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Optimization of Site Layout Planning for Multiple Construction Stages with Safety Consideration and requirements

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Abstract - *In the construction management site layout planning is the crucial task. The site layout can affect safety, travel cost and time, construction productivity, and space utilization. Construction site layout planning involves identifying, sizing and positioning of all temporary facilities on site such as offices, storage area workshop towards the entire project duration. A well planned site layout increases construction productivity; achieve safety in construction, maximizing utilization of space. This paper present the dynamic site layout planning .Which focuses on travel cost, relocation cost, constraint violation cost. The main objective is on obtaining the closeness relationship values between each pair of facilities in construction site with consideration of maximum safety. This study will useful to construction planner and can lead to significant improvement in the safety construction operations and cost of constructed facilities.*

Key Words: Construction management, Site layout planning, Optimization, Construction safety.

1. INTRODUCTION

The Site planning has been the most neglected aspect in construction industry and attitude of the engineer has been that it will be done as the project progress. Construction site layout planning involves identifying, sizing and on-site-positioning of temporary facilities on site. In large projects there are number of manpower, subcontractors and equipment's are involved and if there is no effective planning that increases cost and time. At the same time safety aspect plays very important role in site layout planning. Developing and maintaining an effective site layout is a significant and critical task that should be properly performed and updated during the project planning and construction phases as it can lead to,

1. Reducing the cost of material handling;
2. Minimizing the travel times of labour, material and equipment on site;
3. Improving construction productivity;
4. Promoting construction safety and quality.

Dynamic site layout planning models provide the capability of considering possible reuse of space, relocation of temporary facilities, and the changing space needs. Existing dynamic site layout planning models subdivide the project duration into successive stages and identify the locations of temporary facilities in each of these stages [1].

Good site layout is important to promote safe an efficient operations, minimum travel time, decrease material handling and avoid obstructing material and equipment movements. The site layout is the way your entire site is structured to work together. There are many ways to link a site together and a good site will have links that get a person from one place to another place in logical manner. Aim of construction site layout planning is to find convenient and feasible locations for different temporary facilities [4].

Health and safety issues were often ignored in most previous studies on site layout planning and organization. This despite need for preventing or minimizing construction accidents through proper site layout planning [3].The layout of temporary facility on construction site necessarily changes over time to time, so the term dynamic layout is used to describe a sequence of layouts [2].

2. OBJECTIVE

1. To optimize effective travel cost through site planning.
2. To identify Problems in planning site layout.
3. To enlist temporary facilities and their locations.
4. To improve construction productivity.
5. To achieve safety in construction.
6. To minimize total site layout cost.

3. RESEARCH METHODOLOGY

A dynamic site layout planning model is formulated to identify the optimal location of all construction facilities within the available space on the construction site. Construction facilities are classified into three main categories: fixed, moveable, and stationary facilities.
1. Fixed facilities: It involves predetermined fixed positions on site such as the constructed building and site access. Planners do not need to select the locations of these facilities as their positions and dimensions are predetermined and it can be extracted from the construction drawings.

2. Stationary facilities: It involves temporary facilities that planners need to determine their positions only once such as tower cranes and batch plants. These facilities are not allowed to be repositioned on site in later project stages due to the significant time, cost, and effort required to relocate them.

3. Moveable facilities*:* It involves temporary construction facilities that can be relocated at the start of any of the identified project stages. Examples of moveable facilities include site offices, testing laboratories, storage areas, fabrication areas, and rest areas. A moveable facility can be relocated in cases where there is newly freed space that is better than its currently occupied spot, or if other new facilities have a greater need for its current location. The ability to modify the locations of moveable facilities in various project stages can improve the efficiency of the overall site layout.

This model focuses on four sections,

1) Decision variables

2) Geometric constraints

3) Objective functions

4) Safety consideration

1) Decision variables: Site layout planning helps in decisions making on the positioning of each temporary facility on site. The main decision variables are locations and orientation of each temporary facilities in construction stage [1].

2) Geometric constraints: The geometric constraints that are typically encountered in construction site layouts such as, boundary, overlap, distance, and zone constraints,

Boundary Constraints means to ensure that all construction facilities are located within the site boundaries. Overlap Constraints means to prevent any physical overlap of any pair of construction facilities in same construction stage. Distance Constraints are focuses on distance between construction facilities which satisfy operational safety and security requirement on site. Zone Constraints means to limit the Presence of construction facility outside or inside a specified zone on site [1].

3) Objective function: The objective function is formulated to minimize the total site layout cost. the objective function focuses on three cost components that are travel cost TC_t, relocation cost RC_t, and constraint-violation cost CVC_t which occur in each construction stage(t).

