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APPLICATION OF GRAPH THEORY IN MINIMIZATION OF MOVEMENT OF THE STUDENTS AND STAFF IN THE SCHOOL BUILDING

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ABSTRACT

School is the temple of the knowledge, where learners(students) takes the knowledge from the guru(teacher and other staff). In the school their is movement of the students and staff in the school premises. This paper highlights to minimize movements of the staff and students using Dijkstra's algorithm. The problem is stated as minimization of the movement of the students and staff in school premises and using graph theory the problems is solved. Using the concept of graph theory understand the path and then weighted mean of the graph obtained. Now considering H-type school building. Assign the rooms for different purposes such as laboratory, staff room Principal cabin, library etc. If the weighted mean is more than suggest the different path or assigning the room for different purpose to reduce the path length.

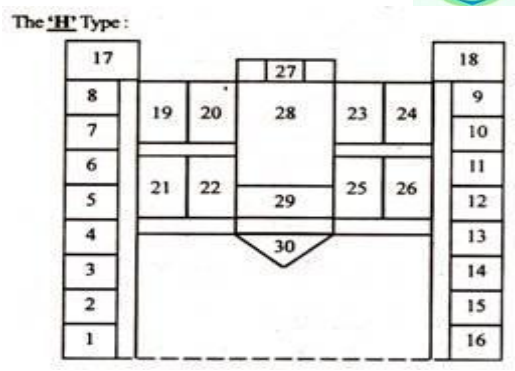
KEY WORDS:- Path, vertex, minimum distance, weighted mean and Dijkstra's algorithm.

I.INTRODUCTION

Graph theory is fetching more and more important in day to day life problems. It helps to solve the problems or conflict not only in mathematics, science and technology but in routine life situation also. It is being actively used in fields as varied as biochemistry, electrical engineering, computer science and operations research. The powerful combinatorial methods found in graph theory have also been used to prove fundamental results in other areas of pure mathematics. Use of edge coloring, vertex coloring, face colouring are best tools in graphs for scheduling. Situation or problems to be represented graphically by drawing a dot or circle knows as vertex.

II.PROBLEM

Consider the pictorial representation of the school (as shown below "H" type of school building) and analysis the situation and get shortest path so that movement will be less in school premises.



Above picture is the representation of the school building and one has to assign the classes, labs, library, staff room, Principal cabin and AV room meeting halls. **The problem** stated is as follows

1. Minimum movement of student in the school premises.
2. Monitoring the students by teacher and providing helps in case of emergency.

III.PROPOSED METHOD TO SOLVE THE PROBLEM

Such problems can be handled with the help of graph theory. By adopting a simple technique of graph theory one can covert the school building into a smart school building. According to Issac S. et al.[12] I interdependency between the element of the school building. Graph theory is useful for Building Information Model (BIM). Modeling the topology of the building project and effective managing and analyzing the challenge can be resolve by Graph theory. Graph based model is the generally approach of representation of complex situation such as room and its physical connection between the building, space and opening for accessibility , links between the nodes and its relationship. Shortest path algorithm, cluster algorithm and Breadth –first search can be used effective in model making.

In a graph **path** is define as a distance between two vertices. The length of the path is called the **weight** of the graph. Weight is distance covered from one vertex to the other vertex in a graph. Considering the weight one should try to minimize the length of the path by proper scheduling of the graphs. There will be many paths in the graph. One has to solve the problem using shortest paths. Minimum weight is the sum over all the paths in a graph between the vertices. Vassilevska V.[7] stated in the thesis "efficient algorithm for path problems in weighted graphs. Problem related to computing optimal path have been abundant in computer science since its emergence as a field. Large number of problems is still unsolved but phenomenon of weight graph helps to solve the shortest path problem. The problem can be easily solved by using Dijkstra's algorithm.

IV.DIJKSTRA'S ALGORITHM

Dijkstra's algorithm solves the single-source shortest-path problem when all edges have non-negative weights. Magzhan K.[9] stated that it is a greedy algorithm and similar to Prim's algorithm. Algorithm starts at the source vertex, s, it grows a tree, T, that ultimately spans all vertices reachable from S. Vertices are added to T in order of distance i.e., first S, then the vertex closest to S, then the next closest, and so on. Following implementation assumes that graph G is represented by adjacency lists.

