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REACTIVE NOISE BARRIER OPTIMIZATION PLAN FOR NOISE POLLUTION REDUCTION IN FIFTEEN DISTRICTS OF TEHRAN

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ABSTRACT

Introduction: In today's society, since noise pollution has been accepted as an environmental problem, so a novel and cost effective management planning is needed. The objectives of this study are to determine the work breakdown structure then to draw a Gantt charts.

Materials and methods: In this paper, the sound levels of $Leq, L\min, L\max$ were studied in fifteen districts of Tehran by a calibrated sound analyzer. Once the dominant frequency was determined, the most appropriate project was scheduled. In this case, the reactive noise barrier optimization regarding to the needy activities and resources has been done by MSP software. Finally, a resource allocation is offered.

Results: The results showed that, if the project is going to start in planning stage, which coincides with the date 01.01.2013 to 12.10.1391 solar calendar, and finish during the approximate duration of 50 days in date of 02.20.2013 or 01.12.1391 solar calendar, so an additional allocation will be added. The start time of some activities delayed to resolve interference. Meanwhile, the best project end date was postponed on 04.30.2013 or0 2.10.1392 calendar.

Conclusions: Based on past experiences, the required time for a project is to determine in approximation time. But since it can be obtained an exact schedule in frame work of project management regarding to sufficient cost and resources, so some management procedure have been offered in which a sufficient planning process is the best to design the reactive noise barriers before planning phase, this can prevent resources losses and leads to project success and its purpose by required timing.

INTRODUCTION

In earlier, the noise pollution was a lesser priority than the other types of pollution. But in this century, the noise pollution due to traffic, including road and rail has affected to reduce the public health and this has changed the common perspectives. As the World Health Organization is introduced noise pollution as the third most hazardous metropolises pollution which can bring adverse effects [1]. Now, many managers and acoustic professionals have endeavored to control the effect of noise pollution on the environment, in other word some of national and international organizations have established and helped to resolve this great problem by issuing regulations and rules. The Committees of World Health

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Organization are required to determine the effects of noise on communities. In addition, Business Council for Sustainable Development stressed on this point in Riodojaniro conference in 1992 that production and service companies must consider their activities and its effects on environment and control their actions. In the same year, it was requested the International Standardization Organization (ISO) to do a more extensive activity in order to codify the environmental management standards [2]. So, the noise pollution control by different methods is considered as an important management problem in the form of project planning, so many civil planners and managers have focused on it. On the other hand, the noise barriers are considered as the most effective methods of noise pollution control due to terrific because it reduces the incoming noise in shadow zone [2-3]. Noise barriers caused a significant insertion loss to provide an acceptable protection for listeners [4-5]. However, if this is a diffusers barrier, the insertion loss is significantly higher than its equivalent plain barriers [6-7]. But it is evident that the success of barrier design is purely dependent on a sufficient pre determined planning to schedule the current activities with resource allocation and the work breakage structure. Most new management techniques and methods have developed by US air –space organization in 1950-1960 that some methods such as work breakage are among them. The work breakage structure is shown tree graphs of products that must be provided [8]. Besides, many studies have done about the projects fuzzy schedule. Ishii (1998) performed the timing schedule based on the minimum time to end of activities Also, Dubois (2003) has presented some procedures to planning based on fuzzy sets [9]. On the other hand, Wang (2002) has been conducted a fuzzy project scheduling to minimize the risk for product development program in 2002 [10].Therefore the objective of this study is Reactive noise barrier optimization plan for noise pollution reduction in fifteen districts of Tehran.

MATERIALS AND METHODS

This research discussed the management and scheduling of Reactive noise barrier optimization in a hierarchy series that can be broken down into a series of activities but before discussing the optimization of planning process, determination of work breakage structure is required to analyze the noise pollution problem tree in order to reach a clear understanding about noise problem. And Then the Amount of noise pollution is measured in fifteen districts of Tehran to determine the dominant traffic noise frequency that has been performed in fifteen regions of Tehran city. Above is presented in detail.

Noise pollution problem tree analysis

Problem tree analyses are first step before project planning that many different organizations have developed this method well. The analysis of problem cause and effect helps to understand the importance of this problem. Since environmental noise pollution is discussed as a problem, in order to overcome this problem, the analysis is done as Fig.1.

