

Investigating the Impact Factors of Night Construction for Urban Road Projects

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Abstract: Construction work on urban roads often causes changes in the speed and trajectory of vehicles, resulting in serious congestion and traffic accidents. Construction work on urban roads also poses several energy, environmental and social problems. In this context, maintenance work is increasingly being carried out at night, when traffic pressure is relatively low, to minimize the adverse effects of road construction. This study uses a literature review and expert interviews to construct a model of the influencing factors of urban road construction at night containing 11 factors. A questionnaire is designed to investigate the road construction enterprises' agreement with these influencing factors. The results of the statistical analysis and factor analysis showed that the factors can be divided into two main factors: the competent factor and the objective factor. The objective factors of road construction have a significant impact on construction companies, which should pay more attention to the impact of road construction at night on construction and traffic. Air pollution and energy consumption are the least important factors for construction companies when considering whether to use night work as a method. The only way to carry out night work is to ensure the safety of construction workers, adequate lighting and a comprehensive traffic control plan.

Keywords: Road Engineering, Night Construction, Influencing Factors, Factor Analysis.

1. Introduction

Urban roads have important functions and functions in the city. They constitute the skeleton of the city, intuitively reflect the economic, political and cultural development level of the city, and show the city image(Li Yunyang,2014). Due to the early construction of many urban roads, their functions cannot meet the needs of current urban traffic development. It is imperative to comprehensively maintain and transform the original roads. However, the urban road maintenance project is carried out in a densely populated city, and its implementation process is different from the implementation of other new road projects. If it is not implemented properly, it will have a great impact on the society. For example, roads are often not completed as scheduled, and residents' travel inconvenience can not be improved for a long time, which is an important reason for the general public's dissatisfaction with road reconstruction projects. Road construction will cause man-made traffic congestion(Tan Xiaoling,2005), which may be caused by the irregular operation of some construction units, such as taking up too much urban space during construction and not setting reminder signs on construction sections. Even because the preliminary work of road construction has not been perfected, the construction unit lacks analysis of the current traffic situation, and fails to make scientific and reasonable predictions about the possible impact of road construction on traffic, resulting in traffic chaos in the construction section and surrounding areas(Dai Youhua,2009).

Under such circumstances, people are more inclined to carry out road maintenance projects at night, because the traffic pressure at night is relatively low, which can minimize the adverse impact of maintenance operations on traffic and

residents. However, night time construction also brings many new problems. For example, from the perspective of workers and construction units, night time construction is prone to fatigue work, and the dark working environment that workers need to face brings considerable difficulties to construction, and at the same time increases the number of dangerous factors on the construction site, all of which bring safety to production. In terms of the living environment of residents, the overtime operation caused by night construction is likely to cause noise disturbance to the residents(Yue Wei,2014).

There is no doubt that the night time construction of road works will be affected by many factors. In the context of high-density cities, how to choose an appropriate night time construction time to avoid the negative impact of construction is an important issue faced by urban road engineering managers and decision makers. Therefore, this study constructs a model of influencing factors of urban road night time construction by means of literature review and expert interviews, and designs a questionnaire based on this to explore the identification of road construction enterprises on these influencing factors.

2. Research Design and Data Collection

2.1. Factors affecting night time construction of urban roads

This study summarizes the influencing factors of night time construction of urban roads into 11 aspects by consulting literature and consulting experts, namely: traffic congestion, personnel safety, traffic control, construction efficiency, construction quality, driving conditions, construction unit cost, construction disturbance, energy consumption, air pollution, lighting (Table 1).

