which we reached the optimal Allocation of the algorithm. The bird swarm algorithm(ACO) was the lowest efficiency and the ant colony algorithm (PSO is better than it, and from Figure.3 and Table .10, it can be seen that due to the fact that the bird swarm algorithm(ACO) has a higher fitness value than the other two algorithms, this solution to the ACO algorithm is not good compared to the other two algorithms, which indicates that the optimization effect is also not good compared to the Ant algorithm and the hybrid algorithm, since the ant colony algorithm had a lower fitness value, and the hybrid algorithm designed in this study contains the lowest value Fitness at a number of iterations equal to(25), which had the optimal solution, which is better than the ant colony algorithm to some extent, and the iterative approximation (25) is also better than the other two algorithms, and the designed (AC-PSO) hybrid algorithm proved its effective and powerful ability to find an optimal solution in the cloud manufacturing (CMfg) environment, which is characterized by its dynamic changes. The company can apply it in solving the problems of resource allocation for the Torrent seal product and all its other products by using the appropriate resources for each manufacturing task, improving the quality of Service provided to the customer, as we note in Table .10, in addition to saving time and cost (show in figure 7) and reducing the load for the company under study. Table (10) concerning the seal torrent product shows the advantages and savings achieved as follows, according to each algorithm separately.

Table (10) may also be from (4) processors, as well as optimal Allocation within the processors themselves, as in the processing of (Oc1, Oc2) and as in Tables (3,5,7), which was reflected in turn on reducing distances, Time, costs, improving service quality and load balancing as follows:

Table (10) shows the savings achieved in the wages of workers through the optimal Allocation of the number of workers, as the original number of workers before the Allocation was equal to (17) workers with total wages estimated at(6800000) million Iraqi dinars, and did not decrease in the algorithms (ACO) and(PSO) but was allocated to the optimal number by adopting the hybrid algorithm (AC-PSO), as the number of workers reached (15) workers and wages of(6000000) million IQD, i.e. with a difference of(2) workers and a wage difference equal to(800,000) IQD from the original wages before Allocation. Also, with regard to the original total completion time before the optimal Allocation was(560)minutes, it became (490)minutes by the ACO algorithm, and decreased to(430) minutes by adopting the PSO algorithm, and the final reduction by the hybrid algorithm(AC-PSO) was equal to(310) minutes, i.e. with a difference from the original estimated at(250) minutes, which in turn reflected on the total completion cost, which before the optimal Allocation was estimated at(9352000) million Iraqi dinars, and after the optimal Allocation by the ACO algorithm, it decreased to(8183000)million Iraqi dinars, and with the adoption of the PSO algorithm, it became(7181000)million Iraqi dinars, and with the adoption of the AC-PSO algorithm, it was estimated at(5177000)million dinars, i.e. with a difference from the original cost It is estimated at(4175000) million Iraqi dinars. With regard to the quality of the original Service before the Allocation, it reached (90%), after the optimal Allocation, the adoption of the (ACO) algorithm was equal to (83%), and in the (PSO) algorithm it was equal to (75%), and the optimal Allocation of it in the (AC-PSO) algorithm became equal to (70%), i.e. with a difference of (20%) from the original. Finally, the load balancing ratio before the Allocation was (82%), after the optimal Allocation by the ACO algorithm, it reached (80%), in the PSO algorithm it became equal to (73%), and in the AC-PSO algorithm it became equal to (70%), i.e. with a difference of (12%) from the original.

5. Conclusions

In this study, the ant swarm, particle and hybrid intelligence algorithms of both were adopted to solve the problem of cloud manufacturing resource allocation of seal torrent product, and the specific objective function of the multi-objective optimization problem was for the purpose of reducing both Time, cost, service quality, and load balance of seal torrent product manufacturing process. The optimal Allocation of seal torrent product resources was reached through optimal Allocation within the four processors for manufacturing the product, where the original path did not change, except that the Allocation was within the processors, specifically the first and second processing., which resulted in a reduction in the total Time by a difference of (250) minutes, with a significant reduction in cost and a difference of (4175000) million Iraqi dinars, and a reduction in the wages of workers by (800000) dinars, with an improvement in both load balancing with a difference of (12%) and the quality of Service with a difference of(20%).

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