Minimize total site layout cost = minimize

$$[\sum_{t=1}^{T} TCt + \sum_{t=1}^{T} RCt + \sum_{t=1}^{T} CVCt] \quad \text{.....Eq.(1)}$$

Where *T*=number of construction stages; TC*t*=travel costs between all facilities in stage *t*; RC*t*=relocation cost of moveable facilities in stage *t*; and CVC*t*=constraint-violation cost for all facilities in stage *t* [1].

Travel cost/meter = (labour cost + vehicle cost)/travel distance. ..... Eq(2)

Relocation cost/sqm = (Dismantle cost + Vehicle cost + Erection cost)/area of warehouse. .....Eq(3)

The CVC cost can be find by considering following factors,

1) Boundary constraint
2) Overlap constraint
3) Min/max distance constraint
4) Exclusion/inclusion zone constraint

The summation of above three cost gives the total site layout cost.

4) Safety consideration: Safety consideration is important factor while formulating the model this consideration focuses on prohibited area, minimum distance, and safety zones [2].

4. IMPLEMENTATION AND CASE STUDY

The case study selected for the application of the developed model and located in Pune City, India.

An application example is used to evaluate the performance of the present model and demonstrate its capabilities in optimizing the dynamic planning of construction site layouts. The project involves the construction of multistory buildings, with perimeter fences and two entrances as shown in Fig. 1. The site area is 60,055 Sqm. with an improper arrangement/layout.

