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Using a Genetic Algorithm to Determine the Best Factory Layout in Southern Iraq: Review

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Abstract

This paper describes the use of genetic algorithms (GA) in the field of layout. The plant layout problem (PLP) is a complex combinatorial optimization problem. The main objective of the PLP is to allocate the physical facilities of an entity into groups of departments within the smallest possible area. Since this type of problem is a classic NP-hard problem, the combinatorial optimization algorithm has been widely used to obtain a satisfactory solution. The subject therefore attracts the attention of researchers and industry. This paper has been applied to real case study data (Southern Cement Company in Iraq). A computer program coded in Visual Basic.NET has been developed to implement the developed GA algorithm. The layout obtained for the real case study plant, in this paper, gave an improvement by 0.019 points relative to the current layout that can be applied. The results also indicated the robustness and accuracy of the proposed GA algorithm. In addition, the proposed GA can be a good option in practical applications.

Keywords: Genetic Algorithms (GA), Factory Layout Design, Positioning Workstations.

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Introduction

Picking up the smallest cost factory layout has many approaches that utilize mathematical models such as queuing theory, flow patterns, transportation model, or network approach. These models require a complete understanding of factory flow and practical experience. After the requirement of the department is found, the most common objective is to find a layout that can process the item(s) in the desired way and minimize the travel time within a department, minimize the handling cost from one department to another, minimize space utilization, and maximize close dependencies. Separating or isolated departments cause conveyor belt waste, one-way material trunk use, and crossing other traffic routes for material handling equipment waste if the flow through the department is not correct. This layout design logic is called flow analysis-independent layout design.

Many studies have been done regarding factory layout design, starting from the beginning of the past century. The factory layout design tries to find the shortest distance/work road to achieve high productivity and low production costs of a factory, with the assurance that it provides workers' safety, avoids back and has a good look to monitor quality, etc (Dhayef et al., 2024).

Choosing the best factory layout has been a subject of interest to many researchers. In this paper, we have used a genetic algorithms approach to determine the most suitable factory layout for a new production line in Southern Iraq. Many production managers and industrial engineers concentrate on choosing the machinery and equipment for their factory, while few others concentrate on choosing the best factory layout, designing the aisle, positioning workstations, material handlers, etc., easily. Since the factory layout does not have a well-defined mathematical model, the human aspect and heuristic approaches should be taken into consideration when choosing the best factory layout (Al-Sadi et al., 2023). Overall Structure of GAs for the Cell Formation Optimization Problem in shown fig. 1.

