A Novel Approach in Determining Points of Interactive Transportations in the Firm

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A Novel Approach in Determining Points of Interactive Transportations in the Firm

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Abstract: Partitioning is the most vital element in designing of a firm layout. Today modern working environments are intended to more use of less space which could increase more interactions between related departments. Although progress communications network has reduced the need for physical transportation but the tangible connections between different parts of a firm seems essential still. The firm is willing to reduce transfers to the minimum possible in order to prevent the vain crowd and time stuck. The purpose of this paper is to use a new approach of decision making in the location and layout of firm’s partitions. With this approach we can reduce travel distance between rooms that saves more time, money and energy so.

Keywords: MADM Method, Assignment Problem, Interaction Points

1. INTRODUCTION

Since the physical layout affects the material handling cost, one of the problems in transportation design is to minimize traverse between departments. As mentioned in [6] about 20 to 50% of manufacturing cost is related to handling so the effect of handling system is not retractable in cost reduction of manufacturing. Absolutely a firm has less handling traffic than a manufacturing system but it could be significant for a firm partly, so the manager wishes to minimize these traffics.

This is one of the Issues of interior architectural design problem; there are a number of specified points as door alternatives for each block location. Any door can be assigned as entrance place for each location, incurring some cost that may depend on the door-office assignment, in such a way that the total cost of the assignment is minimized. Hence the objective function of this kind of problems is to find minimum distance between selected doors and with refer to [1], they proved the NP-completeness of shortest guide path layout, so the mathematical model could not reach the answers of large size for this problem in acceptable time. Some heuristic and metaheuristic researches were developed to face with this field; [7] is accounted as a good reference of different heuristic method for solving quadratic assignment problem (QAP) which is resemble to this problem. [2] presented an improvement heuristic procedure for stochastic quadratic assignment problem.

We would like to solve the door-location assignment problem in multi attribute decision making (MADM) framework. We are going to select best option among others for each location which is depended on the other locations’ points.

2. THE MODEL DEFINITION

Before entering to our model, it is necessary to mention some points. The purpose of this article is locating door in proper location with appropriate alternative door points for each room. There are some assumptions for this model as follow.

A. Assumptions

1. We use a block layout with rectilinear distances between locations in the units of site widths. We declare the area of blocks department so there are some different ways for two points but we plan the minimum path between two points (Fig.1).
2. There is a bridge for transportation from one track to another which is located between two opposite doors’ points.
3. Since we use the coordinates of doors’ points of each location, the sizes of all blocks do not impress our algorithm.
4. The alternatives of doors’ points for each room are specified in fixed points previously. We experienced that is possible to increase the number of these points up to covering each edge. But we explain an example with limited number of points in each block.
B. Mathematical model

An integer nonlinear mathematical model for this assignment problem is developed as follow. The result of this zero-one programming model is limited to the finite number of rooms and alternative points. Although our developed decision method could continue to further sizes of this problem.

\( l,m \): Identifier for offices

\( p,d \): Identifier for door points

\( l_p,m_d \): Identifier for door points \((p,d)\) in the offices \((l,m)\)

\( \text{dis}_{pd} \): Distance between two doors as \(p,d\)

\( y_{lp} \): If point \(p\) is selected for location \(l\) would be 1 otherwise is 0.

\[
\begin{align*}
\text{min} & \quad \frac{1}{2} \sum_{l} \sum_{p} \sum_{w} \sum_{d} y_{lp} y_{wp} \text{dis}_{pd} \\
\text{s.t.} & \quad \sum_{l} y_{lp} = 1 \quad \forall l \\
& \quad y_{lp} \in \{0,1\} \quad \forall l_p
\end{align*}
\]

AS (1) presents the objective function is quadratic but there is no interchange between places like QAP, and we just want to minimize sum up distances. The equation (2) satisfies the condition of choosing one point as a proper door among other doors for each office room. The mathematical structure is less hard than QAP, but our experiments prove that it is time consuming in large sizes.

3. ANP METHOD

Reference [3] explained that analytic network process (ANP) is used to model a problem, one needs a network structure in order to shows the interdependencies among alternatives or criteria, as well as pair wise comparisons to establish independencies and feedbacks within the structure so. Our model contains the interdependencies between points as alternatives in the blocks.

There are some illegal steps for ANP algorithm, [8] explained these steps completely, but we mentioned some key points here; after forming comparison matrices based on interrelated components, a stochastic super matrix would be formed which contains criteria and alternatives then the eigenvector of this super-matrix is calculated. There are some selective methods by using MADM background but not exactly like this quadratic objective function; [4] introduced a decision making method in project selection. [5] developed a multi objective in faculty-course assignment problem; they used weights of objects on analytic hierarchy process (AHP) then solved the synthesized single objective problem.

Since ANP is a prepared method for both tangible and intangible domains, we want to do ANP steps for tangible ones, so we utilize the subsequent processes:

i. Construct the distance matrix of door positions according to the coordinate of them. The row mean is determined as the first weight.

ii. Fix a room as central place which has more interaction to other places, in Fig.1 the fixed room would be \(L1\).

iii. Fix the door with minimum sum of distances to other doors in the fixed room.

iv. Conform comparison matrix based on fixed measure to other doors and make pair comparison between the rows and columns.

\[
c_{ij} = \frac{d_{ij}}{d_{ji}} \quad \forall i, j
\]

We indexed fixed point with “ \(f\) ” so \(d_{ij}\) is the difference between two points \(i,f\) and \(c_{ij}\) is comparing value of two points \(i,j\).

v. Specify the super-matrix and calculate the related eigenvector.

vi. Select minimum priority of door points in each room location at the mentioned eigenvector.

4. REFERENCES

Periodicals:


Books:

