A Cost Control System for Internal Economic Management of Enterprises Based on Particle Swarm Optimization Algorithm

Juanfang Zhong[1]*, Yinsheng Luo[1]
1 Department of Economic Management, Science and Technology College Gannan Normal University, Ganzhou, Jiangxi, 341000, China
E-mail: 15879706776@163.com
*Corresponding author

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Sustainable development relies heavily on the efficient handling of financial information by small and medium-sized firms (SMEs), who are the engine that propels the global economy. In this research, we use the Particle Swarm Optimization (PSO) method as a foundation to build and optimize a financial information administration system for small and medium-sized enterprises (SMEs). The study started with an examination of the needs and difficulties associated with financial information management for SMEs. After that, we dive into the building process of a B/S structure-based SME financial management system and provide a PSO-based early detection model of a SME financial crisis, highlighting the algorithm's possible usefulness in this field. We demonstrate the efficacy of the PSO algorithm in forecasting company financial risk and the trajectory of stock prices in the same time via simulation and experimental verification. Using the algorithm helps businesses better handle market instability and competitive pressure while also improving the effectiveness of financial information administration and reducing the danger of human mistake. Businesses' adaptability and competitiveness may be boosted by this system's ability to determine solutions to their unique requirements. In a performance comparison test, the recommended approach beat two other algorithms, achieving a stable particle swarm fitness value of 0.016 after 800 rounds and the quickest convergence. An actual study of the suggested approach showed that the production team employing it finished the same amount of orders in 32 days and made $460,000 more profit. The team with scores of 4.5, 4.5, 4.3, 4.3, 4.2, and 4.2 outperformed the comparable management style by having the lowest values of employee anti-production behavior. The paper suggests an anti-disturbance management methodology for company supply chains, enhancing stability by rationalizing manufacturer production scheduling.

Povzetek: Algoritem optimizacije rojev delcev je uporabljen za izboljšanje notranjega ekonomskega nadzora in optimizacijo finančnega informacijskega sistema v malih in srednje velikih podjetjih, kar povečuje učinkovitost, zmanjšuje napake in izboljšuje konkurenčnost.

1 Introduction

Several issues impact business operations in the contemporary day. These include a highly competitive market, limited resources, including the economic catastrophe brought through the COVID-19 pandemic. It is vital, in order to achieve greater efficiency, to reduce the costs associated with the production of products, the performance of activities, and the provision of services. Making a contribution to the fulfillment of this obligation is an efficient and appropriate form of internal control. [1]. As a result of increased market competition and the complexity of plant production management brought about by globalization, the control process is being rethought and new approaches are being taken to it's the organizational and methodological bases, drawing on international experience. At this point in time, it is crucial for small businesses' internal control systems to perform well and fulfill users' information demands so that management may make educated judgments on production activities [2]. The significance of small and medium-sized firms in China's national economy is growing as a result of the country's fast social economic growth and ongoing scientific and technological advancements. Because of the manufacturing industry's central role in China's economic growth, its progress is a topic of intense public interest. The evolution of contemporary industrial organizations has rendered the basic cost control idea obsolete [3]. Businesses' product pricing strategies will undergo significant shifts as the cost of carbon credits increases to reflect the monetary worth of atmospheric ecological capacity shortage. Carbon credit, as an essential component, will rise to the status of a major production cost component on par with more conventional items like material and labor costs, etc. [4]. A number of improvements have been made to China's technological advancements and economic level in the last several years. In response to rising demand for EVs, China's automotive sector has been booming recently. The internal management system of the Chinese car manufacturing sector is continuously being upgraded as part of the growth process [5]. A variety of variables impact business operations in the contemporary day. These include intense competition, a lack of resources to carry out manufacturing, and the economic crisis brought on by the epidemic. Zika virus. Reducing costs associated with production, works, and services should be the primary focus of any effort to boost the efficiency of the business [6]. With the current economic climate in Ukraine being what it is, businesses are starting to pay attention to the need of efficient cost management in light of the chances to encourage resource savings, use the "Expenses-output-profit" system to predict and control expenses, and so on. Assuring the steady growth of businesses is now an issue in our nation [7]. It is well-established that businesses use many forms of internal economic control, one of which is the audit. As a management function, an efficient internal audit system is defined by its efficiency, productivity, and cost-effectiveness [8]. The following are some of the main factors that are believed to impact accounting policy choices: ownership, business type, economic activity, number of employees, enterprise size, taxation system, financial statement format (full or simplified), accounting leadership and organizational style, enterprise development strategy, cost framework (pay cost, material cost, depreciation expenditures, Report Word etc.), activity type (seasonal or non-seasonal), pricing procedure, extent of competition, degree of uniqueness of the activity's product, corporate governance, employee motivation, and environmental responsibility [9]. Despite worldwide difficulties, there are more prospects than ever before to break into foreign markets thanks to the processes of firm activity integration in all its forms. Nowadays, major organizations are more likely to take part in integration procedures than small enterprises [10]. This is because large companies have more chances in terms of finance, organization, and competence. Production management at industrial businesses often makes use of data derived from actual cost of production calculations to track adherence to the enterprise's standard cost of production, find methods to optimize labor expenses and material resources, and so on. An industrial enterprise's profitability and economic efficiency determine the level of costs in a market economy [11]. Every sector of our economy has benefited from the recent surge in economic activity. Following the launch of SMEs in China, the country's new accounting standards will help with tax adjustments and the gradual implementation of accounting tax planning. The onus for paying taxes is on the business, but there are a lot of moving parts when it comes to meeting that requirement. To keep tax costs in check, many companies engage in tax planning [12]. An organization's operational expenses, such as those that go into making products and services and those that are immediately written off as a result of financial decisions, are the primary targets of efforts to increase enterprise management efficiency. Optimal methods of accounting and control tailored to the demands of leadership and other users are important due to the ever-increasing number and percentage of administrative expenditures in total firm expenses [13]. As society and the economy progress, competition in the market heats up, leading to a decline in profits for certain businesses. Utilizing IT while simultaneously improving IT project evaluation is a great way for managers to enhance business project management. Such evaluations serve as benchmarks for upcoming IT projects in addition to being indications of the quality of an organization's past IT initiatives [14]. An efficient system for determining a company's worth in today's dynamic economic climate is desperately needed, and this calls for both theoretical and methodological advancements, as well as concrete suggestions [15].

