Isma Younes[*]
Anum Iqbal[**]
Abdul Ghaffar[***]
Anum Liaqut[****]
Ammara Shahid[*****]

Impact Assessment of Orange Line Train during Construction Phase in Lahore Using 'R'

Abstract

The Orange Line Metro Train of Lahore is the prime project of the Metro network in the City. After completion it will hook up different junctions of the city such as Raiwind Road, Multan Road and Mc Leod Road with the Grand Trunk Road. It is the fundamental mass rapid transit train system of Pakistan. The track of Orange Line Metro Train is 27.1 kilometre. The project will be completed in twenty-seven months.

This research is an endeavour towards identification of the sites where noise levels are more than permissible limits set by WHO using tools and techniques of GIS. The study also focussed on the important factors that affected the people of nearby areas.

Key Words: Impact, Assessment, Orange Line Train, Construction.

Introduction:

The transport has always played a key role in defining the infrastructure of any country. It has a great influence on country's economy as it is cost effective as well as saves time, its development and commutation of people. The transport system of any country remarkably contributes in its growth rate. Urban areas are carved and recurved by the transport systems. An area also influences the transport system for both working and non-working travel class.

The connection to every part of a city is furnished by its transport system. It has a relationship with approach to the markets, which has great impact on land values. During 19th century, there was a significant impact of industrialization on urban area. Many structural changes were made along with changes in monitory policy in the field of transportation. It has made a strong connection between urban area and its periphery that will lead to the development of Lahore as well as its periphery.

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[*]*Dr. Isma Younes,* Department of Geography, University of the Punjab, Lahore.
[**]*Anum Iqbal,* Department of Statistical and Actuarial Sciences, University of the Punjab, Lahore.
[***]*Prof. Dr. Abdul Ghaffar,* Department of Geography, University of the Punjab, Lahore.
[****] *Anum Liaqut,* Department of Geography, University of the Punjab, Lahore.
[*****]*Ammara Shahid,* Department of Geography, University of the Punjab, Lahore.

Most of the urban areas of the world are suffering from many issues regarding transportation systems. Rapid transit is touching crest of transportation to fight with the massive number of automobiles. The city planners have recognized the significance of rapid transit system. Hayes (1977) asserted that poor planning and scarce finances have been the major causes of improper development.

A noteworthy growth of automobiles has been noticed in major cities of Pakistan since past two decades. Pakistan makes a total load of domestic transport of around 239 billion commuters kilometres and 153 billion tonne kilometres annually. The growth in demand for transportation services is considerably higher than the growth in GDP. Both public and private transport services consisting of public buses, rickshaws and taxis in Lahore city also cause much noise pollution.

The effects of noise on humans depend on age of the listener, distance between sound and listener, magnitude of noise, duration of exposure and its frequency. The audible range for human ear is 20-20,000 Hz (Wang, 2005). High risk zones are found at many places where population is congested as by Harabidid (2008). Harris (1979) asserted that loud noise results in high blood pressure and disturb the ability to learn even in children. Lords (1963) asserted that introvert people are more affected by noise. Hay (1982) observed the noise induced hearing loss among population. Neitzel (1999) asserted that construction workers in many key trades are frequently exposed to noise pollution and suffer from hearing loss. Davies (2009) also pointed out that long exposures to high levels of noise are associated with high risk of cardiovascular diseases. This research focused on the patterns of

noise pollution during construction of Orange Train along its track in the city and the effects of noise pollution on health of workers during construction and on people living in study area. The Orange Line train is a mega development project of Government of the Punjab, to provide the world class travel experience to the citizens of Lahore. The project is being financed by Chinese Government and the Punjab Government.

This huge project has pros and cons in all of its developmental phases. The main thrust of this research was on the noise pollution produced its construction of new infrastructure and allied factors.

Materials and Methods:

Primary data of noise pollution was collected from 50 sample sites in the field. Sound Level meter was used to measure noise pollution. Measurements were taken at a distance of 1.5-5 meter. The microphone was kept 1.2 meter above the ground surface. The noise levels were measured in the morning from 6 A.M. to 8 A.M, from 12 P.M. to 2 P.M at noon and from 8P.M. to 10 P.M. at night. The averages of noise levels were taken for temporal analysis. Questionnaire method was used to study the effects of noise pollution on human health. Questions related to sources and effects of noise and controlling measures were asked from affected population at places where noise levels were noted more than permissible limits set by WHO. Random sampling technique was applied to collect the data.

The collected data were computed, analysed and displayed. For analysis of data statistical techniques in R were applied and maps were produced using Geographic information techniques.

Results and Discussion:

The noise levels have been given below in Table 1. It can clearly be seen from the Table1 that noise levels were exceeding the permissible noise limits of WHO. Noise levels were measured from both the sides of track of Orange Line Train. The right side of the track has been termed as lower side and represented by L and left side has been termed as Upper side and represented by U. Baghbanpura, Yateem Khana, Shalamar, Mint Gate. Laxmi, Scheme Mor, Daroghawala and Chouburgi Chowk were showing the highest limits. It is pertinent to note that these limits were high enough to cause NIHL (Noise Induced Hearing Loss) among nearby residing population.

Table 1: Noise levels at selected locations:

Locations	F20Feet (dB)	F50Feet (dB)	Locations	F20Feet (dB)	F50Feet (dB)
Baghbanpura 20m_lower	90	90	Scheme Mor L	89	84
Baghbanpura 20 m_upper	93	89	Scheme Mor U	87	86
Sukhner lower	87	82	Yateem Khana Chowk L	93	90
Sukhner upper	84	86	Yateem Khana Chowk U	90	88
Bhatta stop L	88	85	Chappar Stop L	81	79
Batta stop u	89	84	Chappar Stop U	80	76
Chungi l	86	83	Samanabad Chowk L	80	79
Chungi u	85	82	Samanabad Chowk U	81	76
Wara Gujra l	84	81	Choburgi Chowk L	92	90
Wara Gujra u	83	82	Choburgi Chowk U	90	88
Shalamar L	88	82	Choburgi Market L	85	83
Shalamar U	89	86	Choburgi Market U	84	82
Daroghawala L	94	85	Federal Courts L	80	79
Daroghawala U	98	80	Federal Courts U	81	76
Salamatpura Stop L	85	84	Laxmi Chowk L	91	88
Salamatpura Stop U	88	79	Laxmi Chowk U	92	86
Mintgate L	89	80	Lahore Hotel L	80	79

Mintgate U	87	82	Lahore Hotel U	82	76
Ali Town L	83	79	Bohr Wala Chowk L	84	81
Ali Town U	82	78	Bohr Wala Chowk U	83	83
Thokar Niaz Baig L	88	88	Gari Shahu Bridge L	90	88
Thokar niaz Baig U	89	84	Gari Shahu Bridge U	89	89
Hanjarwal L	82	79	UET Gate 3 L	82	78
Hanjarwal U	83	76	UET Gate 3 U	84	74
Waris Colony L	82	80	Singhpura L	88	81
Waris Colony U	81	75	Singhpura U	87	84
Mehran Block Iqbal Town L	80	76	Grass Mandi L	88	85
Mehran Block Iqbal Town U	81	73	Grass Mandi U	90	84
Pak Mint L	84	81	Shalamar L	90	88
Pak Mint U	85	80	Shalamar U	91	89
Salamatpura L	81	79	Salamatpura U	83	76

Source: Younes (2016)

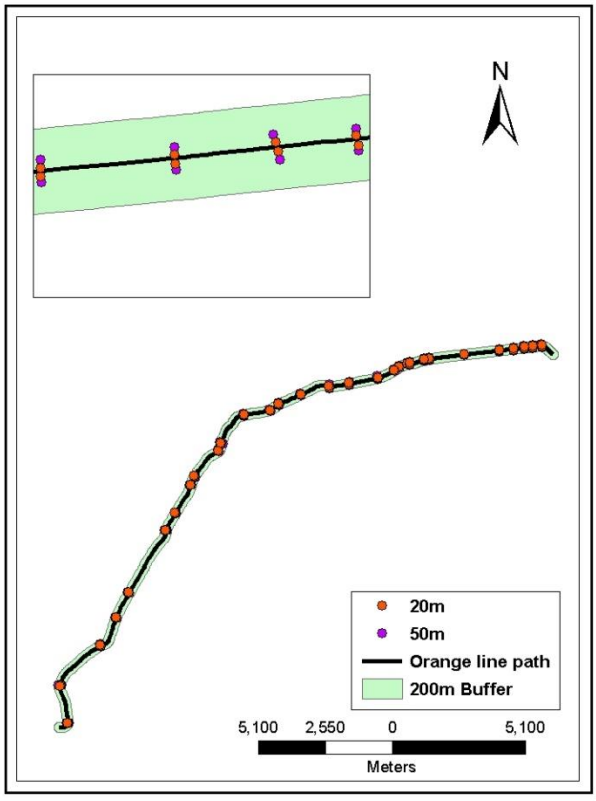

Figure 1: Track of Orange Line Train

Figure 1 shows the track of Orange Line Train. Red dots show the locations that were 20 meters away from the road and purple dots indicate the locations that were 50 meters away from the center of the road. A buffer was made to

extract the area around the road where people were doing economic activities as well residing behind the commercial areas.

Factor analysis was done to extract the most important factors that were having serious impacts on environment, health and property of nearby residing people. The data collected through questionnaire was analyzed and the questions have been shown in Table No. 6. The following tests were performed to compute the factors that have been affected due to construction of Orange train.

1. Data Reliability:

The reliability of data was checked through Cronbach's alpha. It is claimed that coefficient of reliability of 0.7 or higher is acceptable. As our computed reliability alpha value 0.74 is greater than reliability coefficient 0.7 so we can conclude that questions in a survey produce consistent results or data of our study is reliable.

Table2: Reliability Analysis

Raw-alpha	Std.alpha
0.74	0.75

2. Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO):

We first applied KMO in order to check the sampling adequacy of the factors which based on correlation. Factor analysis is appropriate to proceed if the value of overall KMO is 0.60 or more. Table shows that value of KMO is greater than 0.60, so factor analysis is appropriate to proceed.

Table3: Kaiser-Meyer-Olkin factor Adequacy
Overall MSA = 0.66

3. Initial and Extracted communalities:

This table represents the communalities for the variables which explained the proportion of the variance in the variables that has been explained by the extracted factors. The first column shows the initial values of the correlation matrix which is 1 for each variable while the second column exhibits the proportion of the variance in the each variable.

Table 4: Initial and Extracted communalities

	SS loadings	**Proportion Var**	**Cummulative var**
Comp.1	1.000	0.059	0.059
Comp.2	1.000	0.059	0.118
Comp.3	1.000	0.059	0.177
Comp.4	1.000	0.059	0.236
Comp.5	1.000	0.059	0.295
Comp.6	1.000	0.059	0.354
Comp.7	1.000	0.059	0.413
Comp.8	1.000	0.059	0.472
Comp.9	1.000	0.059	0.531
Comp.10	1.000	0.059	0.59
Comp.11	1.000	0.059	0.649
Comp.12	1.000	0.059	0.708
Comp.13	1.000	0.059	0.767
Comp.14	1.000	0.059	0.826
Comp.15	1.000	0.059	0.885
Comp.16	1.000	0.059	0.944

Comp.17	1.000	0.059	1.000

4. Determination of factors:

There are several ways for the determination of factors that are:

4.1. Determination of factors on the basis of Latent Root Criterion:

Latent root criterion is the most commonly used criterion for the determination of factors or components and also called eigenvalue criterion. A Kaiser-Guttman rule is to **select those components whose Eigenvalues are greater than 1.** Eigen values less than 1 are considered to be insignificant.

4.2. Determining the number of factors on the basis of Total variation Explained Criterion

Another criterion that is used for the determination of factors is Total variance explained. It explained the maximum variation by each component. The factors having eigen values represent the amount of variance explained. We have 17 factors or components. Here, standard deviation shows the eigen values. Therefore, we have seen that first fsix factors explained maximum variation. First component explained the highest variance i.e. 23% and the last component explained the least. The total variations explained is 69.15%.

Table 5: Importance of Components

	Standard deviation	Proportion of Variance	Cumulative Proportion		Standard deviation	Proportion of Variance	Cumulative Proportion
Comp.1	1.9722386	0.2288074	0.2288074	Comp.10	0.86764785	0.04428311	0.88834720
Comp.2	1.6542794	0.1609788	0.3897862	Comp.11	0.80012551	0.03765887	0.92600608
Comp.3	1.3414319	0.1058494	0.4956356	Comp.12	0.80012551	0.03428025	0.96028632
Comp.4	1.10704710	0.07209137	0.56772697	Comp.13	0.71906734	0.03041517	0.99070149
Comp.5	1.03607205	0.06314384	0.63087081	Comp.14	0.338245740	0.006730011	0.997431499
Comp.6	1.01553910	0.06066586	0.69153667	Comp.15	0.150723797	0.001336333	0.998767832
Comp.7	0.96100047	0.05432482	0.74586149	Comp.16	0.1200625671	0.0008479424	0.9996157746
Comp.8	0.92406649	0.05022935	0.79609083	Comp.17	0.0808197456	0.0003842254	1.0000000000
Comp.9	0.90307557	0.04797326	0.84406410				

5. Bar Plot of eigen values:

Bar plot maps the components against the eigen values. We usually chose those components whose eigen values are greater than 1. Figure represents that 6 components have eigen values greater than 1.

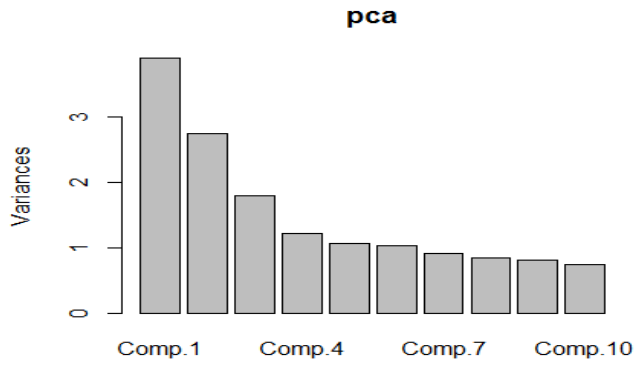

Figure: 2: Bar Plot:

6. Scree Plot

The scree plot maps the factors against their eigenvalues and a cut-off point is determined where there is an unexpected change in the slant of the line. The point at which the curve first becomes a straight line is considered the maximum number of factors to extract. Therefore, scree plot considered six factors.

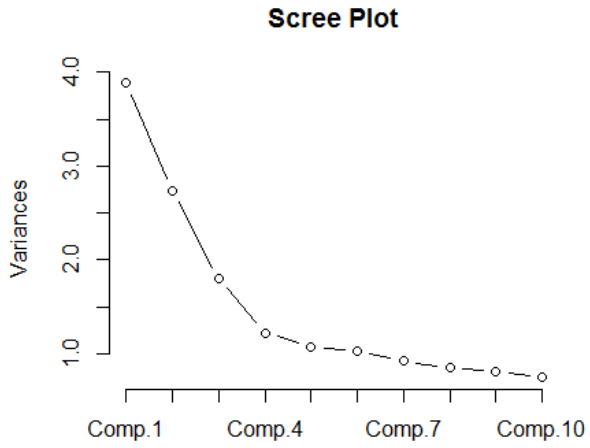

Figure 3: Scree Plot

7. Results of correlation matrix:

The correlation matrix shows the correlations of each factor with itself and with other factors.
The correlation with itself is always 1. The correlation coefficients above and below the diagonals are always same.
The following table shows the correlation matrix of the variables.

Table 6: Correlation Matrix

	awareness	passenger	government	LandValue	passengrBurden	PakEconomy	EducationalStops
awareness	1.000000e+00	0.09943051	0.24635201	-0.013344717	0.022213083	1.065884e-20	-0.02606430
passenger	9.943051e-02	1.00000000	0.14216651	0.092412730	0.070677059	2.042413e-01	0.19025296
government	2.463520e-01	0.14216651	1.00000000	0.031819732	0.239967749	2.167150e-01	0.10273589
LandValue	-1.334472e-02	0.09241273	0.03181973	1.000000000	-0.020025311	1.306095e-02	0.16324386
passengrBurden	2.221308e-02	0.07067706	0.23996775	-0.020025311	1.000000000	2.422538e-01	0.03705398
PakEconomy	1.065884e-20	0.20424125	0.21671503	0.013060946	0.242253841	1.000000e+00	0.14759388
EducationalStops	-2.606430e-02	0.19025296	0.10273589	0.163243862	0.037053984	1.475939e-01	1.00000000
DailyRoutine	-4.869871e-02	0.25622188	0.09637117	0.153786648	0.093591282	1.781694e-01	0.07672201
AirQuality	5.280250e-02	0.21494852	0.23318048	-0.008768784	0.250220017	1.467334e-01	-0.02202017
HearingProblems	1.658410e-01	0.15859164	0.13731904	0.026557207	0.136302040	3.423820e-02	0.10374069
MarketsEffect	2.221308e-02	0.07067706	0.24969617	0.011593601	0.984210526	2.282777e-01	0.03705398
BusinessEffect	9.923552e-02	0.09286624	0.13328071	0.080044762	0.051728205	1.956381e-01	0.19864356
TrafficFlow	1.463592e-01	0.14051631	0.14363002	0.143518305	0.142566275	1.875853e-01	0.08590253
Asthma	2.221308e-02	0.07067706	0.23996775	-0.020025311	0.984210526	2.282777e-01	0.05558098
SkinAllergy	1.658410e-01	0.15859164	0.13731904	0.100327228	0.136302040	5.054210e-02	0.10374069
Frustration	5.231693e-02	0.13396976	0.13851755	0.029110932	0.138609258	2.588484e-01	0.22611038
PakChinaRelation	9.868009e-02	0.09115489	0.12407704	0.139558609	-0.009050793	-1.021451e-01	0.15133478

	DailyRoutine	AirQuality	HearingProblems	MarketsEffect	BusinessEffect	TrafficFlow	Asthma
awareness	-0.04869871	0.052802501	0.16584096	0.022213083	9.923552e-02	0.14635920	0.022213083
passenger	0.25622188	0.214948524	0.15859164	0.070677059	9.286624e-02	0.14051631	0.070677059
government	0.09637117	0.233180480	0.13731904	0.249696172	1.332807e-01	0.14363002	0.239967749
LandValue	0.15378665	-0.008768784	0.02655721	0.011593601	8.004476e-02	0.14351830	-0.020025311
passengrBurden	0.09359128	0.250220017	0.13630204	0.984210526	5.172820e-02	0.14256628	0.984210526
PakEconomy	0.17816940	0.146733359	0.03423820	0.228277658	1.956381e-01	0.01875853	0.228277658
EducationalStops	0.07672201	-0.022020165	0.10374069	0.037053984	1.986436e-01	0.08590253	0.055580976
DailyRoutine	1.00000000	0.143237274	-0.01974192	0.112822367	1.431894e-01	0.02628084	0.093591282
AirQuality	0.14323727	1.000000000	0.08100056	0.231453515	1.788547e-01	0.15341773	0.231453515
HearingProblems	-0.01974192	0.081000560	1.00000000	0.136302040	1.645731e-02	0.91111210	0.154721235
MarketsEffect	0.11282237	0.231453515	0.13630204	1.000000000	3.762051e-02	0.14256628	0.984210526
BusinessEffect	0.14318940	0.178854700	0.01645731	0.037620513	1.000000e+00	0.06885467	0.051728205
TrafficFlow	0.02628084	0.153417727	0.91111210	0.142566275	6.885467e-02	1.00000000	0.161831988
Asthma	0.09359128	0.231453515	0.15472124	0.984210526	5.172820e-02	0.16183199	1.000000000
SkinAllergy	-0.01974192	0.081000560	0.97851311	0.136302040	-1.427444e-20	0.88863770	0.136302040
Frustration	0.25858550	0.022099718	0.13842626	0.138609258	1.057218e-01	0.12416303	0.138609258
PakChinaRelation	0.08763748	0.088747523	0.38431824	0.002262698	1.010846e-01	0.38817664	-0.009050793

	SkinAllergy	Frustration	PakChinaRelation
awareness	1.658410e-01	0.05231693	0.098680086
passenger	1.585916e-01	0.13396976	0.091154890
government	1.373190e-01	0.13851755	0.124077035
LandValue	1.003272e-01	0.02911093	0.139558609
passengrBurden	1.363020e-01	0.13860926	-0.009050793
PakEconomy	5.054210e-02	0.25884836	-0.102145149
EducationalStops	1.037407e-01	0.22611038	0.151334782
DailyRoutine	-1.974192e-02	0.25858550	0.087637484
AirQuality	8.100056e-02	0.02209972	0.088747523
HearingProblems	9.785131e-01	0.13842626	0.384318243
MarketsEffect	1.363020e-01	0.13860926	0.002262698
BusinessEffect	-1.427444e-20	0.10572185	0.101084593
TrafficFlow	8.886377e-01	0.12416303	0.388176637
Asthma	1.363020e-01	0.13860926	-0.009050793
SkinAllergy	1.000000e+00	0.15814510	0.384318243
Frustration	1.581451e-01	1.00000000	0.067341405
PakChinaRelation	3.843182e-01	0.06734140	1.000000000

8. Component loadings:

The table 7 represents the Factor loadings. The factor loadings are also known as component loadings which represent the correlation coefficients between the variables and factors. The table shows loadings that are greater than 0.3.