Table 1. Influencing factors of night time construction of urban roads

Factors	Definition	Reasons	Sources
Traffic congestion	Traffic inconvenience to vehicles and people caused by the closure during road construction	When the road needs to be partially fenced due to construction, the original number of lanes will change, and the accompanying changes will include road linearity, lane width, and vehicle lateral clearance. It is very easy to cause traffic accidents and cause traffic chaos, that is, "traffic congestion" is the main influencing factor for night time construction.	Cheng Qingqing (2017)
Personnel safety	Safety of construction workers, vehicles and pedestrians during construction	Due to the improper organization and coordination of various elements in the construction process, there is no sound safety management system, the capital investment in safety management is small, and the safety awareness of construction participants is low, that is, "personnel safety" is The main influencing factors of night construction	Fang Huaixia (2017)
Traffic control	Reduce the impact on vehicle drivers through effective road planning	When road reconstruction is carried out, most of the original roads must be kept open to traffic, which will cause traffic congestion and traffic accidents. These phenomena will not only affect the normal transportation of the road, but also affect the smooth progress of the construction, resulting in social and economic losses and negative social reactions. It is very necessary to control traffic, ensure the smooth passage of traffic, avoid traffic accidents, and ensure the smooth completion of construction, that is, "traffic control" is the main influencing factor for night time construction.	Zhang Wei (2013)
Construction efficiency	The impact of construction workers on construction efficiency due to health, family and sleep factors	The survey found that 90% of respondents believed that night time construction would reduce work efficiency. The survey results indicate that construction at night generally reduces work efficiency, that is, "construction efficiency" is the main factor affecting construction at night.	Li Huilong, Wu Bing (2007)
Construction quality	Road construction quality in night construction	Under the dim light and the long-term habit of working during the day, the attention of the construction workers will decrease to a certain extent, which will cause the risk of a certain decline in the construction quality [9], that is, "construction quality" is the main factor for night construction. Influencing factors	Li Huilong, Wu Bing (2007)
Driving conditions	Driving conditions of vehicles in the construction area during night construction	Due to the lack of light at night, the driver's recognition of objects and the level of visual recognition are relatively low. The driver's driving conditions are poor, and it is difficult to obtain surrounding traffic information. The occurrence of traffic accidents [21], that is, "driving conditions" is the main influencing factor for night construction	Zhang Sheng (2015)
Construction unit cost	Costs incurred during night time construction (such as purchase of temporary safety facilities, configuration of night time lighting facilities, maintenance of construction machinery, etc.)	Compared with daytime construction work, night time construction needs to use some special construction facilities, including lights, warning lamps, etc., so the cost will increase to a certain extent [9], that is, "construction unit cost" is the main cost of night time construction. influencing factors.	Li Huilong, Wu Bing (2007)
Construction disturbance	The impact of noise, light, etc. generated by night construction on surrounding residents	The research results show that 40% of the people said that the noise of night time construction has a very serious impact on their lives [17], that is, "construction disturbing residents" is the main factor affecting night time construction.	Lai Xianjin (2017)
Energy consumption	Night time construction can reduce air pollution from vehicle congestion	The energy consumption caused by vehicle congestion can be reduced through night time construction [22], that is, "energy consumption" is the main factor affecting night time construction.	Ren Yongzhong (2017)
Air pollution	night time construction can reduce air pollution from vehicle congestion	Night construction can effectively reduce traffic congestion, thereby reducing air pollution caused by congestion [23], that is, "air pollution" is the main factor affecting night time construction	Zhang Yan (2014)
Lighting	The impact of night construction lights on construction workers	The quality impact of night time construction is mainly related to lighting, so with sufficient lighting, the quality produced by the project is similar to that produced during daytime work [14], that is, "lighting" is the main influencing factor for night time construction.	Park (2002)

2.2. Questionnaire design and data collection

Based on the above-mentioned influencing factors of urban road construction at night, this study designed Likert's five-point attitude scale (Likert-type Scale) questionnaire, revised the questionnaire through pre-investigation, and finally determined the questionnaire version. The final questionnaire is divided into an introduction part and a subject part. The introduction part includes the purpose of the investigation, words of thanks, confidentiality instructions, contact emails and instructions for filling in, so as to eliminate the concerns of the respondents and obtain the cooperation of the respondents; the main body The part includes (1) basic information of the investigators, including: gender, age, position, educational background, length of service and average income. (2) Assess the importance of different influencing factors to road night time construction, that is, the

investigation of the influence factors of urban road night time construction. The questionnaires were distributed both online and offline. A total of 110 questionnaires were collected, of which 102 were valid. A total of 80 questionnaires were collected online through Questionnaire Star, of which 74 were valid questionnaires, and the questionnaire effectiveness rate was 92.5%. By distributing paper questionnaires offline, a total of 30 questionnaires were collected, of which 28 were valid questionnaires, and the effective rate of the questionnaires was 93.3%. The subjects of this questionnaire survey are all employees of road construction enterprises.

3. Results Analysis

3.1. Background information

The specific distribution of the sample background data information summary is shown in Table 2.

Table 2. The specific distribution of the sample background data information summary

	Statistical classification	Frequency	Percentage (%)
Gender	Male	74	72.55%
	Female	28	27.45%
Age	Under 25	15	14.71%
	25-30	33	32.35%
	31-40	31	30.39%
	41-50	20	19.61%
	Over 50	3	2.94%
Position	Project Manager	24	23.52%
	Constructor	12	11.76%
	Quality Officer	5	4.9%
	Safety Officer	10	9.8%
	Budget Officer	10	9.8%
	technician	23	22.55%
	Documenter	1	0.98%
	Management staff	6	5.88%
	others	11	10.78%
	Under Junior	3	2.94%
Education	Technical secondary school	6	5.88%
	Senior High school	7	6.86%
	college	35	34.31%
	Bachelor degree or above	51	50%
Working years	Under 5	41	40.2%
	6-10	24	23.53%
	11-20	23	22.55%
	Over 20	11	10.78%
Wages	temporary worker	3	2.94%
	Under 4000	13	12.75%
	4000-6999	33	32.35%
	7000-9999	25	24.51%
	10000-12999	13	12.75%
	Over 13000	18	17.65%

3.2. Reliability analysis

Reliability analysis is an important indicator to test the reliability of a survey and research, and it is the basis and premise of statistical analysis of questionnaires. Research without reliability has no practical value. Reliability analysis plays a key role in testing the validity of the scale.