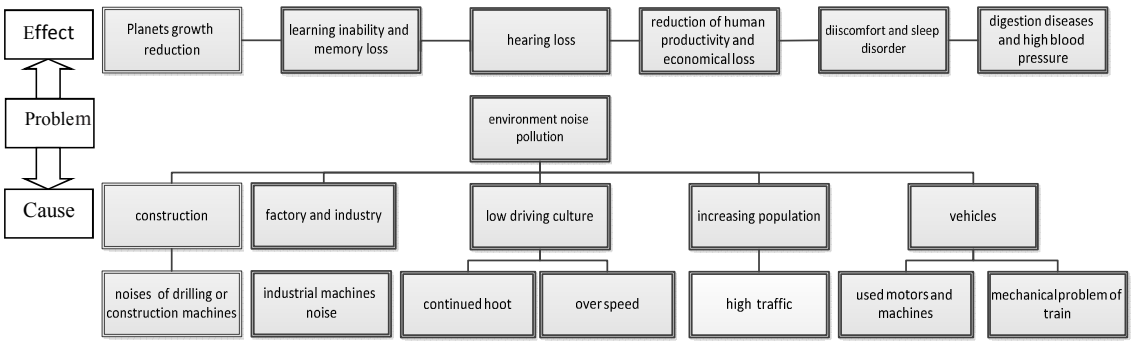

Fig.1.: Noise pollution problem tree analysis

The breakdown structure of reactive noise barrier project

Work breakdown structure is an outcome-based structure of project elements, which is organized and defined the project range. The breakdown structure of Reactive noise barrier optimization project often is used like an area statement to develop the common knowledge about project area. The lower level of the work breakdown structure represents an increasingly detailed description of the outcome. Table 1 represents sub activities are required to perform in considered project. These sub activities are based on Work Breakdown Structure (WBS) in framework of project work breakdown structure as Fig.2. It is worth mentioning that in this project, all time values are considered as approximation and just as the required time to provide the substructures of each activity.

Table1. Breakdown Structure code and description of reactive noise barrier design and optimization project

Description	Code
Reactive noise barrier optimization	ORNB
To determine dominant frequency of noise traffic	ORNB1
To determine the average sound pressure level in 9 districts of Tehran by octave band frequency analysis (Linear Network)	ORNB1.1
To determine barrier performance by numerical modeling	ORNB2
To model barrier designs in Excel software	ORNB2.1
To determine the barrier insertion loss at frequencies from 50 to 4000 Hz	ORNB2.2
To determine the average of A weighed insertion loss of the designed barriers	ORNB2.3
To determine surface impedance	ORNB3
To determine impedance of Schroeder diffusers	ORNB3.1
To determine surface acoustic resistance	ORNB3.1.1
To determine impedance of perforated sheet with welled surfaces	ORNB3.2
To determine the acoustic resistance of perforated sheet	ORNB3.2.1
Barrier optimization	ORNB4
To determine diffuser barrier geometry	ORNB4.1
Preparation of barrier with considered geometric properties	ORNB4.1.1
To predict the barrier performance	ORNB4.2
Replacement of the order of (64) according to the program loop	ORNB4.2.1
To define a cost function	ORNB5
To determine the imaginary part of negative admittance	ORNB5.1
To compare of mean imaginary part of admittance in 3 modes 64,729, 4096 in dominance frequency	ORNB5.2
To determine perforated sheet placement inside the wells	ORNB5.3