1.1 Problem statement

The financial information management framework is a crucial tool for small and medium-sized firms (SMEs) since it helps with data management, decision-making, and operational efficiency. To make sure the system can handle the unique demands of businesses, a thorough requirements study should be conducted before construction begins. The following are the main necessities:

- **Data analysis and reporting requirements:** In order for businesses to fully grasp their financial status, the system have to provide robust data analysis capabilities. Various reports, such as financial statements every month and cash flow predictions, should be easy to create and adapt to specific requirements. In order for users to make educated financial choices, crucial data and trends should be easily accessible.
- **Security requirements:** Protecting the privacy and authenticity of financial information requires stringent security measures inside the system. Users should be granted varying degrees of access to protect sensitive information. It is expected that the system can identify and address such dangers. Risks including data leaking or illegal access.
- **User-friendliness requirements:** Users should be able to enter and query data with ease if the system has an intuitive user interface. In order for users to fully use the system's functionalities, it is necessary to supply them with training materials and help papers. Adapt to the demands of a wide range of consumers by supporting a number of languages and devices.

The nonlinear linkages and complicated restrictions in business economic management are often disregarded by the standard particle swarm optimization technique, leading to unstable optimization outcomes and making it difficult to use in reality. Consequently, this issue requires a novel optimization technique. Through the use of optimization techniques, we can address this issue and enhance performance with regard to cost and CPU time.

1.2 Objectives

The goal of this optimization study is to identify the key performance indicators (KPIs) for economic entity internal management. Return on investments, asset turnover, profits per share, and other economic cost management metrics may provide light on the financial health of investment schemes. One can get a good picture of a company's financial health using a number of metrics.

1.3 Paper outline

Following is an organization of the succeeding parts that are included in this work. In Section 2, a quick summary of the history of cost optimization for businesses is presented, as well as an overview of the literature that is pertinent to the topic. The suggested method for solving the optimization issue of small and medium-sized enterprises (SMEs) in economic cost management is presented in Section 3. In the fourth section, the assessment procedure and the results that are associated with it are discussed in detail. In the conclusion, the paper is concluded in Section 5, which also includes a discussion of potential future developments.

2 Related work

The purpose of the research reported in [16] was to examine several organizational factors and provide recommendations for enhancing the methodological backing of production cost management inside the company. One item you may use for control is the "Test to evaluate accounting software of production costs" which is an ICWD. There are a number of things you can learn from this, including how well the enterprise's material resource rationing works, the general principles for organizing the primary, synthetic, and analytical accounting of production costs, how well the structure of internal control over production costs works, and how reliable and accurate the cost of production and its estimations are. With the data collected from the internal control of primary accounting, the ICWD "Checking the primary accounting for manufacturing costs" may be used appropriately.

An overview of the method for small agricultural businesses to keep tabs on their production activities is what [17] is all about. Approach to doing out research. General scientific and specialized ways of learning processes and phenomena, such as analysis, synthesis, induction, deductions, analogy, abstraction, systematic, logical, and monographic procedures, provide the theoretical and methodological foundation of scientific inquiry. Introducing the key points (the outcomes of the effort). They describe the characteristics of small business internal control systems in line with national and international standards. A lack of a well-organized internal control system has a direct impact on production costs, as shown in the study of small business operations. That section defines the key components, procedures, and phases of internal control at small farming companies so that their sequence may be seen.

The purpose of that article is to look at different aspects of the organization and provide suggestions on how to improve the flow of internal control over production costs and product costing [18]. A tool for internal control may be the developed working papers. Internal control planning cannot be successful without the following documents: process of assessing the efficiency of finance and internal control structures; organizing data collected from main accounting inspections and production-wide consumption guidelines of material assets; drawing broad conclusions from inspection findings; considering and acting upon errors and violations identified throughout internal control; and lastly, executing efficient internal control.

Agricultural businesses' management functions should be fortified in light of the requirements of sustainable development in order to achieve the goals of updating accounting practices and providing analytical assistance for economic potential management [19]. An approach to better accounting and analytical management of agricultural enterprises' economic potential based on sustainable development was developed by applying scientific techniques based on the dialectic of knowledge and objective principles of economic development, nature, and society. That scientific topic was solved by using the structural approach, comparing empirical facts, making abstract-logical generalizations, and finally, systematizing and synthesising all of the results. In line with sustainable development principles, the proposed forms primarily aim to enhance the process of working alongside the Management Report, which is responsible for documenting audits of accounting and logical management systems of economic potential and capacity.

The article's [20] goal in publishing it is to shed light on the enterprise's unique organizational structure and the need of internal auditingIt is well-established that businesses use many forms of internal economic control, one of which is the audit. The efficacy, efficiency, and affordability of the system for performing internal audits are the primary indicators of the quality of that management function. The enterprise's internal audit service is necessary and should be operational. Weighing the pros and downsides of internal audit, authors taken into account the quirks and procedures of its structure. What is meant by the term "internal audit" and whether or not it should be used by the company to enhance the overall efficiency of their accounting system and operations are both clarified.

In [21] focus on the years 2006–2018, that study aims to dissect the Research and Manufacturing Association «ELSIB» PJSC's tactics for decreasing product demand. The results demonstrated the significance of establishing a reliable management system with specific decision-making procedures in trying economic times. That is a trustworthy alliance, cost optimization, market work, cluster model implementation, ongoing R&D work, financial resource access, and the establishment of a system of interconnected business operations.