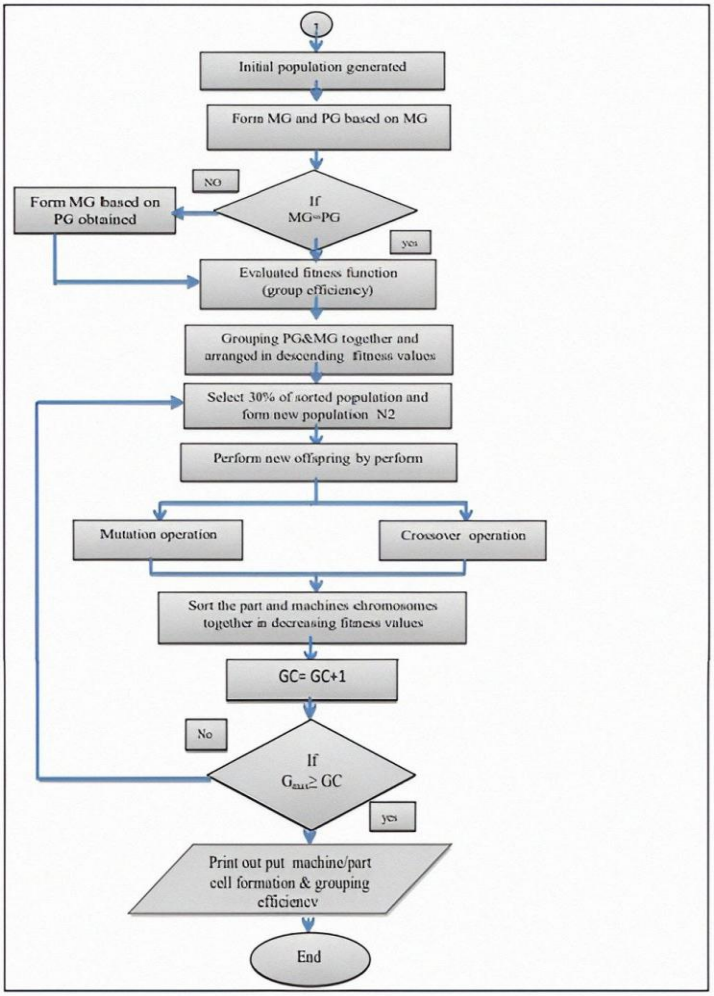


Figure 1: Overall Structure of GAs for the Cell Formation Optimization Problem

Background and Rationale

According to a comprehensive survey, there are no or few research articles that address the factory layout problems. All other genes were then re-initialized and replicated for the formation of initial populations. Thus, the primary industrial goal of factory design optimization is met because flexible layout design demands a digital and implementable approach. It is recommended that human factors be taken into account in future research work in order to obtain a practicable approach. In the context of factory systems research, industry operators could theoretically adopt the empirical research's key findings. Afterward, suggestions for further research are given.

To assess the gap or opportunity in this field that is presented by many countries as a long-term concern for sustainable development due to the need for industrial growth, industrialization through factory establishment can provide an indispensable path that requires product and employment opportunities. There are various stages of constructing a new manufacturing unit, including factory site selection, factory design and planning, and factory system layout management. In managing factory scheduling problems, the INTI-IGA-based hybrid approach with the chromosome structure was used during the study. The genetic algorithm's primary strength lies in its ability to locate solutions within the model area. It often serves as a usable alternative approach to other optimization methods.

Genetic Algorithms in Optimization

All versions of genetic algorithms have two main components, which are the construction of the initial population and the exploration of the space of possible solutions. The construction of the initial population is related to the development of an initial generation of individuals distinct from each other for each problem dimension. As far as the exploration of the solution space is concerned, genetic algorithms perform a long search starting with the initial population, going through a fixed number of generations, and obtaining solutions by applying genetic operators that are based on a probabilistic approach (Al-Aqeeli et al., 2016).

Genetic algorithms are a search heuristic that is inspired by Charles Darwin's "Origin of Species". They are based on the mechanism of evolution, and the main components of genetic algorithms are encoding of solution, evaluation, initialization, selection, reproduction, recombination, mutation, termination, and some other value of operations like the number of the generation and a population size. Genetic algorithms can be used in layout optimizations of factories. They are a type of optimization technique that works well for solving complex decision-making problems and are effective when it comes to optimizing a clear problem, where the solution from a set of individual solutions with the parameters of these is found.

Scope and Objectives

Meanwhile, it is difficult to find an accurate representative of the real-world factory layout problems, so it is an excellent topic to use in research. A genetic algorithm is a popular technique in solving such NP-hard problems. Moreover, after obtaining the fitness value, the designer can present the solution in a graphical approach that can help the designer understand their factory layout well. The purpose of this review is to analyze and identify the techniques used to solve the factory layout problem and then illustrate the multi-product group technique for handling different-size facilities in designing a factory layout using an efficient genetic algorithm.

Using a genetic algorithm to determine the best factory layout in southern Iraq: review. One of the main tasks required by non-experienced manufacturers is to find the optimal layout for their planned factory. The factory layout problem can be included in the more generic plant layout problem, which in turn can be regarded as a general case of the quadratic assignment problem. The factory layout problem is an NP-hard problem, and for small-size facilities, it is possible to obtain an optimal solution using exact methods. However, such methods will be very time-consuming and can be inapplicable to large size factories.

Factory Layout Optimization

This section aims to give a holistic view of the state of the art in the field of factory layout. A historical background is given first, then we discuss the types of layout found in each individual component of the supply chain, and we conclude by reviewing the non-genetic studies (Al-Mudhafer & Alabbas, 2012). First, we introduce material handling systems and discuss a variety of algorithms developed. It is by material handling that the physical shape of the layout is determined, because once the relative position of equipment is decided, then material handling only runs between the equipment. Until today, their development is still considered an expensive process, with mixed results at very high costs. For instance, patching conveyors together is an efficient method for work-in-process areas,

but the slotting conveyor is not designed to distribute material evenly nor accurately to multiple workstations, and that can lead to overtax one work zone while other sites are underused.

Key Factors in Factory Layout Design

The examined manufacturing objectives are many objective functions such as minimizing the time and space, which could result in minimizing the material cost, production cost or improving the work cell utilization under different facility layout considerations. Completely layout remodeling is an extremely expensive and time-consuming project in practice. If companies have limited capital, they may choose the proper automation levels to speed up the required manufacturing. The number, types, and allocation of the machines also impact the manufacturing layout, so the capital isn't enough to determine the best manufacturing layout. The equipment is produced, purchased, or rented at different cost levels. To protect the commercial secret, equipment configuration is kept confidential and the possible layout generation limits the search for the best location of candidate building-blocks to avoid reverse-computation problems. Many books or publications are dealing with manufacturing layout design under limited equipment and minimum size of building-block conditions. They search for the lowest cost to configure the given layout combinations with a mathematical model. The manufacturing cost is estimated by a variety of equipment use factors or finance models such as NPV model, IRR model, the interest factor, PVAF, annual cost or expected cost (Al-Mudhafer & Shahed, 2011).