Table 7: Loading of Factors

	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5	Comp. 6	Comp. 7	Comp. 8	Comp. 9	Comp.10
awareness				0.578		0.318	0.442			0.432
BusinessEffect			0.360			0.303	-0.566			0.384
passenger			0.353			-0.376		0.531	-0.308	0.316
LandValue				-0.320	-0.513		0.313		0.524	
government				0.429						-0.636
AirQuality				0.378	-0.347	-0.363	-0.312			
Frustration			0.308		0.482			-0.404		
PakChina Relation					-0.345			-0.337	-0.414	
TrafficFlow	0.347	0.374								
SkinAllergy	0.347	0.392								
HearingProblems	0.348	0.391								
passengrBurden	0.365	-0.375								
MarketsEffect	0.366	-0.372								
Asthma	0.368	-0.368								
PakEconomy			0.313		0.396				0.402	
EducationalStops			0.344	-0.304		0.450		0.319	-0.436	
DailyRoutine			0.403			-0.386		-0.416		

	Comp.11	Comp.12	Comp.13	Comp.14	Comp.15	Comp.16	Comp.17
awareness			0.323				
BusinessEffect			-0.300				
passenger			-0.422				
LandValue							
government		-0.375					
AirQuality	0.573						
Frustration	0.507		-0.333				
PakChina Relation		0.587					
TrafficFlow				0.800			
SkinAllergy				-0.509	-0.433		-0.566
HearingProblems					0.566		0.500
passengrBurden					-0.378	-0.641	0.337
MarketsEffect						0.754	
Asthma					0.540		-0.595
PakEconomy	-0.303	0.486					
EducationalStops							
DailyRoutine		-0.331					

9. Rotated Component Matrix:

The next step is the rotational method for achieving more meaningful factor solution. The study main focus on finding **which variable measure which factors**? Rotated component matrix is an important tool for interpreting the

factors because it simplifies the factor structure. For getting better results we applied varmax rotation. First six factors are loaded. The sum of square of loadings shows the eigen values of each loadings. Table shows that eigen values of first six factors are greater than 1. We have seen that our p value i.e. 0.000 is less than 0.05 so we reject our null hypothesis and concluded that six extracted factors are sufficient.

H_o: 6 factors are not sufficient

H_1: 6 factors are sufficient

Table 8:Rotated Component Matrix

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
awareness					0.423	
passenger			0.402			
government					0.522	
LandValue				0.969		
passengrBurden	0.979					
PakEconomy			0.470			
EducationalStops			0.373			
DailyRoutine			0.454			
AirQuality						0.283
HearingProblems		0.972				
MarketsEffect	0.979					
BusinessEffect			0.300			
TrafficFlow						0.243
Asthma	0.979					
SkinAllergy		0.963				
Frustration			0.482			
PakChinaRelation		0.388				

Table 9: Loading of factors and variance

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
SS loadings	3.007	2.989	1.207	0.985	0.659	0.221
Proportion Var	0.177	0.176	0.071	0.058	0.039	0.013
Cumulative Var	0.177	0.353	0.424	0.482	0.520	0.533

Test of the hypothesis that 6 factors are sufficient
The chi square statistic is 173.14 on 49 degrees of freedom.
The p-value is 9.24e-16

10. Labeling Of Factors:

The 6 factors have been extracted and have been labelled.

Table 10: Factor Labelling

Factors	Group	Name Of Group
F1	Passenger Burden, Market effect, Asthma	Economic Impact

F2	Hearing problem, Skin Allergy, PakChina Relation	Health effects
F3	Passenger, Pak Economy, Educational Stops, Daily routine, Business Effect, Frustration	Social and economic issues
F4	Land value	Land value
F5	Awareness, Government	Awareness
F6	Traffic flow, Air quality	Pollution

Table 10 shows the names of groups. Group 1 was given the name of economic impact which means that the nearby markets were affected during the construction of Orange Line Train. Group 2 was given the name of health effects that shows that people were badly affected by temporary noise induced hearing loss and also suffered from skin allergies. Group 3 was labelled as social and economic issues as the residents were facing issues related to their movement for educational activities and daily routines. Group 4 was labelled as land value. The inhabitants in the area informed that land values of commercial land have been reduced due to construction of this train. Group 5 highlighted the level of awareness of people which shows that inhabitants of the area were well aware of the issues caused due to this construction. Group 6 was labelled as Pollution as environmental impact of construction of Orange line train. It is obvious that the construction of pathway of Orange Line Train caused a lot of traffic flows that ultimately resulted in noise pollution. While air pollution was also caused due to construction activities performed in the area.

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