That article [22] makes an effort to use cost control theory to examine how listed shipping firms handle their funds and limit risk. With that goal in mind, it delves into the elements impacting shipping costs for publicly traded ocean shipping businesses before turning its attention to the trends in fund management and prevention of risk inside these firms. The report concludes by suggesting that publicly traded ocean transport businesses establish systems to mitigate financial risk. Listed maritime shipping firms' transportation costs were impacted by a combination of internal and external environmental variables, according to the report. Using COSCO Group as an illustration, it was discovered that the company has a significant debt payback risk in the long run, in addition to a low risk associated with short-term debt servicing. Controlling expenses helps bring down company expenses, and COSCO's financial resources are looking excellent.

Table 1: Comparison of proposed and existing methods

References	**Objectives**	**Findings**	**Limitations**
Reference [16]	Production cost management in company	Checking the primary accounting for manufacturing costs	Does not organizing the primary, synthetic, and analytical accounting of production costs
Reference [17]	Small agricultural businesses to keep tabs on their production activities	Study of small business operations	Lack of a well-organized internal control system has a direct impact on production costs
Reference [18]	How to improve the flow of internal control over production costs and product costing	Internal control planning cannot be successful without the following documents	Does not production-wide consumption guidelines of material assets
Reference [19]	Agricultural businesses' management functions for economic potential management	Scientific methodologies based on the dialectic of knowledge and objective principles of economic development, nature, and society were used to improve agricultural businesses' economic accounting and analytical management based on sustainable development.	Does not documenting audits of accounting and logical management systems of economic potential and capacity
Reference [20]	Used many forms of internal economic control, one of which is the auditing.	Weighing the pros and downsides of internal audit, authors taken into account the quirks and procedures of its structure	Does not well performed internal auditing
Reference [21]	Research and Manufacturing Association for decreasing product demand	Trustworthy alliance, cost optimization, market work, cluster model implementation, ongoing R&D work	Lack of optimization
Reference [22]	Presented cost control theory to examine how listed shipping firms	Elements impacting shipping costs for publicly traded ocean shipping	Lack of short-term debt servicing

	handle their funds and limit risk.		

3 Methods and materials

3.1 System components & architecture

The major components of this study are follows:

- **Front-end user interface:** Users mostly engage with the system using web browsers. Data input, report creation, data query, and other financial operations are accessible to users when they log in to the system. The front-end user interface has to be easy to use and adapt to various platforms including smartphones, tablets, and PCs.
- **Application server:** Data processing, calculations, and verification are all part of the application server's basic business logic. The framework and language it uses may be customized to meet individual requirements; examples include Ruby on Rails, Python, Java, etc. The front end should be able to connect with the back-end server using a secure application program interface (API) provided by the application server.
- **Data server and database:** Typically, a system for managing relational databases is used to store and handle financial data by the data server. For easier query and report production, data should be kept in an organized manner. A recovery and backup strategy should be in place for the database to guarantee the safety and accessibility of data.

These are the primary benefits that may be gained by designing a system for managing financial information for SMEs.

- **Data collection and storage:** The system's data collecting and storage capabilities should include a wide range of financial metrics, such as sales revenue, costs, expenditures, cash flow, and more. In order to facilitate analysis and reporting, data should be maintained in a systematic manner. Data backup and recovery procedures should be in place to guarantee the security of stored data.
- **Cost optimization**: Particle swarm optimization (PSO) algorithm optimize costs and allocate resources by mimicking the way particles search for food. By using the PSO algorithm, the system may assist businesses in making cost-effective resource allocation decisions, such as choosing the most efficient supplier, route, or allocation of resources.
- **Forecasting and trend analysis:** Applying the PSO algorithm to data extraction and forecasting techniques allows one to uncover patterns and trends in financial forecasting and analysis. In order to aid in decision-making processes like investment planning and fund management, the system may assist businesses in projecting their future financial situations.
- **Cost-effective decision-making:** Choosing the optimal product or project portfolio is only one example of how a PSO-based approach may aid businesses in making cost-effective choices.
- **Financial analysis and report:** To discover the optimal approach that maximizes the advantages, the system simulates the behavior of particles. To aid businesses in comprehending their financial status, the system is capable of producing analytical reports and financial statements. The PSO algorithm can optimize costs, analyze risks, and forecast trends, and then use that data to produce reports.

3.2 Data processing

Normalizing the data with the arithmetic mean approach is important to remove the variation produced from various values. Its minimal boundary is 0 and its maximum border is 1 after normalizing the identical factor. The following equation may be used to get the mean value:

$$T = \frac{X - X_{\max}}{X_{\max} - X_{\min}} \quad (1)$$

The letter T represents a set of normalized data. Among the data sets that have been compiled, X is considered the starting point. $X_{\min}$ and $X_{\max}$ identify the lowest and highest data group from the ones that were gathered. Table 2 displays the results from the normalized samples.

3.3 Enterprises economic cost modeling

Assuming there are m work operations in the production process, the factory primarily focuses on minimizing the cost of each procedure. As a function of the work technique, the following formula represents the lowest unit cost target:

$$\min C_i = \sum C_{ij} x_{ij} / x_i \quad (2)$$

and Constraint condition

$$d_{ij} \le a_{ij} x_{ij} \le b_{ij}, x_{ij} \ge 0, i = 1,2,\cdots,m, j = 1,2,\cdots,n$$
$$x_i = f(x_{11}, x_{12,} \cdots, x_{mn}) \quad (3)$$

C_i it stands for unit's product price of labor method i;

C_{ij} causes the use of j resources in work process i, which in turn causes the unit cost;

x_{ij} represents the amount of resource j used in work method i as a technique parameter;

a_{ij} denotes the amount of time spent working with a product or the technique's parameter effect coefficient, both of which have an impact on the work method i;

x_i stands for output, output amount, and execution process i;

d_{ij} is the resource that is used up in the work process i at the lowest possible quantity or method parameter;

b_{ij} stands for the resource that is used in the work method i to the greatest extent possible, either in terms of quantity or the maximum permitted technique parameter;

$f(x_{11}, x_{12}, \cdots, x_{mn})$ is the work procedure's production function i.