Efforts in such a field mostly involve optimization of manufacturing layout to make full advantage of the available capacity. Manufacturing layout involves the physical organization of the employees, workstations, machinery, material, and other equipment. We are to decide where these resources are located to obtain a specific production objective or goal, which is mostly related to productivity of production process. That is why the effectiveness of layout design could significantly impact the profitability of a production plant. There are a number of books and review papers dealing with facility layout problems, which could be classified under the following 5 groups. First group of the optimization studies books or publication focus on analytical solutions and heuristic algorithms, which are used to optimize the results of the optimization problems depend on the manufacturing objectives with the location of departments, workstations, and material handling flow in manufacturing environment.

Challenges in Factory Layout Optimization

With the push toward Industry 4.0 and automation production, one of the most important parameters that major money and time of development and implementation is business and production workshop layout. Because layout involves specifying the location of all departments, work produced, office, and more than that, connection between all elements in the factory and other functions of the business. Most money and time investment is used for analytical tools, time-dependent tools, and processes to gain the most benefit while having the delivery of it. During recovery and response, which is specifically monitoring, controlling, and amendment in current factories' workshop and business layout for responding to a new situation. Due to the significant effects of the factory layout, various researches have been undertaken to improve its performance. Although many factory layout models and algorithms have been proposed in the literature, practical imprecise and uncertain issues in the process of layout still exist.

The layout of a factory or any work site is the arrangement of the working area where the activities are carried out to achieve the final or semi-finished product. Many problems are usually related to factory layout, such as minimizing space or closer interaction between different departments to minimize logistic and material handling costs and time, while maximizing communication, flexibility, and life cycle longevity of the organization. The purpose of the factory layout is to locate the department containing similar processes under one area and to position the department so as to minimize time, effort, and cost in the production of the article. The advantages associated with good factory or job-shop layout include reduced material handling cost, reduced work in progress time, reduced production cost, better company customer service, lower work in progress inventory, reduced labor time, reduced journey to move product from one workplace to another for logical removal, reduced amount of time to locate, collect, or move material and information, increased efficiency of communication and planning in the organization.

Genetic Algorithms: An Overview

In this context, facility layout is a strategic and important issue in the planning of a factory, since the correct definition of the layout, among other factors, reduces transportation costs, minimizes delays and damage to materials and stopping during material handling, and improves the relationship and interaction between employees. These costs need to be minimized under the constraints of the particular layout problem, which usually include limitations on the amount of space, the flow of materials, and the nature of the relationship (Mahmood et al., 2024).

A factory production unit is a manufacturing company that produces a product through a process that requires a group of operations. The factory layout problem aims to establish the relative position of departments, equipment, and offices in such a way that their interactions are minimized. This way, a good facility layout configuration can help reduce major operating costs such as handling movement, materials handling, and equipment use.

In plant layout, the main objectives are to minimize the handling cost of the various products, minimizing the possible materials handling, the handling cost and the material delays. This problem is typically formulated as an objective function, representing the total cost of the layout, subject to a number of constraints which represent distance metrics and/or material flow volume and/or load capacity, etc (Hassan & Khalaf, 2020).

Mathematical optimization problems have many fields of application. They are particularly applied in fields of engineering, economics, and sciences. Examples of these mathematical optimization problems include linear programming, nonlinear programming, and quadratic programming. Usai et al. defined the optimization problem as finding the set of variables that leads to either maximum or minimum values for a given function.

Definition and Principles

The genetic algorithm has the ability to deal with mixed structure issues that contain both continuous and binary type rules. When designers design factory layouts, the concept of new or renovated facilities is very limited. Factors like technological advancement, which affects the product size and revenue, the production volume, and others, lead factory designers in the direction of designing multiple and versatile layouts that can satisfy many different layouts.

In other words, the program has the ability to search and obtain a solution in an appropriate reasonable time, where classical optimization tools or methods fail to reach the best possible solutions in the required business issues. It is a conceptual prototype to explore which solutions are the best. Therefore, it is widely used in business and sciences that are blurred and not very clear (Khalaf & Hassan, 2021).

The paper at hand studies this issue in a multi-criteria environment based on the Genetic Algorithm. As for the Genetic algorithm, it is a computer simulation tool that derives from part of the theory of organic evolution based on the natural selection law. It is widely used to solve complex optimization problems for subjects where classical optimization tools are not applicable.