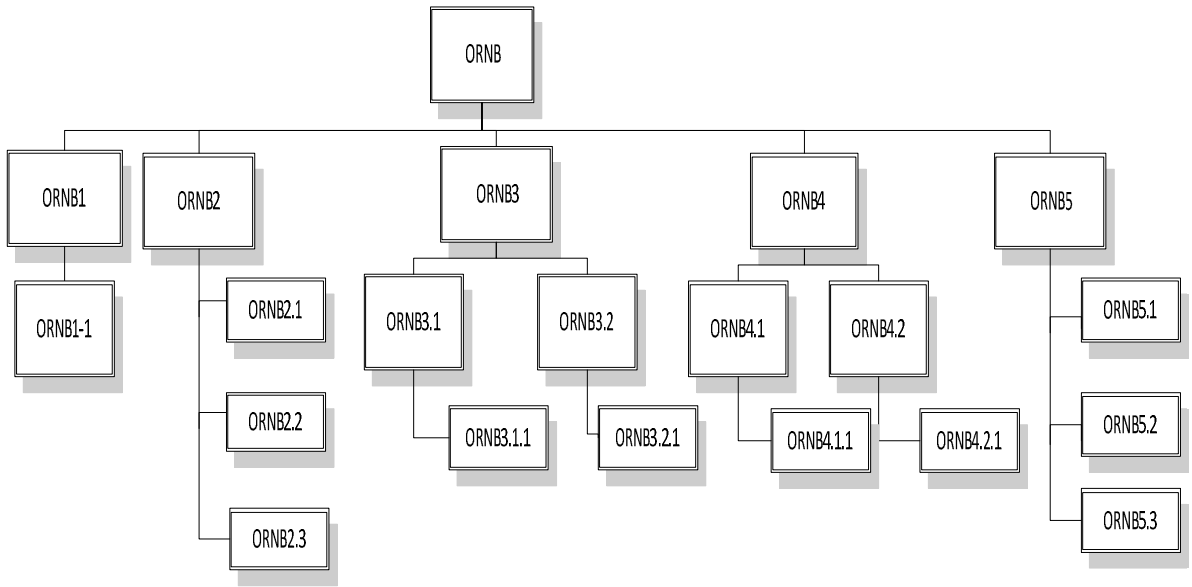

Fig.2. Work Breakdown Structure (WBS) of the project design and optimization of reactive noise barrier

Noise pollution measurement

Noise pollution frequency analysis for 15 districts of Tehran was done prior reactive noise barriers optimization planning. This was done to determine the dominant frequency of traffic noise. Then Lmax, Lmin and Leq are measured by the sound meter at different octave band frequencies from 125 to 8000 Hz. List of selected stations with measured sound levels are presented in Table 2 and noise frequency analyses in Octave band in Table 3 also, Octave band frequency analysis of traffic noise in the selected stations (dBL) can be seen in Table 4 as follows:

Table 2. Noise pollution levels in the 15 districts of Tehran in dBA

Number	Local station	Measuring time (hours)	L_{min}	L_{max}	L_{eq}	SPL
1	Revolution Square	16:45	68.4	83.3	75	75
2	Fatemi street	17:15	63.5	77.8	70.1	72
3	Motahari street	17:45	62.5	76.5	71	70
4	Seyed Khandan	18:25	61	80.1	69	72
5	Resalat square	18:45	67.2	79.4	70.5	71.4
6	The second square of tehranpars	19:20	60	84	71	70
7	Piroozi street	7	63	85	74.7	75.2
8	Siroos crossroads	7:35	66.5	94.5	75.3	73.5
9	Shush square	7:40	64	82	74.5	75
10	Afsarieh	8	63	85.2	72.9	74
11	Hemmat highway	9:20	74.5	88.4	84.5	84.3
12	Sanat square	9:35	67	82	71	70
13	Second square of Sadeghieh	10	62.1	88.2	73.9	50.7
14	Azadi square	10:15	69	89	78	75.1
15	Tajrish square	11	69.2	85	74.2	72

Table 3. Octave band frequency analysis of traffic noise in the selected stations (dBL)

Number	Sound pressure level (dBL)						
	Frequency (Hz)						
	125	250	500	1000	2000	4000	8000
1	75.8	68.7	67.9	64.1	60.5	59.8	49.8
2	76.6	65.3	62.2	60.7	57.1	54.2	43.7
3	75.4	65.5	61.8	60.6	58.3	59.2	49.5
4	77.1	66.8	59.9	60	58	55.4	56.9
5	76.5	677	62.8	61.1	58	59.4	49.7
6	74.4	68.4	65.6	63.9	60.3	58	49.4
7	747	68.7	64.9	61.7	60.3	58.8	48.1
8	77.7	71.6	66.4	65.6	62.6	59.8	52.8
9	75.2	68.6	65.1	64	60.8	56.2	45.1
10	73.3	71.4	68.8	67	68.9	61.2	55.6
11	73.9	72.5	72	74.3	68.8	56.6	51.5
12	72.1	66.7	64.4	61.3	67.4	54	45.5
13	74.7	68.8	66.1	63.7	59.9	58.8	48.9
14	74.3	69.8	68.4	65.7	63.2	60.9	52.7
15	67	66.9	66.7	66.7	62	63.1	53.4

Table 4. Sound pressure level at octave band frequencies from 125 to 8000 Hz (dBL)

Number of points	Frequency (Hz)	Min	Max	The average sound pressure level	SD	95% CI μ ± 2σ	
						Lower limit	Upper limit
15	125	70.7	79.7	75.2	3.5	68.3	82.1
15	250	70.7	79.7	69.1	2.5	64.2	73.9
15	500	70.7	79.7	66.6	5.5	55.8	77.5
15	1000	70.7	79.7	66.2	10	48.1	84.2
15	2000	70.7	79.7	63.6	9.3	45.2	82.1
15	4000	70.7	79.7	60	3.8	51.7	66.5
15	8000	70.7	79.7	51.7	8.2	35.3	68.1