Cost optimization model

Coal, heat, and other reusable byproducts are created during the working process in addition to the products used in subsequent work procedures. The profit might be generated directly from these items. It is necessary to dispose of some castoffs and pollutants that are produced throughout the working process. It will cost more for the business to dispose of waste and pollutants. For example, if process I discards r different types of resources or waste, the amount is Q_{ir}. The revenue price or disposal cost of the r resource types is C_{ir}. Therefore, apart from the goods that are directly used in the subsequent process, the revenue is:

$$F_i = \sum\ Q_{ir} C_{ir} \quad (4)$$

Total cost optimization model

The sum of all production expenses and inputs is known as the "process manufacturing cost." The goal of a cost optimization system is to obtain the lowest product cost by minimizing disposal costs or reusing resources and maximizing profits. As an objective function, the following formula:

$$\min C = \sum_{i=1}^{m}\ (C_i x_i + C_0 + F_i)/x_m \quad (5)$$

i stands for work process , $i = 1,2, \cdots, m$

C_i means the total cost of all work procedures;

C_0 stands for fixed cost;

F_i stands for the cost of labor method that involves disposing of resources or reusing those resources i.

Process manufacturing is inherently continuous, hence the output of one work procedure should be proportional to the output of the one before it. It is possible for one work technique to provide the product for another. There is an imbalance in the production needs across the various job operations. In order to keep production in check, every process generates some goods for sale or outsourcing. The work procedure's product amount, denoted by a_i, i-1 outlines the process for work i. The frequency with which work-related procedures involve outsourcing or acquiring products i is x_{i-1}^0, outsourcing $x_{i-1}^0 < 0$, obtaining products is $x_{i-1}^0 > 0$, the following conditions of limited supply and demand:

$$x_i = \frac{x_{i-1} + x_{i-1}^0}{a_{i-1}}\ i = 1,2, \cdots, m \quad (6)$$

Enterprise profit optimization model

The primary goal of each activity or decision should be to maximize profits. Factors like product cost, product sales, and product pricing all have an impact on an enterprise's profit. Factors such as product demand, sales volume, and market conditions influence the bottom line. The enterprise profit optimization model's goal function is:

$$E = \sum\ (p_k x_k - C_k) \quad (7)$$

Constraint condition

$$g_k \le x_k \le h_k$$

$$x_k = f(p_k)$$

$$x_k \ge 0$$

E is a symbol for business profit;

k represents the end result;

p_k represents the cost of the k product;

x_k means the amount of product k that has been sold;

C_k denotes the price of the product k;

$F(p_k)$ stands for the purpose of selling.

3.4 Traditional PSO

In 1995, Kennedy and Eberhard were the first to present particle swarm optimization, a computational intelligence (CI) method that draws inspiration from nature. Swarm intelligence techniques, of which PSO is a subset, are a component of computational evolution, one of Cl's three tenets. The underlying idea for this algorithm came from trying to simulate the navigational and foraging behaviors of a school of fish or a flock of birds. Similar to a search algorithm, the PSO algorithm uses a large population of people, or particles, to identify the best solution in a multi-dimensional search space. The placement of the particles, which stand for potential solutions, represents the dimension of the desired function that requires optimization. Particles keep exploring hyperspace in pursuit of the best outcome, all while adhering to these rules:

- Keep track of the current direction and speed of each particle;
- Log their best position so far using a measure of fitness that measures their proximity to the ideal solution:
- Know which spot is the finest option among all particles on a global scale.

The PSO algorithm's performance is affected by the parameters and stopping conditions that are chosen. The algorithm's performance may be improved by choosing appropriate parameters and terminating conditions.

- **Parameter selection:** How well an algorithm finds the ideal global temperature of a problem is dependent on the optimization parameters. An important part of optimizing is choosing these parameters. Here is a rundown of how each parameter option was analyzed:
- **Number of particles (N):** If the particle number is low, it may affect how well PSO works. The total amount of iterations may be reduced by increasing the particle number. So, the algorithm is still capable of finding the best option.
- **Acceleration coefficients (c_1 and c_2):** the quickening coefficients c_1 and c_2 guide the particles to move toward P_{best} and G_{best}, respectively. Particle motions toward an optimal solution may be constrained by small values. Nevertheless, particles may depart from the solution if the value is too high.
- **Maximum velocity ($V_{\max}$):** In order to keep the particles from escaping the search space, their velocities are usually limited to a certain range. Particles may only investigate the local best if $V_{\max}$ is too little, but they could skip over a good solution if it's too big.
- **Inertia weight (w):** Both local and global investigations are balanced by the inertia weight. When the inertia weight is big, the search is robust on a global scale, but when it is small, the search is robust on a local one. During optimization, the inertia weight's value might alter. Hence, the literature suggests self-adaptive methods that change the inertia weight value while searching.
- **Stopping criterion:** In PSO optimization, the stopping condition is crucial to ensure that the method does not end before finding the global optimum. In order to prevent the method from squandering computing resources, it must terminate automatically when the optimum solution is identified. Consequently, the length of the optimization procedures is significantly affected by the stopping criteria choice. The literature presents a plethora of stopping criteria, including a tolerance, a maximum number of iterations, and the total amount of function evaluations.