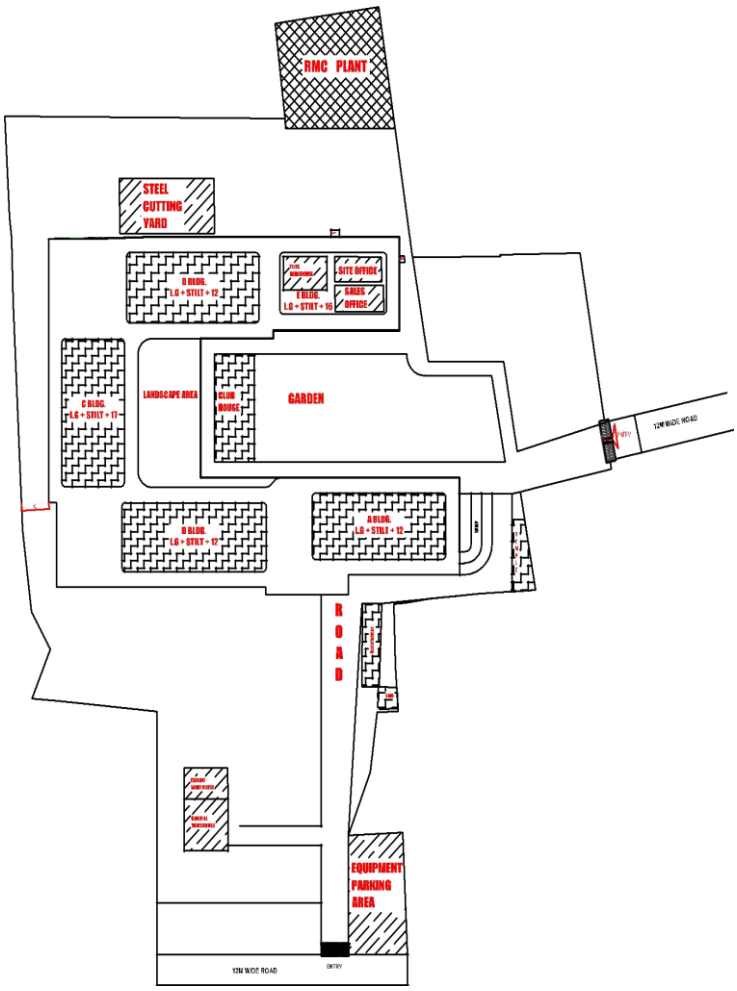

Fig-1.Actual site layout

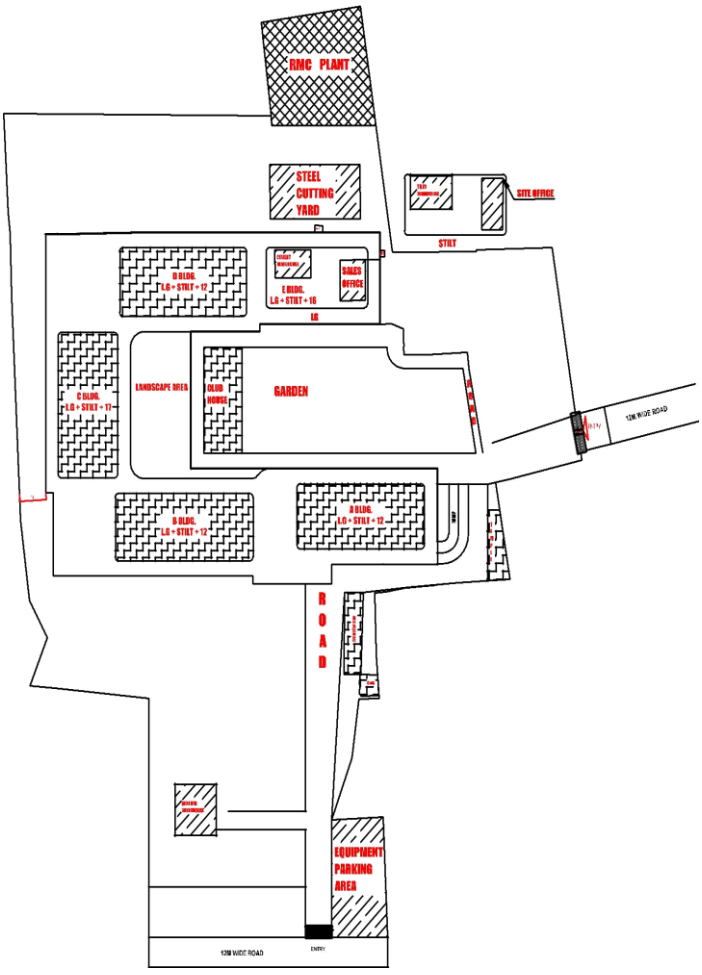

Fig-2. Alternative site layout

From the actual site layout we have find travel cost of materials by considering labour cost, travel distance and travel time. As considering above factor we can get total travel cost then by dividing this total travel cost by travel distance we can get travel cost per meter. After travel cost we find relocation cost of temporary facility by considering dismantle cost, vehicle cost, erection cost then we can get relocation cost per square feet of temporary facility.

From the actual site layout (fig. 1), the possible alternative layout model is prepared based on methodology i.e. show in fig.2,

Then from each site layout calculate the total site layout cost. Following table show different site layouts and their related cost,

Table-1: Site Layout and their Cost

Site Layout	Travel Cost (TC)	Relocation Cost (RC)	Constraint-Violation cost(CVC)	Total cost
1	5,17,750	0.00	00	5,17,750.00
2	2,74,550	52,000.00	00	3,26,550.00
3	14,000	70,200.00	00	84,200.00
4	6,040.02	70,850.00	00	76,620.02

The optimal solution is one with minimum travel cost. In this research the optimal layout reduced travel distance between the temporary facilities which effects on reduction in the cost of construction operations i.e. travel cost of resources on site. It also enables the simultaneous maximization of construction safety on site and minimization of travel cost of resources. It also identifies the location of temporary facilities which removes the problems of double or triple handling of materials on site. Thus, it reduces the overall construction site layout cost.

5. CONCLUSION

This paper helps to minimize total site layout cost in construction process and identifies effective management, travel time, problems in site layout planning, interrelation between the temporary facilities, construction productivity and cost effectiveness. This research is helps to identify a global optimal location and orientation for each temporary construction facility on site. Also it is capable of generating global optimal dynamic site layout plans by estimating and optimizing the future costs of layout decisions. The advantage proposed study is to minimize the cost of material flow and equipment flow within the site and also achieves safety on the site.

REFERENCES

[1] Khaled EI-Rayes and Hisham Said, Dynamic Site Layout Planning using Approximate Dynamic Programming Journalof Construction in civil engineering, ASCE, VOl.23,N0.2,2009.

[2] I. D. Tommelein and P.P.Zouein , " Interactive Dynamic layout Planning ", Journal of Construction Engineering and Management,ASCE,Vol.119,No.2,1993.

[3] Emad Elbeltagi,tarek Hegazy and Adel Eldosouky ," Layout of construction Temporary Facility Considering safety, Journal of Construction Engineering and Management, ASCE,Vol.130 No.4 ,2004.

[4] Saurabh Arun Samdani,Lalit Bhakal and arvind kumar singh,"Site Layout of Temporary construcation facility using Ant Colony Optimization.

[5] Haytham M. Sanad; Mohammad A. Ammar; Moheeb E. Ibr; Moheeb E. Ibrrahim,"Optimal Construction Site Layout Considering Safety and Environmental.Aspect", Journal of Construction Engineering and Management,ASCE,Vol.134,No.7,2008 .

[6] Hesham M. Osman, Maged E. Georgy, Moheeb E. Ibrahim, " A hybrid CAD-based construction site layout planning system using genetic algorithms" Automation in Construction,2003.

[7] Farnaz Sadeghpour; Osama Moselhi; and Sabah T. Alkass, "Computer-Aided Site Layout Planning", Journal of Construction Engineering and Management,ASCE, Vol.132,No.2,2006.

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