Planning process of reactive noise barrier optimization

This phase of project initiated after measurement of noise pollution in 15 districts of Tehran, which included the work scheduling due to work breakdown, sources allocation regarding to project activities with observation of priority and resource leveling. Project schedule contains the minimum planned start time and expected finish time, which can be as primary until the resource allocation, is verified. The resource allocation is basic part of project planning which must be considered. In this project, the required resources are acoustic design, computer, sound level meter etc. The scheduling plan is prepared in MSP software in regard to the current resources and normal times of activities. The program itself does work schedule and its calculation automatically. According to plan, the project started on 01.01.2013 and finished on 02.20.2013. Due to some effective factors on failure of project completion, the exact time of the plan is not perfectly clear at the beginning of project, therefore the above mentioned time is an approximated time. In this case, after each activity in the process of scheduling, a certain Gantt chart with consideration of resources is needed to be allocated. On the other hand, some resource allocations may be at over allocations state, which they will be leveled off by delay technique in some interference activities

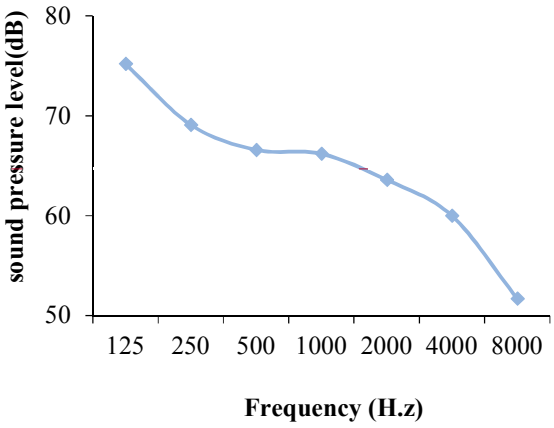

Fig.3. Average sound pressure level of Tehran traffic noise at octave band frequency analysis (dBL)

RESULTS AND DISCUSSION

Based on measurements findings, the logarithmic average sound pressure level (Table 4) was calculated at different octave band frequencies from 125 to 8000. According to Fig.3, the highest sound pressure of traffic noise is at frequency 125 Hz. So, the frequency 125 is used as index in order to optimize the reactive T shape barrier.

Schedule with resource allocation

In this project, in order to optimization planning, the resources allocation was done after completing the activities and their relationship .Gant chart indicates sometimes a project required some concurrent activities in order to complete in due time. While the used resources such as computer, acoustic design is considered as for one person

and one set during more than 8 work hours. This makes over allocation and it indicates at least one of resources that is dedicated to over allocation. It caused labor and equipments loss and its effect is shown in longer times. So, the resource leveling is done to recover this problem in next step.

Schedule with resource leveling

After following resource allocation, the leveling is important subject in planning project. There are different ways to do this matter such as the changes of scheduling, amount of current resources and delay of activities. The mentioned procedures lead to better schedule to reach the certain purpose and in this research, delay is used to begin interference activities. As it is shown in previous table, the resources interference is occurred because of concurrent and parallel using of some activities in one resource and result to make a red dummy against the activities. In this case as Fig.4 it can resolve the interference when the beginnings of some activities are postponed. So, by considering 4 months than 2 months planning for all activities, it can be hoped that all required substructures supplied in approximation date 02.20.2013 and that same time , it can designed noise barrier effectively.