One of the purposes for achieving optimization is to find the best layout for the associated departments, with the least material handling costs, work in process inventory, and manufacturing time. In other words, to arrange a group of equipment, whether it is in the service sector or in the manufacturing sector, in a way that achieves increased efficiency and lower costs. This group of equipment, known as a cell or group of cells, may contain different equipment components based on the nature of the department.

Applications in Industrial Engineering

Genetic algorithms operate at a higher speed to reach solutions that normally differ in optimal strategic decision variables than the solutions that differ in, say, arbitrary allocations of resources. Hence, guiding practitioners to better final formulations of scheduling models. To aid in understanding the essential operations underlying genetic algorithms, several graphical representations have been introduced, used extensively, and become a basis for discussion for many genetic algorithm techniques. With the rapid increase in complexity of the problems under study, the development of hybrid genetic algorithms becomes almost inevitable. Optimal or near-optimal solutions to project scheduling problems in a reasonable time and by the employment of reasonable-sized computers is the goal scored by hybrid models.

The application of genetic algorithms in solving some of the problems in industrial engineering was a good motivation for the professionals in this discipline to have a good amount of contribution. In this heading, some of the applications of this tool are mentioned. Some of the earliest contributions were, who introduced this tool into sequence-dependent setup time problems. Genetic algorithms have since been tested on a large number of other related sequencing problems. Long before the contributions, genetic algorithms were used for solving project schedule networks. Genetic algorithms have also been applied in a large number of other operations problems, such as Johnson's 10 by 10 combinatorial scheduling problem .

Factory Layout Optimization

Consideration of factory layout involves short runs of movement in process planning and scheduling to long-time planning, so that costly alterations may be made in the future. These problems can be combined to assure planners and managers of a high degree of utility and flexibility. Several forces guide and control the determination of factory

layout. Any attempt to summarize these forces presents great difficulty because there are not only a large number of forces, but they also interact in many ways. Traditional trade-offs in factory layout problem consideration are subject to the costs of total machinery and handling equipment. The common discussion of factory layout has presented the problem as determining the arrangement that permits the least expensive flow of materials from operation onwards through the range of finished products. Experience has shown that this problem is sensitive to plant layout arrangements. Therefore, determination of the best layout is a necessary part of the solution of the many design aspects of a production and distribution facility.

Factory layout is the concept that is used in design problems to decide how manufacturing entities should be organized in a plant. Generally, these entities can be machines, departments, workplaces, workstations, or storage areas. Generally, this concept is considered in most of manufacturing or assembly systems in arranging the manufacturing entities in the best possible position for a specific objective. In manufacturing system problems, factory layout can be considered at the beginning of an installation of new machines, or it can be considered in an existing manufacturing plant at any stage when changes involving relocation of the plant layout. It is clear that having the best factory layout could save time and increase productivity in a manufacturing plant. Thus, factory layout problems have attracted great interest from many researchers.

Importance and Benefits

Today, the concept of sustainable development and planning is very popular. The concept of sustainable production is to produce using the available sources so that the needs of the present generations are fulfilled without causing bad impacts on the resources of the next generations and without traditional uses of the environmental components. Any project aims to find a reasonable solution that determines how the actual state of the present generation does not affect the resources of the next generation. The layout is very important for traffic flow and many other considerations. Changing the layout is so important when the resources of the present generation are decreasing or the necessities are increasing.

Society needs many products for its optimal welfare. So, technological developments are necessary for them. These developments can lead to many new facilities that contain many machines, and each machine may have many tools. In the company, placing the facilities can be done in the best layout, which may be based on many decision factors such as the total cost, total inventory, and the total flow. The lifetime of each factory and the production process have many uncertainties. To minimize the risk, flexible manufacturing systems were used. They have much more installations (i.e. AGV, Robot) than manufacturing systems. Now, the number of factories in Iraq is increasing. So, investments in this field are increasing. Some planned installations may not be purchased in the beginning of building the factory, but one can reserve the suitable place for it. Any machinery and some installations may be flexible to be replaced by the required machinery quickly. Idle installations and renew the layout in a time less than the fixed life of the factory are the advantages of using the flexible system.

Challenges and Limitations

Educational institutions develop the policy of preserving genetic algorithms in the form of what is called the "knowledge resistance", in an educational way with models that simplify reality, avoiding the creation of unsafe situations. The limited complexity of the operational results of the genetic algorithm is another big limitation. Small differences in problem definition may lead to great differences in terms of performance; therefore, even very good solutions have limited applicable aspects. It is an important fact that while a genetic algorithm can provide an optimal solution, it is not capable of checking whether the proposed solution is feasible in practice or not. Any method cannot solve all the problems, and the genetic algorithm as a whole does not have the effect and determines a suitable fit to each problem. Furthermore, it is important to note that, even though a feasible solution and an optimal solution for a problem can be easily obtained, even small changes in the problem are required to be reported with the genetic algorithm.