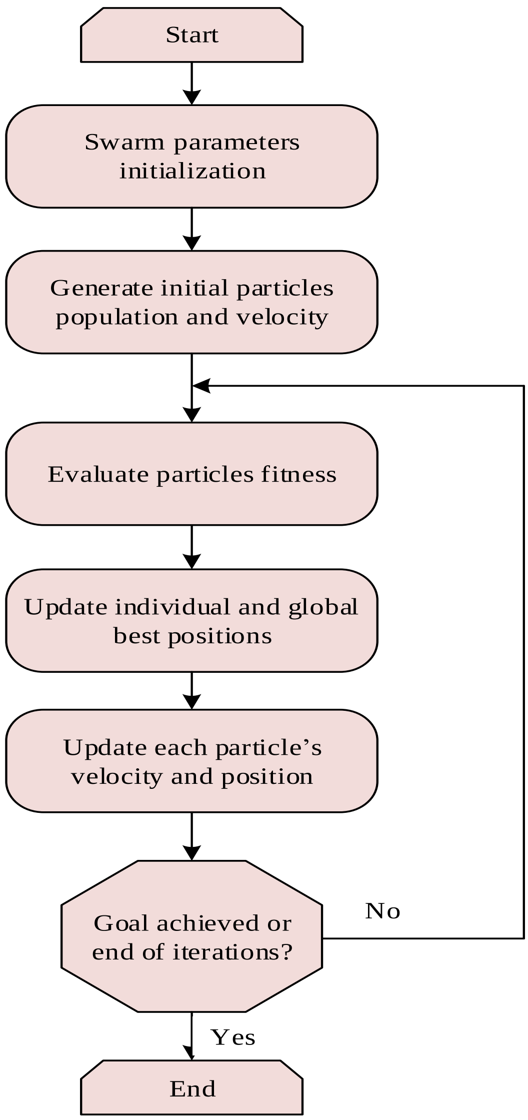


Figure 1: PSO Model

Equation (1) shows that by combining the aforementioned data, each particle is propelled towards a new position with an updated velocity

$$X_t(t+1) = X_t(t) + V_1(t+1) \quad (8)$$

where $X_i(t+1)$ and $X_i(t)$ are vectors that represent the present and future locations of each particle, and $V_i(t+1)$ is the vector of velocities that indicates the future course and speed of every particle.

Equation (2) shows that these values are stochastically modified at each iteration using both the individual particles' historical optimum locations and the overall particles' history global best positions. where φ_1 and φ_2 are two positive numbers (acceleration constants), r_1 and r_2 are weight factors in the series of [0. 1], and $P_{i\text{ inst}}$ and P_{slatsot} are the optimal locations of individual particles and the world's particles, respectively. If the inertia weight, or weight factor, is equal to one, then the canonical PSO method is used; otherwise, the original the PSO method is used. Until we reach a particle position near enough to the target result or the maximum number of iterations is surpassed, the aforementioned iterative procedure keeps running. As seen in Figure 1, the aforementioned procedure

At each iteration, the distance each individual particle travels is updated by combining three separate components, as can be seen when studying Equation (2):

- The inertia component $wV_/()$: This word usually means that each particle will keep moving in the same direction (speed):
- The cognitive individual component $\varphi_1 \cdot \tau_1 \cdot (P_{i\text{ dost}} - X_i(t))$: This section details the separation between the present positions of all particles and the optimal locations for each one;
- The social component $\varphi_2 \cdot r_2 \cdot (P_{\text{slob host}} - X_i(t))$: Distance from each particle's present location to the optimal position determined by the swarm as a whole is computed by this component.

Modifying variables r_1 and r_2 alters the effect of social and cognitive variables on velocities in Equation (2). The inertia weight w, which affects the exploration-exploitation balance in PSO algorithms, is similar. Iterations often result in a linear reduction of this factor. To allow the swarm to move freely and swiftly while searching the area of search for the optimal answer, it begins at a high number (e.g., 0.9). The swarm's exploration level should drop as iterations go on, and it should concentrate on exploiting the neighborhoods around personal and global optima. Swarm convergence requires the selection of limitations in addition to the initialization of the aforementioned parameters prior to executing the PSO algorithm. The absolute maximum speed must be specified, and the sum of the acceleration coefficients should not exceed four.

Of all the heuristics used for DR applications, PSO has the largest user base. Here are the key benefits of PSO when compared with other optimization methods:

- Simple and easy to use;
- Robustness and rapid convergence, especially in complicated and severely limited multi-dimensional search spaces:
- Very useful as it can solve a wide range of optimization issues:
- Very adaptable, as it may be tweaked and hybridized to suit the needs of different problems and get better results.

3.5 Binary version of PSO (BPSO) for Cost Managememt

The location vectors of particles in the binary form of PSO may only take on the binary values 0 or 1, representing positions in binary space. To update the velocity, we utilize the same equation as in the old form of PSO. To change the location of a particle, the formula is:

$$x_{ij}^k = \begin{cases} 1 & \text{if} \quad u_{ij}^k < s_{ij}^k \\ 0 & \text{if} \quad u_{ij}^k \geq s_{ij}^k \end{cases}, \quad (9)$$

where u_{ij}^k is a chance number among 0 and 1 , and s_{ij}^k is also known as the sigmoid function.

A sigmoid-shaped curve $s_{ij}^k = \frac{1}{1+\mathrm{e}^{-v_{ij}}}$ (10)

The velocity V_{ij}^k is restricted within the series [$-V_{\max}, V_{\max}$]. These limits are equivalent to the particle location probability x_{ij}^k to change to 0 and 1. The maximum rapidity $V_{\max} = 5$ is equivalent to the highest possible likelihood that a particle's value will be 1. The slowest possible speed $V_{\min} = -5$ represents the lowest possible chance that a particle's charge is zero.