Dijkstra (G, w, s)

Initialize single-source (G, s)

S ← { } // S will ultimately contains vertices of final shortest-path weights from s

Initialize priority queue Q i.e., Q ← V[G]

while priority queue Q is not empty do

u ← EXTRACT_MIN(Q) // Pull out new vertex

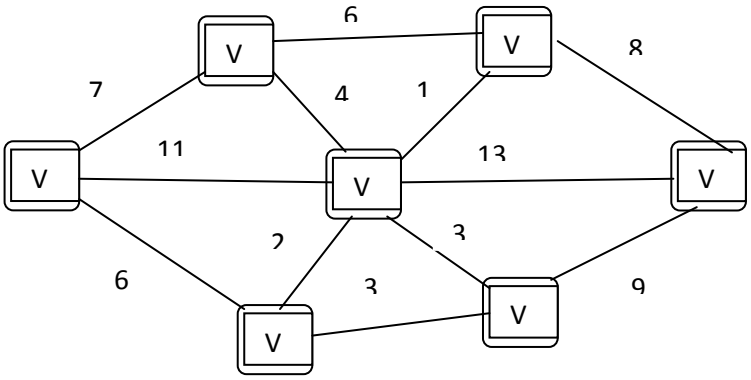
S ← S È {u}

// Perform relaxation for each vertex v adjacent to u

for each vertex v in Adj[u] do

Relax (u, v, w)

To understand above algorithm, we formulate a situation. One has to starts with vertex V1 and reach V7 connecting all vertices. The number mentioned on the path is the distance between the vertices.



Following table shows the distance between the given nodes i.e. vertices. If there is no connection in the node then put " * " in the respective box.

	V1	V2	V3	V4	V5	V6	V7
V1	0	7	*	6	11	*	*
V2	7	0	6	*	4	*	*
V3	*	6	0	*	1	*	8
V4	6	*	*	0	2	3	*
V5	11	4	1	2	0	3	13
V6	*	*	*	3	3	0	9
V7	*	*	8	*	13	9	0

We now compute another table which shows the shortest route table. In which start from V1. There are three paths connecting V2, V4 and V5, among them shortest is V4. Go to V4 and go over the same procedure to reach at V7.

	V1	V2	V3	V4	V5	V6	V7	min	vertex	final
1	0	7	*	6	11	*	*	0	V1	
2		7	*	6	11	*	*	6	V4	V1
3			*		2	3	*	2	V5	V4

4		4	1			3	13	1	V3	V5
5		6		*		*	8	6	V2	V3
6	7		6	*	4	*	*	4	V5	V2
7			1			3	13	1	V6	V5
8							9	9	V7	V6
										V7

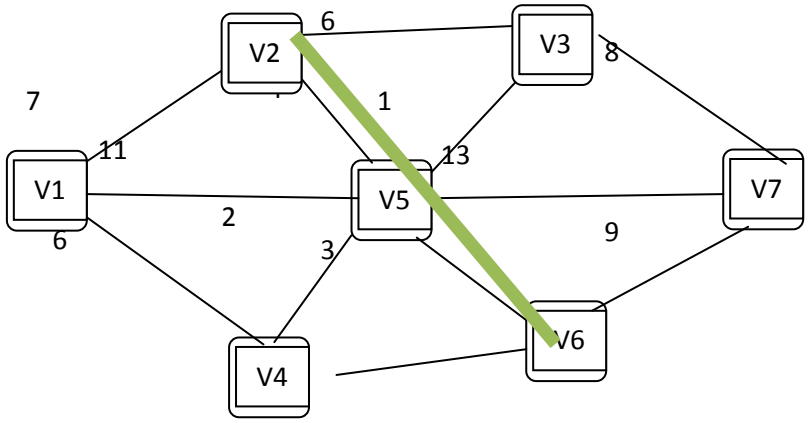
So the required sequence will be V1, V4, **V5**, V3, V2, **V5**, V6, V7.

Weight of the above graph = 6 + 2 + 1 + 6 + 4 + 1 + 9 = 29

But in the above situation V5 has been repeated, so one has to make improvement in the graph. This improvement should avoid the repetition of the vertices and the time must be saved. Again one has to give solution to the problems arises. Look at the figure in the graph V2 to V6 via V5 gives total weight function 4+3=7. The improved suggested to above said situation is that connect V2 and V6, definitely the weight function will be lesser than 7 and required less time to commute. We apply this solution to above case also.