Challenges and limitations are an inseparable part of the meta-heuristic algorithm, especially a genetic algorithm. That is why in this chapter we take about the main challenges that genetic algorithm faces in finding feasible solutions to an optimal problem and in this particular situation of factory layout. The time that a genetic algorithm may take to find a solution to a complex layout problem is very long and in many cases maybe indefinitely long. The representation of the problem in an integer form, the running mode of chromosomes, and how to modify the code of the problem are main challenges and restrictions of the layout problem for a genetic algorithm.

Case Study: Factory Layout in Southern Iraq

While classical methods require the engineer's interference and judgment to draw a model evaluation, genetic algorithms give very good results by using genetic operators such as selection, mutation, and crossover. These genetic operators, along with the fitness function, reduce the present layout to get the evaluation factor. In addition, genetic algorithms are good at avoiding local optima. The effect of this pool layout on the performance of the factory will be investigated in this study, in terms of production and performance. Finally, because the Governorate of Najaf is growing at a fast pace, the construction of a factory in that province represents a sole source of living for the majority of young people, not least to enforce their roots in that province. While they provide a good environment for accommodating investments not covered. From the above information, it is necessary to organize such a factory.

Iraq is suffering from an absence of many industrial products because of the embargo on Iraqi products. In addition, there is an increase in the consumption rate of these products following the increase in the standard of living after adopting the strategy of paid salaries. There is a big difference between the production of products compared to the consumption, which leads to a huge increase in the prices of these products. This has led the government to adopt a plan from the year 2000 titled "thermal year", and the main point of that plan is the establishment of several factories in some governorates in the south of the country. Factory layout has a great effect on the production line in terms of production rates and human resources.

Current State and Challenges

To design a sustainable facility location, facility layout, distribution network or a complete supply chain, a company could consider: how to reduce the negative effects of the supply chain, improve the production within the supply chain, and whether to close the plant, in part or in whole. Applying a genetic algorithm for determining the best factory layout in southern Iraq for paper and napkins. Although the results of this paper are promising, there are many steps still to be taken. The aim of this paper is to contribute with the step forward in the expected direction. This research can easily be seen as a multi-stage assignment and here we describe some directions and define a set of tasks that could help the research to reach the next destination.

Supply chain managers are now beginning to consider these aspects of sustainability factored in when they make decisions. There are models which are able to account for energy consumed during the production or manufacturing processes. Other models are common but more difficult to calculate, such as end-of-life disposal. This one fact alone makes it difficult to calculate sustainable supply chains. In this section, we study some of the literature about the existing state of sustainable supply chains. As the world uses its natural resources to make the products it needs, it generates polluting waste. Over time, both the continuous use of resources and the generation of a large amount of waste have a negative impact on human health and the environment.

Data Collection and Processing

- Factory spaces of the Industrial Research and Consulting Foundation, which provided the required factory planting data and worked in the designed factory.
- Quality department of industrial redevelopment consultancy foundation where all the required production, work environment, and employee health data were provided.

The object of current research from workshop workshops in the Research and Industrial Development Consulting Foundation of south of Iraq, where current research was taken from two separate states:

- Environment data: in terms of radiation data using a Geiger counter in the working environment available to employees, and health work statistics in the factory to be designed, e.g. the number of fertile employees.
- Production data, including the introductory data of the research states, and the land which can be loaded on this land are divided into three groups (good industrial, scraped, unsupported equipment).

Indeed, data were presented by the Ministry of Industry and Minerals in each of its research states. The data concentrated in two basic groups.

Genetic Algorithm Implementation

Controlling of paint assembly line layout design requires the solution with challenging multi-objective criteria, such as to provide fast wall coating interval times; to be as low as possible with material handling costs and to allocate the best fitting layout within an existing industrial building space. No single disciplinary professional is capable of responding to all of these objective requirements separately, so that successful management of paint assembly line facilities of better layout designs would be used for implementation with multi-criteria solution methodologies. High

wall coating quality is also very critical for successful automotive paint application results. Use of hard automation systems inside the paint area in the industry, open creating the robot joint flexibility problems during the paint area and its surrounding congested area operations of related production processes. Results of the genetic algorithm solution were quite satisfactory.