In order to fulfill their own requirements for the management of the economy innovation and innovation communication, businesses strive to form strong or weak communication relationships with other businesses. Regarding the internal subsystem E in Figure 1, the first level core enterprise e_1 absorbs the innovation economic management of the transformation-related innovation enterprise D. At the same level, enterprise e_1 controls the economic management learning gastrointestinal enterprises e_2 and e_3, which manage to make up for their own shortcomings and take on intermediary transfer tasks by learning and digesting the creativity economic management in e_1. In the second level of E, you may find the economic management application services enterprisese_4, e_5_e_6 and e_7. These businesses are governed by the upstream enterprise e_2 and are responsible for carrying out service innovation initiatives. A unifying economic management demand signal will be sent to the upstream firms by the related core enterprisee_4, which is believed to be responsible for collecting the innovations in economic management from the second level. The corresponding financial management will be sent down quickly if the economic management stored in $e_2$can meet the demand; otherwise, the demand signal will be sent layer by layer and, until the core R&D institution D is found, creative economic management that meets the needs will be searched for. Enterprise D conducts economic management research, development, and processing according to the feedback gap. Now is the time for D to immediately feed back the newly-developed innovative economic management to the demanding firms so that they may continue with the incrementally screening and distribution process. As we can see, catching up on economic management innovation entails finishing the invention in a methodical fashion. Dynamic fluctuation, hierarchy, analysis, timeliness, etc. are also features of the communication job.

Concurrent with the enterprise's economic management innovation's change, the clock variable may be reset to zero in economic management innovation. This is the official way of looking at the enterprise financial oversight variable for the exchange conversion clock: The following mapping describes the clock's interpretation on the set X of clock variables: Each clock is given a time value via the transformation X→T. All of the interpretation sets with the time on the X is T^X. Let $t \in T$, and the clock interpretation $v + t$ is defined as $(v + t)(x) = v(x) + t$, in which $\forall x \in X$. When $|x| = n$, The symbol may be used to understand the time on the clock $(T_i)_{1 \leq isn}$ to indicate $v(x_i) = T_i$. For a subset λ of the X, $[\lambda \leftarrow 0]v$ has come to represent this kind of lock interpretation; for every$x \in \lambda, ([\lambda \leftarrow 0]v)(x) = 0$. Not to mention that for every $x \in X/\lambda, ([\lambda \leftarrow 0]v)(x) = v(x)$.

The synchronous task is one of three economic management included in the first frame f_1 with the period T_1, the asynchronous task f_2 with the period T_2, and the sporadic task f_3 using the shortest possible arrival time interval T 3. Figure 3, in the shaded area, shows their worst-case execution time (WCET for short). Following from the previous explanation, it is reasonable to assume that f_2 may be transformed into a synchronous cycle job and the system's processing burden will be raised when the initial start time R is set to time 0. All other jobs with an arrival time interval higher than in the third erratic economic management innovation T_3 are able to be transformed into tasks with an arrival time interval of T_3 for scheduling and execution, and then compressed.

For economic management scheduling using the preemptive EDF algorithm, the three jobs listed above may be transformed into preemptive synchronous regular tasks, which are simpler, f_1, f_2 and f_3, in the second picture, and the times between them are T_1, T_2 and T_3, in that order. As a result, the due date for the tasks may inform the real-time scheduling optimization.

4 Results and discussion

For this study, we compared the wheel cost information of 1,340 vehicles with varying body types. "Siemens Teamcenter Product Cost Administration" is the program that the original equipment manufacturer uses to keep the data. The product life cycle monitoring program's prior calculations and publicly available information formed the basis of the computations. The cost engineer has access to the following data throughout the early stages of design; this data will be used to construct the machine learning model:

- Production site, product lifecycle, shape, and other basic data
- Substance (such as: amount, mass, and cost of substance)
- Manufacturing (a synopsis of the processes involved in manufacturing)
- Steps for assembly
- Parameters of the process (such as cycle duration and melt weight)
- Step name of the method (casting, for example)
- Process manufacturing step charges, which are examples of surcharge rates
- Investments in tools
- Tasks performed and time spent

For PSO, swarm size is 100 and problem dimensions are 50, and iterations 1000, and fitness is 100. The choice of measure R^2 is an effective assessment parameter for optimization issues.,

$$R^2 = 1 - \frac{\sum_{i=1}^{n} (y_i - \hat{y}_i)^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2} \quad (11)$$

Here y_i represents the true worth of the prediction for that specific case i. Dimensions $\bar{y}_l$ is the the model's goal size y is the average of every value y_i and the size $\hat{y}_i$.

It is important to take into account both the variance-based value and the dispersion of the individual outcomes. This is why we bring in MSE and RMSE, or root mean squared error, to measure this kind of thing.

$$\mathrm{MSE}(y, \hat{y}) = \frac{1}{n_{\text{samples}}} \cdot \sum_{i=0}^{n_{\text{samples}}-1} (y_i - \hat{y}_i)^2$$
$$\mathrm{RMSE}(y, \hat{y}) = \sqrt{MSE} \quad (12)$$

When there are numerous duplicate values or missing feature values in the dataset, data preparation is primarily concerned with fixing those features. These qualities are eliminated prior to feature selection because they might cause model deterioration, which in turn affects the accuracy of forecasts. There are other elements that aren't included since they have nothing to do with expenses and can't be used for cost estimate. Even after data preparation, it is premature to presume that all residual characteristics are model-relevant. It is recommended to keep the total amount of features minimal since having too many data characteristics might make the model complicated and cause unstable cost estimates. A wrapper-based feature selection strategy is utilized to decrease the model size. If any data points are missing, they should be filled in with other data or eliminated altogether to provide a full set, which is necessary for the next data categorization. The second choice is better for this article since it prevents data corruption. The next step is to begin the process of selecting an algorithm. Fig 2, 3, 4, and 5 illustrates the performance of the transportation cost, MSE, RMSE, and accuracy.