V.IMPROVEMENT IN GRAPH

Improvement in the graph can be joining the V2 with V6



By this improvement in the graph we can avoid revisiting V5 again. Also time can be saved.

Then the weight function will becomes

Weight of the above graph = 6 + 2 + 1 + 6 + 4 + 1 + 9 < 29.

By adopting this method the weight of the graph can be minimize.

VI.SOLUTION TO THE PROBLEM

Dijkstra algorithm helps to get the solution to of the problem of less movement in premises as it is stated in the beginning. Weighted graph concept of Dijkstra algorithm is suitable to solve the problem. In this case room becomes the vertex in the graph. Similarly other placed like washroom, library, and labs become vertices. The path connecting them in the graph gives weight to the graph. The total length of the edges connecting any two vertices gives total weight function. The main aim over here is that the entire student in school must cover the less distance i.e. length of the path will be minimum.

For that we first assigning the rooms in the following ways as it is given in the table and then weight function is generated, keeping in the mind that total movement in the school by students and teacher will be minimum.

Step-1 Allotting the room for different purpose:-

Room Number	Room Allotment
27	Principal
20	Staff room for teacher teaching Classes 1 to 8
1 to 8	Class room 1 to 8 , such as room 8 for class 1 , 7 for class 2 and so on.
19	Library for classes 1 to 8
21	Computer lab for classes 1 to 8
22	Science lab for classes 1 to 8
17	Junior wash room
9 and 10	Class room for 9^{th} and 10^{th}
15 and 16	Class room for 11^{th} and 12^{th}
11 to 14	Labs Phy, Che, Bio, Comp Sc.
23	Staff room for teacher teaching classes 9 to 12
24	Library senior section
25	Meeting room
26	Medical aid room
18	Senior wash room
28	Passage in front of Principal cabin
29	AV room
30	Passage for monitoring play ground

Now we find the path length of the moment of each student, teacher and the Principal of the school and then explore it to the number of students available in the school.

Step-2 assigning the path length:- Let us consider a student of primary class cover average distance 5 units (considering a class length is one unit) to go for wash room. Considering it that they go for washroom twice in a day so overall 10 unit distance. If we consider the school runs for 5 days per week then it will be **50**. Considering students of primary section visiting labs once in a week. So the distance cover will be again to be considered as **5** units. Similarly the student is going to the playground in 20 steps per day. In case they are visiting play ground four times per week then total movement will be **80**.

Step-3 obtaining the weigh of the situation:-

Member	Wash room	Labs	Play ground	Total
Student (P)	50	5	80	135

Step-4 exploring the same for different stages in the school:- Consider the situation for senior section student of classes 9^{th} to 12^{th}. Let us consider the student of senior class the average distance cover the distance of 5 units (considering a class length is one unit) to go for wash room it happens twice in a day so overall 10 unit distance. If we consider the school runs for 5 days per week then it will be **50**. Senior section visiting labs once in a day. So the distance cover will be again to be considered as 5 units per day. Hence total distance will be **25**. The frequency of visiting to playground for this group will be considered as two and they are reaching to the playground in 20 steps. So the total weight will be **40**.

Member	Wash room	Labs	Play ground	Total
Student (S)	50	25	40	115

Overall movement of the students considering 30 students in a class will be the total weight of the graph.

For Primary 135 X 30(students) X 8(classes) = 32400

And for Senior 115 X 30(students) X 4(classes) = 13800

In all student movement in a school per week =46200 units.

Similarly teacher teaching to these classes will taking 5 to 6 periods per day i.e. in a week they are taking nearly 28 to 33 periods. Their movement for the classes room will be nearly 7 steps so total movement will be 210 steps (7 steps X 30 period). In a school if there are 40 teacher then 210 X 40 = 4200 units completing their weekly work.

Principal making a round in a school once a day with 14 to 17 steps. In a week his/her total steps will be 75. In all total weight of the above graph will be the sum total of all which will be =46200+4200+75=50475. Hence for the above situation the graph has the total weight equal to 50475. Apart from this we make any other allotment then weight of the graph increases. This is the minimum length of the all paths in a graph. Hence the problem gets solved.

VII.CONCLUSION

Hence using Dijkstra's algorithm the problem is solved. Here one of the allotment and weight of the graph is obtained. Likewise we can have different allotments and weigh of the graph is calculated. If we get minimum weigh in the second situation then the new changes to be incorporated and better solution can be obtained.

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