The research subject was to design a factory layout that maximizes productivity and minimizes material handling costs using a genetic algorithm. The search and finds the most used optimal building layout can be very costly and time consuming. Compromises between available solutions are important to overcome many qualitative and quantitative conflicts in the factory layout design. In this paper, the genetic algorithm solution method was used to provide high and acceptable quality results to preliminary paint assembly line layout settings for achieving the objective of operational strategic properties.

Problem Formulation

The results showed that the algorithm had a high execution power. The paper was organized and arranged as follows: section 1 gives an introduction to the investigated problem and its logic. Section 2 deals with the proposed genetic algorithm to determine the best factory layout. In Section 3, a case study on a factory that produces small energy equipment is presented. The last section gives the conclusion of the work.

In this paper, it is used an optimal method that recognizes to determine the best layouts of the factory. This method is a kind of the genetic algorithms that help to determining the best factory layouts. The company took a representative survey of its production engineer and selected from them the real experienced. The logic of the plausibility was to limit the number of algorithms realizations and to obtain this fact and gives heuristics solutions that consider not only criteria that belong to the production or the technology of the machinery but also give consideration to real experienced effects paradoxical to those previously published in the literature.

One of the important problems before these factories is setting up their factories and what the longest technique that helps these companies setting their factory on the area that these factories existent buildings? Is there a technique possible to save the long time and using this time for the establishment of the factory? The idea of this paper is to provide a possible solution that helps to set up the layout of the factory buildings that are existing in Nasser factory, with no changing. The layout of these buildings cannot be demolished to set up the location of the experienced sections that the company prefers to establish.

The city and province of Tirat are situated in the south of Iraq. In 2013, a company decided to establish a new factory that will produce small energy equipment such as electric cable, circuit breakers, and cable glands in order to supply neighboring countries with these products. Other provinces in Iraq, especially the deprived centers of Iraq, are preventing from numerous factories due to the activities of the terrorists and militias.

Genetic Operators and Parameters

Representing optimization problems' solutions by permutations can resolve combinatorial problems easily and efficiently. A greedy representation requires some tools that allow diversifying the populations without the loss of feasibility. Crossover plays this role in many ways. Traditional crossover operators, such as partially-mapped (PMX) crossover, are difficult to apply to such problems as the Traveling Salesman Problem. On the other hand, straightforward approaches, such as cycle crossover (CX) or masked PMX (MPMX) crossover, are inappropriate for the Job-Shop Problem and move no genetic material between two parents. Meanwhile, other techniques such as hybrid algorithms or commercial optimization software, which are corpulent, require a dedicated career that limits its training to experts in this field.

a). Crossover Operators

This section has three subsections. The first one is devoted to addressing both of the crossover operators found in the ordering-based representation called simple crossover (SC). In addition, one of the most known mutation operators, transposition (TP), is also discussed. For the second subsection, it handles the determination of the GA parameters. Finally, the last one was developed to elaborate some improvements of this research design.

Performance Evaluation

Then, another goal is the proper assignment of machines and operators in the same way. It is sometimes desirable to maximize the overall effectiveness. Process facilities are allocated towards the appropriate type of tool. Furthermore, optimal subjective functions may involve several unrelated goals. To achieve the output of constraints, optimization will satisfy these objectives only with regard to the constraints placed on available resources. Ey cases in which the

making of the facility layout problem is subjective requires the consideration of special constraints. Reasons to upgrade due to fire, safety, and health regulations encourage the company to investigate the facility layout's robustness. A solution that satisfies both the concerned service time and distance travelled of the users of the layout is then called for. Finally, the use of space is to maximize the aspect of layout and to minimize the floor space requirements. The space can be an unmanufactured square footage of a construction project. Practical constraints, since building dimensions are fixed. However, when the building is vast or has many floors, the descent of a phenomenon yields an actual building floor.

A common alternative is the total material handling cost. Material handling cost is a set of costs that resists the transportation of goods so it looks like the same objective function used in above. However, the primary cost rate is a measure of friction, including fluid flow resistance, rather than roughness, garbage, etc. Industrial companies also consider operators' safety, environmental pollution control, job satisfaction, close cooperation, and flow among products, while preparing their layouts factors that might be more practical than the need to achieve material handling cost. Another common objective function is congestion minimization. Congestion refers to the overloading of a facility such as a process, department, production line, or service area. When a facility is overwhelmed, waiting times can become important. There are times when cues are present to keep track of the requests. Time can be lost when a production item goes wrong and must be remade or repaired. Then the priority is given by the urgency or due date of the items in the queue. When cues form, it is often the result of process imbalance.