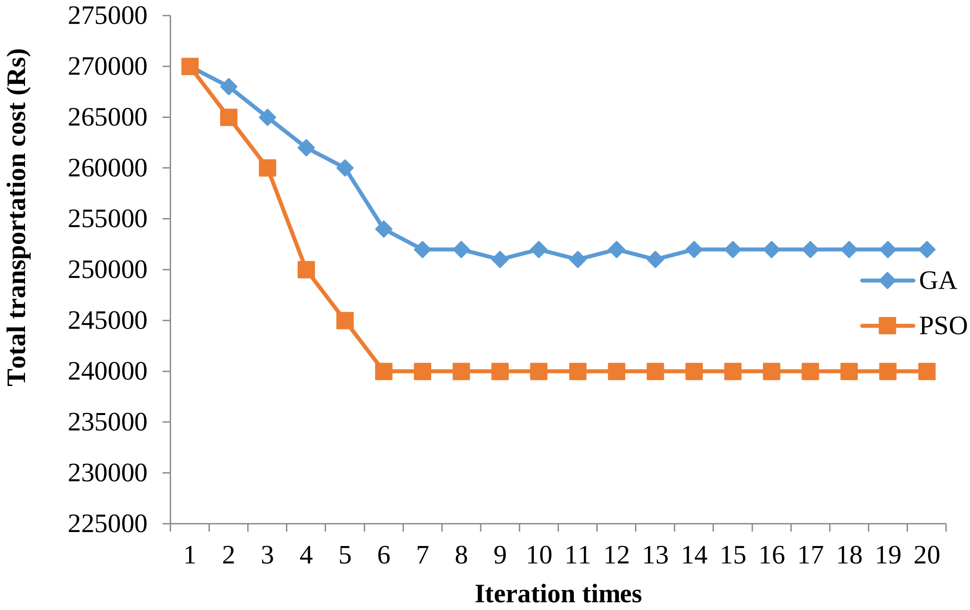


Figure 2: Cost vs. no of iterations

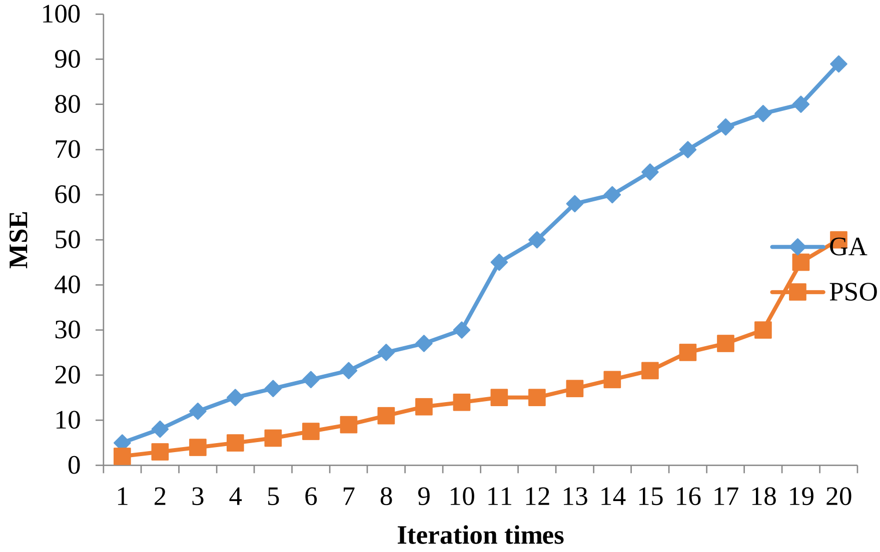


Figure 3: MSE vs. no of iterations

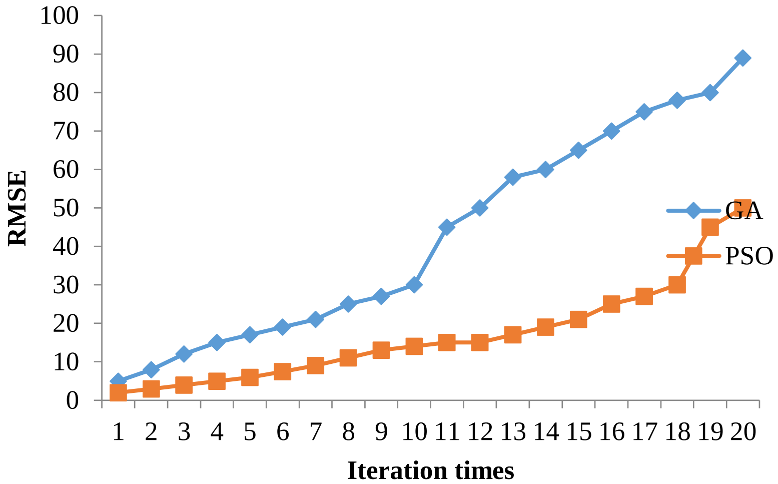


Figure 4: RMSE vs. no of iterations

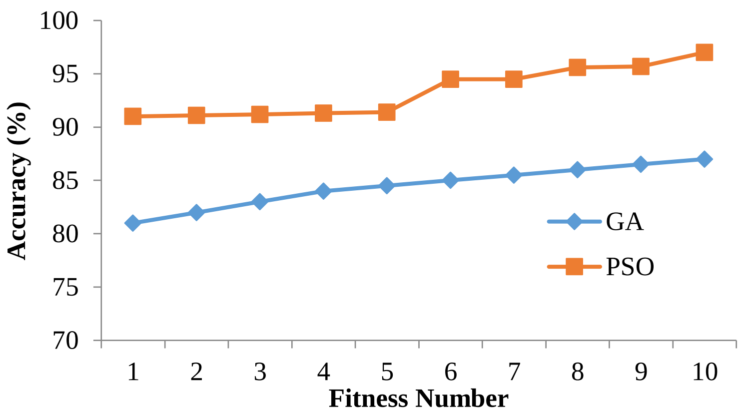
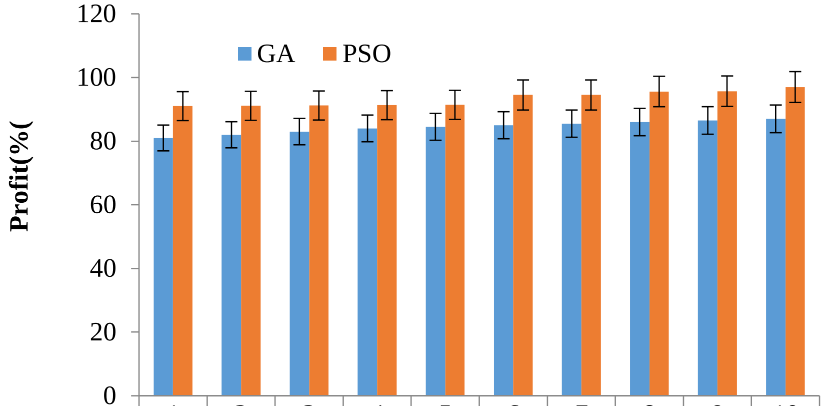
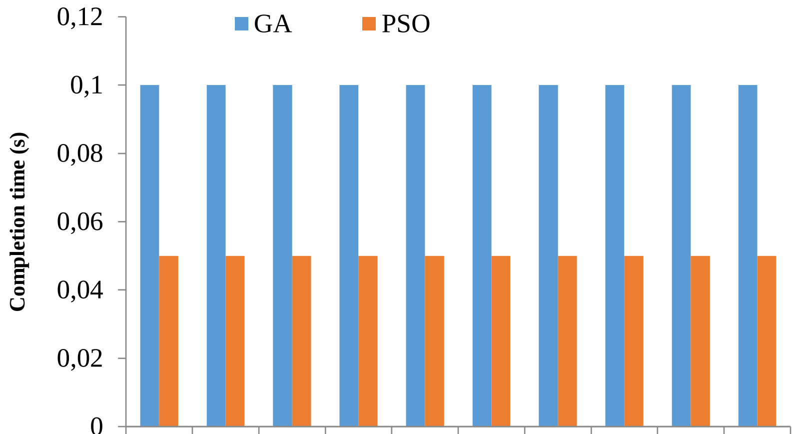


Figure 5: Accuracy vs. no of iterations



	1	2	3	4	5	6	7	8	9	10
GA	81	82	83	84	84,5	85	85,5	86	86,5	87
PSO	91	91,1	91,2	91,3	91,4	94,5	94,5	95,6	95,7	97

Figure 6: Profit analysis



	1	2	3	4	5	6	7	8	9	10
GA	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
PSO	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05

Figure 7: Completion time analysis

The results of the experiments shown in Figures 6 and 7 demonstrate that the optimization method that is provided in this article is capable of obtaining the best solution to the issue in a short amount of time. Furthermore, it has evident benefits in the event of a greater number of individuals and positions, and it enhances the effectiveness of personnel allocation. When it comes to solving the issue of HR optimum allocation, this approach is quite successful. The experimental findings presented in this part demonstrate that the enhanced PSO has a rate of convergence that is quite quick, and that the improved PSO has an error rate that is about five percent lower on average than the classic approach. In addition, the exactness of this technique is around 94%. Over the course of this segment, the system has not only enhanced the effectiveness of personnel allocation but also addressed the issue of optimally allocating persons in situations when there are a significant number of individuals and positions.

5 Conclusion

The economic innovation in management strategy's overarching objective is to facilitate the ongoing improvement of core competitiveness by providing firms with various linkages to the management model they need. On the other hand, businesses' economic management innovation strategies should begin with a well-organized, non-redundant network connection architecture. In this study, we use the particle swarm optimization (PSO) technique to solve economic dispatch (ED) problems in an efficient and reliable way. Due to its reduced computing time requirements, this PSO approach outperforms all others. Initially the technique integrates chaos theory to particle population initialization to fix unequal particle distribution