IJEASM

International Journal of Engineering Applied Science and Management
ISSN (Online): 2582-6948
Vol. 5 Issue 5, May 2024

OPTIMIZATION TECHNIQUE FOR MULTI-OBJECTIVE DYANAMIC FACILITY PROBLEM

Dr. P. N. Ahirwar
Associate Professor
Mechanical Engineering Department
Madhyanchal Professional University, Bhopal, MP, India

Abstract: *Facility layout problem is one of the oldest activities performed by industrial engineers. Facility layout problem or facility layout design has been a popular research area among researchers due its significant influence upon manufacturing cost, material handling cost, work in process, lead time and productivity. "Layout problems are generally found in several types of manufacturing system. Typically, layout problems are related to allocation of facilities (e.g. Machines etc.) in plant. Numerous works related to facility layout have been published so far. However, research on many aspects of facility layout problem is in initial stage; hence facility layout problem is still an emerging field to work on." Therefore, in this paper a review of work done by numerous researchers have been made about facility layout problem that can be used to meet current and emerging trends in facility layout design. The new developments related to facility layout have been discussed in these studies which suggest future direction for future research on facility layout problem.*

Keywords: *Manufacturing facility, facility layout problem, material handling, dynamic layout, survey*.

1. Introduction

To operate efficiently in terms of manufacturing and services, companies should not only be concerned with the optimal planning and operational policies, but also have a well-designed facility layout (Pillai et. al. 2011). Facility layout problems deal with the placement of facilities (man, machine, material etc.) in plant area subjected to different constraints. An effective facility layout design once optimized lead to improvement in manufacturing cost, material handling cost, work in process, lead time and productivity. Facility layout is a core element of facility planning. In return poor facility layout design increase the material handling cost, work in process, lead time and productivity.

Material handling cost (MHC) is one of the foremost indicator of efficiency of layout (Emami, 2013). "Since 25-55% of total operating cost of a manufacturing company and 15 -70% of the total cost of manufacturing a product are attributed to MHC (Mohamadghasemi, 2012). Alternatively, ineffective design of facility layout can add to 36% to MHC (Mohamadghasemi, 2012), companies can reduce these costs by at least 10-30%" (Pillai et. al. 2011). Additionally,

Past research shows that 35% of system efficiency lost by applying incorrect facility layout (Izadinia, 2016). Throughout the field for production and industrial engineering, FLP is thus the most critical issue, capturing the interest of engineers and researchers concerned with complex layouts. If content movements around facilities shift over the planning process, so the configuration of the facility becomes complex (McKendall, 2016). Flow data for each time is believed to maintain and stay stable throughout the period (McKendall, 2010).

"Generally, DFLP include the selection of layout or making decision associated with the change of layout or not. Therefore, layout design is determined in planning horizon such that MHC and cost of rearranging facilities should be minimized" (Abedzadeh, 2013).

In this paper a review of work done by numerous researchers have been made about dynamic facility layout problem that can be used to meet current and emerging trends in facility layout design. The new developments related to dynamic facility layout has been discussed in this study which suggests future direction for future research on dynamic facility layout problem.

In pursuing new research directions, its literature review is indeed a valid approach or essential step that allows scrutinizing some philosophical aspects and directs that research into new theoretical growth. The review of the literature presented in this is recent and relates to dynamic layout optimization. The main motivation of this paper is to suggest future direction for future research on facility layout problem.

2. Impact of Workshop Features on Layout

Such instance, individual differences which design problems influence the layout: the range of amount of output, the preferred material handling mechanism, the multiple different flows, facility forms, pick-up or pick-drop positions.

Products variety and volume

"The design of layout is mainly depend upon products variety and production volumes. Four different types of layout exist in literature: fixed product layout, process layout, product layout and cellular layout. In fixed product layout, product usually circulate within the production facilities. Different resources are bought to perform operations on product. This type of layout is generally use in the manufacturing of ships and aircrafts. Process layout groups similar operations. This layout is commonly used in the manufacturing of wide variety of products. In cellular layout, machines are grouped into cells, to process the families of similar part. Here, best arrangement of machines in each cell is the primary concern."

Facility shapes and dimensions

It is possible to differentiate between two various materials of the facility: normal, "i.e. rectangular (Kim and Kim, 2000) and irregular, i.e. polygon with at least one polygon a 270° angle (Lee and Kim, 2000)." "As mentioned by Chwif, et. al. (1998), a facility has a fixed dimension, defined by a fixed length (Li) and a fixed width (Wi). In this case, the facilities are called fixed or rigid blocks. According to the same authors, a facility can be also defined by its area, its aspect ratio: ai=Li/Wi, an upper bound aiu and a lower bound ail such that ail ≤ ai ≤ aiu. The aspect ratio was also used by Meller, et al. (1999). If ai = ail = aiu, this corresponds to the fixed shape blocks case (Chwif, et al., 1998)."

Material handling systems

It refers to the distribution to suitable locations of both the content. Wheel), Automatic Guided Vehicles (AGV), robotics, etc. are material handling devices (El-Baz, 2004). Tompkins, et al. (1996) reported which 20-50 percent of production costs were attributable to both the handling of materials, and then 10-30 percent could be minimized by a good arrangement with handling equipment. The challenge is coordinating equipment along its material handling route while working with such a material handling device. Two based construction concerns are taken into account: designing the configuration of the building and choosing the handling equipment. "The material handling unit type defines the pattern to be used for the system configuration (Heragu and Kusiak, 1988; Devise and Pierreval, 2000). Co, et al., (1989) found out how the configuration of both the facility influences the handling device collection.

Despite the challenge of jointly addressing these questions, one of them might be addressed before another one (Hassan, 1994). You may differentiate between the primary elements of configuration configurations depending on the form of material handling: single row layout, multi-row layout, loop layout and open-field layout. (Yang, et al., 2005)."

Backtracking and bypassing

Two basic motions relevant to both the flow-line structure who influence the flow of both the processes were backtracking nor bypassing. Backtracking seems to be the transfer throughout the chain of installations throughout the flow-line arrangement of even a section of one facility to the other accompanying it "(Braglia, 1996; Kouvelis and Chiang, 1992)". The amount of such movements must be reduced. Bypassing happens when ever a portion skips those structures when going into the arrangement of the flow line (Chen, et al., 2001). Hassan (1994) noted that so many techniques for dealing with reducing backtracking were provided, but no method for approaching bypassing was proposed in the literature. To their understanding, no studies apply to any of this movement of components.

Pick-up and drop-off locations

The location of parts entering and exiting buildings, called pick-up and drop-off (P/D) points, also needs to be determined. While they can theoretically be positioned somewhere within or inside the limits of both the facility region (Kim and Kim, 2000), some researchers limited whose possible location due to the uncertainty caused. "(Das, 1993; Rajasekharan, et al., 1998; Welgama and Gibson, 1993)".

3. Dynamic Layout Problem

Manufacturing plants should be capable of adapting rapidly to changes in demand, production volume , product mix nowadays. On average, 40 percent of the sales of a business result in new goods, Page (1991) reported. The adjustment in the product mix, however, results in the alteration of the output flow and hence changes the structure. Gupta and Seifoddini (1990) suggested that every 2 years, 1/3 of US firms experience a significant re-organization of manufacturing plants.

The dynamic layout impact goes the normal layout problems "(considered static or single layout problems)" while taking into account changes throughout the flow of material handling over many periods of time "(Balakrishnan, et al., 2003b, Braglia, et al. 2003)". The planning horizon would then be broken into phases which can be specified through weeks, months, or years. Estimated flow data remains constant with each cycle. A layout plan also for complex layout problem consists of a sequence of templates combined with the time by each layout.

The aim should be to decide a configuration on the planning horizon with each period, thus minimising the amount of the expense of material handling for certain periods and also the sum of both the expense for rearrangement among periods "(Balakrishnan, et al., 2003b; Baykasoglu, et al., 2006)". While moving services from one site to the next, rearrangement expenses are incurred. "(Baykasoglu and Gindy, 2001)".

In any case, however, dynamic layout analysis couldn't be applicable. In fact, where the discrepancy here between cost of handling of materials and the cost of rearrangement has become too high, it's also good to address two drastic cases: (1) that cost of material handling is now far cheaper than the increase of rearrangement, otherwise the structure can indeed be changed if required, if demand changes arise, with little advance preparation (Hirano, 1989). (2) Rearrangement prices are much higher than material processing costs, and then the same configuration is being used for the whole planning horizon. (Kouvelis, et al., 1992).

4. Past Studies or Survey

A analysis of work performed by different researchers on the issue of facility architecture has indeed been carried out in every section. Uh, Wei et. Through evaluating experimental effects of a corresponding implementation, Al. (2019) compared many algorithms. The T-CGA process, which again is lower than the old method of precision and reliability resolution, is often more easy to validate. "Al Hawarneh, Bendak, and Ghanim, (2019)" That used a grid framework for layout design dependent upon this safety proximity level amongst facilities, a grid layout approach was designed to accommodate safety as both a design parameter besides cost. Dixit and Lawlor (2019) identify the introduction of even an altered genetic algorithm to solve the problem with facility configuration through reducing the expense of overall material handling. An isomer-based elitism has been used and that effects of both the proposed algorithm were comparison to earlier observations throughout the literature. An expanded algorithm is recommended for calculating the algorithm's performance. The findings show that perhaps the feasibility of both the suggested approach is comparable with previous work so this isomer-based elitism across a broader variety of problems will be tested for use. The series of logistic chaos takes advantage of Ye, Liu, and Jiang (2018). The algorithm guarantees the precision of both the Genetic Algorithm's cross but variance points. Throughout this dissertation, that algorithm is extended to theoretical simulation in aeronautical planning. Results from the simulation revealed how this approach increased that genetic algorithm's accuracy. Uh, Peng et. Al. (2018) deals with the topic of stochastic dynamic facility architecture in addition to material transfer amongst facilities during demand volatility. Experiments measuring the cost deviation ratio under varying degrees of fluctuation illustrate the robust layout's positive performance relative to the predicted layout. A novel dynamic facility architecture problem (DFLP) was proposed by Pourhassan and Raissi (2017) to structure and rearrange production facilities which mathematically reduce material handling or the associated expenses. The findings suggest that now the genetic algorithm for non-dominated sorting is more useful in terms of precision but quantification in celerity. "Li et al. (2015) suggested a multi-objective under security decisions for a joint complex construction site configuration. The algorithm of particle swarm optimization helped everyone solve infeasible solutions. Wang et al. (2015) Integrated modeling of construction details including firefly algorithm for automatic planning of crane layout.

A cost-oriented binary-mixed-integer-linear-programming approach suggested from Huang and Wong (2015)" is subjected to architecture safety restrictions including facility layout preparation under multiple construction phases. Pedestrian confusion but dynamics utilizing four success metrics modeled from Zhang et al. (2016). Throughout this study, in a busy subway station, route preparation was evacuated and compared. Zhang et al. (2017) merged storage position designation and use a mixed integer programming model with either a capacitated lot-sizing problem. Those who also proposed a heuristic approach towards Lagrangian relaxation and solve some large-scale problem models. A hard mathematical NP model with incorporating the problem of dynamic cell forming posed through Mehdizadeh and Rahimi (2016). And using a variety of auxiliary variables, researchers suggested a linearizing strategy then overcome it with a multi-objective optimization with vibration damping through multi-objective simulated annealing algorithms. Optimization of travel distance through store allocation within such a mathematically analyzed just-in-time warehouse layout design (Horta, 2016). A minmax method was introduced here with store allocation of floor place clusters. Whose research paper recorded a decrease in distances of 2000 km/month in Portugal.

5. Current Trends and Future Scope of Work

From this study, so the use of GA is most relevant, improvement in using GA, SA, TS, ACO and PSO to improve multi-objective FLP becomes observed. The emphasis towards dynamic facility layout optimization modalities which meet room specifications and decrease re-layout costs is often acknowledged, although the fundamental concern of material handling costs remains significant. The variability between targets including methodologies is based on, It should be remembered because FLPs deal with either a broader spectrum of variables that have to be taken into consideration. The use of hybrid approaches such as meta-heuristics and AI for prioritizing targets through eventual optimization becomes likely to be part of both the potential scope of developing robust facility layouts; Hybrid interface generation, independent of both the involvement of the designer; but 'parallel GA' implementation. It is important to conduct an exhaustive analysis of different multi-objective approaches to FLP. Research prospects must also be discussed throughout the aforementioned lines.

6. Conclusion

FLP And one of the most significant classical supply management and organizational engineering issues that really has grabbed the ire of many literary scholars in recent decades. Despite that importance, research is still at its initial stage on several facets including its major issue; it therefore really seems fascinating and promising to focus on FLPs. An effort has been made throughout this report to provide a systematic and comprehensive analysis of different FLP articles depending on multiple literature sources, that will help to explain the present state of science in this field and enrich its body of knowledge of the this independent research. Readers were able to recognize any concerns with the findings of the literature analysis. They find that multiple published paper hats were regarded from various facets of the several sources mentioned in a previous of the whole paper (i.e., layout evolution, workshop characteristics, problem formulation, and resolution approaches). It emerges from that kind of review whether papers relating to layout designs appear to still be reported frequently throughout significant scholarly journals and also that FLPs remains another open area of study.