A variety of objective functions can be used to represent the quality of a proposed facility layout. One frequently proposed objective function is the total transportation cost. The objective of a proper facility layout design should be the minimization of transportation cost. However, this objective function has two weaknesses. First, transportation cost relies on distance between different departments and is computed based on all possible flows between each pair. Then, there are costs associated with the integration of diverse methods and machines. Because of these drawbacks, the above objective function is not suitable for service or research facilities where the problem is subjective. Recently, the field of mobile robotics in manufacturing is growing rapidly. Then, a good objective of a facility layout is to find a solution that allows the shortest travel time for a mobile robot to move from one location to another.

Metrics and Criteria

Within previous survey research or grounded theory research, it is rational to anticipate some familiar themes and key factors. Briefly, these themes and factors can be sub-categorised into our seven criteria. While existing literature strengths or moderates these key criteria, these are presented as Reference +: seven codes. Due to the ongoing survey research study, factors listed here are initial pre-research factors, progress to refine or reform key decision-making factors. Users can apply these listed results from the follow-up decision-making criteria and group as guidelines to new empirical research. Moreover, this is also useful for managers who are considering the FSM.

Based on the literature, a follow-up categorization is described under six other main criteria and considered metrics. For each group, the paper provides a comparative approach of the relevant criteria that we feel would assist to clarify further decision-making factors beyond the initial presentation of the seven criteria. Extension regarding these sub-criteria would be a helpful guide to managers who are considering FSM. Finally, the paper will provide a comparison between various research disciplines in the attempt to achieve these sub-criteria.

Comparative Analysis

The genetic algorithm was applied to solve the floorplan problem for the Garment Company in Vietnam to minimize the material handling cost/product and increase productivity. In this case, the expensive material handling has a significant impact on production effectiveness. The factory consultant proposed the third alternative factory layout, which had a smaller GOP. Then, the consultant applied the genetic algorithm using the areal size of the machine, finishing processes and parts in the production area, and the material flowchart between the finishing and cutting area to predict the estimated production effectiveness. According to the genetic algorithm analysis, the new layout can reduce the proletarian congestion in the finishing area by 4 times economically.

Comparative analysis is considered to clarify the significantly better developments of the current operations. When the best form of solution is sought, it is necessary to explore all the design possibilities in the search area. Therefore, in this comparative analysis, we will compare the solution of the selected positions (2^{nd} best, 5^{th} best, 6^{th} best, 8^{th} best, and 9^{th} best) from the result in table 9 to identify a more efficient solution.

Discussion and Future Directions

This investigation lacks the primary data threshold. There are some issues and variables gaining access to their information under experimental tests in a comprehensive way in Iraq's plants and factories. This fact validates the use of experts or opinion polls, along with available literature, to capture the information required for the FACTOR. Another limitation of this research is the distinct GAs reliable on incorporated cone parameters and ACTIVE parameters. Moreover, this investigation cannot evaluate or model premature working life acknowledgment or estimates of deviations. Different genetic algorithms, when reflecting a Bayesian studier of these choices, can be used in future work to assess these issues. Overall, three certainties can be mentioned: first, there is great bargaining power for alternative factory floor designs that provide adequate public space and direct sun that is an efficient factory layout across southern Iraq; second, factory floor design limits some possible configurations, mainly by the large size, layout, and specific requirements which limit the degree of flexibility of a different system for layout alternatives; and third, future consumer-oriented author's symbolic manufacturing research can be influenced by environments, contacts or social relationships exempts creativity independent of relationships, judgments, beliefs, products, experiential memories, relationship marketing, manufacturing strategies, market orientation, or manufacturing values research contexts. With demonstration and great organization, product records of assembly agility have to refer to a considerable percentage of opportunities for appropriate diversification and replacement for agility.

One of the limitations of this research is that the nature of the GA relies on iterative tests. Thus, some GA tools are not compatible with the large size of the initial population. Another limitation might be the binary method used to model the nature of the problem and Object-Oriented Programming for the mentioned purposes. Additionally, the used GPR sounds galloping until it reaches the goal. Another limitation of this research includes the assumption that the best factory layout is related to economic and survival issues, and other issues might be neglected. Consequently, conclusions might not be applicable to all locations. The factory functional units depend on the collective culture, macro and micro, industrial environs, and site characteristics of the factory surrounding. These factors might limit the generalizability of the conclusions made and applied.

Key Findings and Implications

Data warehousing clustering can be viewed as the process of partitioning aggregate data into a number of parts based on the homogeneity of certain features contained in the data. It does not define an agglomerate or a subgroup. Initially, we do not know the number of groups that are formed, nor the number of members for each formed group. Each data point joins the most similar cluster based on the nearest values between the aggregate and class central data points. Genetic algorithm has already been successfully used in clustering. In the context of data warehousing clustering, we tested the method on matrix data, which are dense data columns with a few empty cells. We also checked the generation of libraries of motifs, searching for a feature with a degree of membership throughout the data space.