produced by random initialization. The Logistic mapping sequence generates a huge number of particles and picks the best ones for initialization, improving particle quality and ensuring equal distribution. Second, particle swarm optimization algorithm's sluggish late convergence speed makes local optimum solution simple to find. A fitness-based dynamic inertia weight updating approach addresses this issue. This may boost convergence speed in the algorithm's later stages, improve the global optimum solution, and allow particles to search globally for the population's best solution. Finally, a fitness function based on task completion time is devised, and the IPSO algorithm integrates and optimizes corporate resources. IPSO is more stable and converges better than particle swarm optimization. In the experiment, best strategies are chosen to allocate resources for each project step. The findings demonstrate that IPSO can solve this resource allocation issue better. It can efficiently distribute limited corporate resources and reduce project loss from construction delays. The optimization results suggest that the IPSO technique developed in this work can integrate and plan company internal resources and increase operation efficiency.

In this research, we also compare the cost in Rs./hr. and C.P.U. time for 15 runs with the same swarm size and iteration number. The particle swarm approach is used in this research. It outperforms the genetic algorithm in reaching the global optimum value, is relatively unaffected by increasing the problem's peak value and dimension, and excels at handling complicated problems, particularly those with several peaks. With the same number of iterations but various sizes, we can also get the C.P.U. time. The outcome demonstrates that the PSO method may quickly and efficiently solve ED issues with better results. The model's high prediction accuracy is demonstrated by performance testing experiments, where the error reaches an objective accuracy of0.9887. In an experiment comparing with the PSO and genetic feedback models, this study built a model about faster convergence speed and a total precision of 92%, which is significantly greater than the other two approaches, further proving the chaotic particle swarm model's superiority. Because of this, it's safe to say that the method of study may be useful for companies' circular economy financial management.

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