References

[1] Pillai VM, Hunagund IB, Krishnan KK (2011) Design of robust layout for dynamic plant layout problem. Comput Ind Eng 61(3): 813-823.

[2] Emami S, Nookabadi AS (2013) Managing a new multi-objective model for the dynamic facility layout problem. Int J Adv Manuf Technol 68(9):2215–2228.

[3] Mohamadghasemi A, Hadi-Vencheh A (2012) An integrated synthetic value of fuzzy judgments and nonlinear programming methodology for ranking the facility layout patterns. Comput Ind Eng 62(1):342–348.

[4] Mohamadghasemi A, Hadi-Vencheh A (2012) An integrated synthetic value of fuzzy judgments and nonlinear programming methodology for ranking the facility layout patterns. Comput Ind Eng 62(1):342–348.

[5] Pillai VM, Hunagund IB, Krishnan KK (2011) Design of robust layout for dynamic plant layout problem. Comput Ind Eng 61(3): 813–823.

[6] Izadinia N, Eshghi K (2016) A robust mathematical model and ACO solution for multi-floor discrete layout problem with uncertain locations and demands. Comput Ind Eng 96:237–248.

[7] McKendall AR Jr, Hakobyan A (2010) Heuristics for the dynamic facility layout problem with unequal-area departments. Eur J Oper Res 201(1):171–182.

[8] McKendall AR Jr, Shang J (2006) Hybrid ant systems for the dynamic facility layout problem. Comput Oper Res 33(3):790–803.

[9] Abedzadeh M,Mazinani M,Moradinasab N, Roghanian E (2013) Parallel variable neighborhood search for solving fuzzy multiobjective dynamic facility layout problem. Int J Adv Manuf Technol 65(1):197–211.

[10] Mohammad Reza Pourhassan, Sadigh Raissi (2017), An integrate d simulation-base d optimization technique for multi-objective dynamic facility layout problem, Journal of Industrial Information Integration, 8, 49-58.

[11] Z. Li, W. Shen, J. Xu, B. Lev (2015), Bi-level and multi-objective dynamic construction site layout and security planning, Autom, Constr., 57, 1-16.

[12] J. Wang, X. Zhang, W. Shou, X. Wang, B. Xu (2015), A BIM-based approach for automated tower crane layout planning, Autom, Constr., 59, 168-178.

[13] C. Huang, C.K. Wong, (2015) Optimization of site layout planning for multiple construction stages with safety considerations and requirements, Autom, Constr., 53, 58-68.

[14] L. Zhang, M. Liu, X. Wu, S.M. AbouRizk (2016), Simulation-based route planning for pedestrian evacuation in metro stations: A case study, Autom. Constr. 71.

[15] G. Zhang, T. Nishi, S.D.O. Turner, K. Oga, X. Li (2017), An integrated strategy for a production planning and warehouse layout problem: modelling and solution approaches, Omega, 68, 85-94.
[16] E. Mehdizadeh, V. Rahimi (2016), An integrated mathematical model for solving dynamic cell formation problem considering operator assignment and inter/intra cell layouts, Appl. Soft. Computing, 42, 325-341.
[17] M. Horta, F. Coelho, S. Relvas (2016), Layout design modelling for a real world just in time warehouse, Commp. Ind. Eng., 101, 1-9.
[18] Yunfang Peng, Tian Zeng, Lingzhi Fan, Yajuan Han, and Beixin Xia (2018), An Improved Genetic Algorithm Based Robust Approach for Stochastic Dynamic Facility Layout Problem, Discrete Dynamics in Nature and Society, https://doi.org/10.1155/2018/1529058.
[19] Al Hawarneh, A. Bendak, Ghanim. F, (2019), Dynamic facility planning model for large scale construction projects, Automation in Construction, 98, 72-89.
[20] Xiaoxiao wei, Sicong Yan, Yuanqin (2019), Optimizing facility layout planning for reconfigurable manufacturing system based on chaos genetic algorithm, 7(1), 109-124.
[21] Ye, J., Liu, X. Jiang S. (2018), Track optimization based on chaos genetic algorithm and its simulation analysis, Journal of mechanical design and research, 27(6), 55-57.