WBS	task name	Duration	Start	Finish
ORNB	**Reactive noise barrier optimization**	**94.5 dys**	**Tue 1/1/13**	**Tue 4/30/13**
ORNB1	**To determine dominant frequency of noise traffic**	**14 dys**	**Tue 1/1/13**	**Sat 1/19/13**
ORNB1.1	To determine the average sound pressure level in 9 districts of Tehran by octave band frequency analysis (Linear Network)	14 dys	Tue 1/1/13	Sat 1/19/13
ORNB2	**To determine barrier performance by numerical modeling**	**60 dys**	**Tue 1/1/13**	**Mon 3/18/13**
ORNB2.1	To model barrier designs in Excel software	50 dys	Tue 1/1/13	Tue 3/5/13
ORNB2.2	To determine the barrier insertion loss at frequencies from 50 to 4000 H	5 dys	Tue 3/5/13	Mon 3/11/13
ORNB2.3	To determine the average of A weighed insertion loss of the designed barri	5 dys	Tue 3/12/13	Mon 3/18/13
ORNB3	**To determine surface impedance**	**18 dys**	**Wed 3/20/13**	**Sat 4/13/13**
ORNB3.1	To determine impedance of Schroeder diffusers	10 dys	Wed 3/20/13	Tue 4/2/13
ORNB3.1.1	To determine surface acoustic resistance	10 dys	Wed 3/20/13	Tue 4/2/13
ORNB3.2	To determine impedance of perforated sheet with welled surfaces	10 dys	Sun 3/31/13	Sat 4/13/13
ORNB3.2.1	To determine the acoustic resistance of perforated sheet	10 dys	Sun 3/31/13	Sat 4/13/13
ORNB4	**Barrier optimization**	**43 dys**	**Sat 1/19/13**	**Wed 3/13/13**
ORNB4.1	To determine diffuser barrier geometry	2 dys	Tue 3/12/13	Wed 3/13/13
ORNB4.1.1	Preparation of barrier with considered geometric properties	2 dys	Tue 3/12/13	Wed 3/13/13
ORNB4.2	To predict the barrier performance	20 dys	Sat 1/19/13	Tue 2/12/13
ORNB4.2.1	replacement of the order of (64) according to program loop	20 dys	Sat 1/19/13	Tue 2/12/13
ORNB5	**To define a cost function**	**6 dys**	**Thu 3/14/13**	**Thu 3/21/13**
ORNB5.1	To determine the imaginary part of negative admittance	1 dy	Thu 3/14/13	Sat 3/16/13
ORNB5.2	To compare of mean imaginary part of admittance in 3 modes 64,729 ,4096 in dominance frequency	2 dys	Sat 3/16/13	Mon 3/18/13
ORNB5.3	To determine perforated sheet placement inside the wells	3 dys	Mon 3/18/13	Thu 3/21/13
ORNB0	Finish	0 dys	Tue 4/30/13	Tue 4/30/13

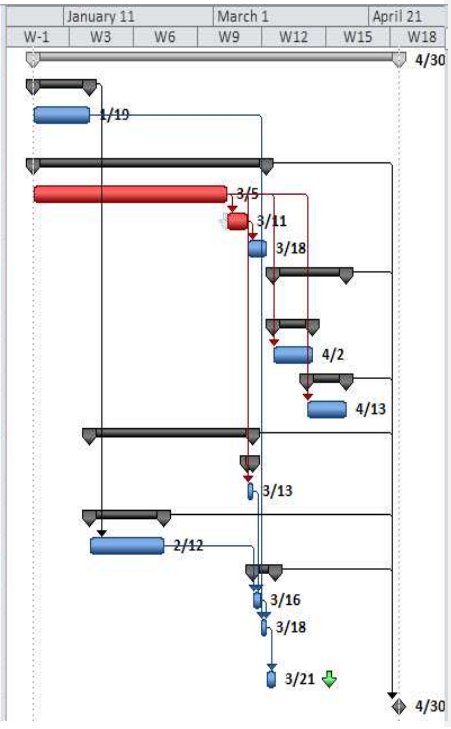

Fig.4. Schedule with the correct resources

CONCLUSIONS

Reactive noise barrier optimization planning process was investigated by considering work breakdown structure and required time for every activity. According to past researches, the use of work breakdown structure can explain activities better to stockholders. Also, it is designed to help break down a project into manageable chunks that can be effectively estimated and supervised .This studies has shown the work breakdown structure lead to insure the correct and on line data flow in work place of project and its codes are used as tool to measure activity schedule. Rational scheduling, resource allocation and leveling projects are properly followed the organizational goals[11-12] .If more resources are added, the efficiency of the project will reduce and lead to a lower recovery of additional resources. This project indicates the above activities have used human resources (acoustic designer) materials (computer, etc) and resource allocation optimization to reach pre determined purposes. Since the project was faced with so many challenges in terms of resource allocation, so it was felt to need the leveling. However, there was not any limitation in the project; so, the completing time of project was changeable. This indicates there were no critical activities in project. Thus, delay technique than addition of resources was used in the beginning of some interference activities in order to reduce cost and increase productivity. The results lead to lengthen project time 2 months more than pre determined schedule. The current study indicates in resource leveling, the use of delay method in the start of a series of concurrent and parallel activities that can lead to cost reduction. Therefore, this study indicates the managers and designers can meet the project purposes by a correct design and also development of work breakdown structure of noise barrier optimization, which lead to the cost reduction and noise pollution.

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COMPETING INTERESTS

The authors declare that they have no conflicts of interest.

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ETHICAL CONSIDERATIONS

The authors state that they have no ethical considerations.

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