In this study, an overview is provided for the facility layout problem (FLP) and the process of clustering in general, as well as how genetic algorithm (GA) was used for the optimal placement of facilities on a map. The study also demonstrates the use of GA for this purpose. Regarding the study findings, although two points of view were presented and the results are consistent with earlier research, the paper could use more realistic data.

Potential Enhancements and Extensions

A similar study should be carried out for various other manufacturing industries so that basic theories can be derived for the optimal factory layout with minimal adoption or improvement. This necessitates an excessive level of expertise and experience, notwithstanding owing to the variable nature of construction tasks which disallow for a one-size-fits-all solution. In addition, and to the best of the authors' knowledge, this study report is the first one in Iraq embracing a genetic algorithm so as to plan an optimum factory layout.

The research reported in this article can be optimized in several directions. One possible research improvement is the production operation time, which was solved using a simulation for different factory layout alternatives. The alternative to the simulation is to develop mathematical expressions or formulas for manufacturing workstations whose layouts will be validated in real small-scale construction applications. A mathematical optimization model for finding the best factory layout would consequently be formulated. The most well-liked factory layout will be selected in accordance with the best ratio relating to the whole building construction time and the expense of the building possessing the optimized factory layout.

Conclusion

Moreover, it requires a much smaller population size than other popular hybrid strategies. Finally, the heuristic has excellent low cardinally parallel feature and can solve large instances of the problem in few minutes. The method was also successfully applied to compare efficiency of various chamber typologies.

In this article, a new setting for solving the factory layout problem is proposed. It uses an explicit chromosome representation and i)-(ii)-mutation and i)-(ii)-crossover operators with minority-shift heuristic for encoding and decoding values of a chromosome. A minority-shift assignment approach for allocating blocked areas to preferred places is another achievement of this study. Results show that the proposed setting may produce 2%-13.9% improvements in total/handling costs in comparison with the average and min models of the proposed method.

Searching for the best practical layout of a factory is a major problem in production physics, and a substantial number of algorithms have been introduced to solve this problem or at least to supply suggested solutions. In spite of this work necessity, the subject remains partially open and practical problems, such as selecting proper genetic operators and size of population, are indispensable without full investigation.

Summary of Findings

The research also applied and contrasted four different performance criteria in making a single comparison, the first of which was budget cost, which has a high rate of significance, being chosen in a 2 by 3 factorial experimental design with three layouts of the industry tool for the benchmark. The other two features are the number of characteristic areas and the lowest time of travel. It also needs to rationalize the selection of the factory locations that pose the least problems and are the highest acceptable. Also, the economic part of the layout problem aims to measure and decide what the right form of strategy, function, and location can be, with solutions based not solely on decreasing travel cost but also on reducing the flexibility of the system to cope with growth, piece-part size, or the travel rules.

This research applies a genetic algorithm to solve the job-shop problem of designing a factory layout optimized for use in the southern region of Iraq. It is designed to overcome the weaknesses which characterize the use of genetic algorithms. The paper investigates the problem of arranging functional areas at a factory to establish internal NAF walls while of two factories, Factory A and Factory B, a genetic algorithm model will be exploited for the purpose of resolving this problem. This will show the configuration of Factory A and its detailed design specification. For the layout environment, the research will specifically choose a rectangular environment in Factory A and consider the same environment for Factory B.

Contributions and Recommendations

Color four a.

1. The second approach is the most important and involves adding more variables to genetic algorithms, such as the type of soil, wind patterns, and certain types of heat, etc. A practical solution to this problem could be to generate a noise map of energy. In the generated map, the following color pattern can be used: - No generated map color: represented by the decimal number zero. - Color 1 (blue): designates the target for the placement and/or repositioning of an energy facility. - Color 2 (purple): designates the prohibitions for the contemplated employment. - Color 3 (red): designates the features on the ground that can create different problems.
2. Currently, after searching for the best company arrangement with genetic algorithms, their algorithm must be run from the beginning in order to obtain different results as repositioning nearby factories could cause positive changes. However, it is important to ensure that genetic algorithms guarantee the best solution. A practical solution to that problem could be to execute Genetic Client with a number (n) and no value should be the root of n. Currently, the authors do not have a reference for this. Another solution with which this paper could be expanded is to solve the problem using simulated annealing algorithms. Additionally, geographic information systems exist for the optimization of different problems, and the authors have come across a reference that uses genetic algorithms through a simple interface. Small problems are simple to generate without the use of geographic information systems because they have a feature called map outlines.

Although the authors believe that the present paper is the first reference that solves the problem of locating factories using genetic algorithms, the paper may be expanded in the following two topics.

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