The reliability analysis of this questionnaire mainly adopts the Cronbach α coefficient method. The value of the α coefficient is between 0 and 1. The closer the coefficient value

is to 1, the higher the degree of internal consistency of the scale is. The higher the reliability of the scale. It can be seen from Table 3 that the reliability coefficient value is 0.886, which is greater than 0.8, thus indicating that the reliability of the research data is of high quality. Regarding the " α coefficient of deleted item", the reliability coefficient value after the analysis item was deleted did not increase significantly, thus indicating that all items should be retained, further indicating that the research data has a high level of reliability and can be used for further analysis.

Table 3. Reliability analysis table

	Correction item total correlation(CITC)	Item deleted α coefficient	α
Traffic jam	0.432	0.888	
Personnel safety	0.569	0.881	
Traffic control	0.738	0.868	
Construction efficiency	0.693	0.871	
Construction quality	0.646	0.874	
Driving conditions	0.676	0.871	0.886
Construction unit cost	0.586	0.877	
Construction Disturbs Residents	0.673	0.872	
Energy consumption	0.584	0.878	
Air pollution	0.678	0.872	
Lighting	0.447	0.885	

3.3. Factor Analysis

Factor analysis is a method that simplifies data processing and problem analysis. It uses fewer indicators to describe and express information that contains almost all the data by means of dimensionality reduction. Whether the scale is suitable for principal component analysis is judged by calculating the scale's KMO sampling moderate measurement value and Bartlett's sphericity test value.

Table 4 is the test table of KMO and Bartlett. It can be seen from Table 5 that the KMO value of the urban night time road construction influencing factor measurement table is 0.878 and greater than 0.7, indicating that the survey data is very suitable for factor analysis. Bartlett's test P value is 0.000, which is less than the significance level, indicating that there is a correlation between the survey data.

Table 4. KMO and Bartlett's test

Kaiser-Meyer-Olkin		.878
Sphericity test: Bartlett	Approximate chi square	529.807
	df	55
	Sig	.000

Figure 1 is a factor loading rubble diagram, the number of components on the abscissa is the number of factors, and the eigenvalues on the left are the eigenvalues of the factors. It can be seen from Figure 41 that the first and second factor values have larger eigenvalues, indicating that these two factors can basically cover the explanation of the original variable; starting from the third factor, its eigenvalues decrease and are lower than 1, indicating that they do not play an important role in explaining the original variables.

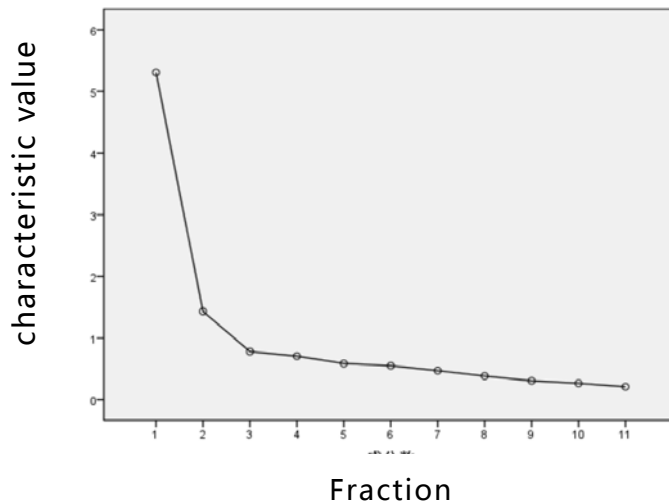


Figure 1. Factor Loading Gravel Plot

Table 5 explains the total variance. It can be seen from Table 6 that after extraction by the principal component method, there are two common factors whose eigenvalues are greater than 1, which are 5.309 and 1.433 respectively, and

the explanatory power of the influencing factors reaches 61%.

In summary, we only need to extract the first two factors.

Table 5. Explanation of total variance

	Initial characteristic value			Extract Square Sum Loading			Rotation sum of squares loading		
	total	Variance(%)	Cumulative(%)	total	Variance(%)	Cumulative(%)	total	Variance(%)	Cumulative(%)
1	5.309	48.261	48.261	5.309	48.261	48.261	3.511	31.921	31.921
2	1.433	13.025	61.296	1.433	13.025	61.286	3.230	29.365	61.286
3	.781	7.104	68.390						
4	.707	6.425	74.815						
5	.587	5.334	80.149						
6	.550	5.003	85.152						
7	.471	4.284	89.436						
8	.384	3.491	92.926						
9	.305	2.773	95.700						
10	.265	2.409	98.109						
11	.208	1.891	100.000						

Table 6 is the factor load matrix table. It can be seen that the main loads of traffic congestion, personnel safety, traffic control, construction efficiency, construction quality and construction unit cost are related to the first common factor.

The main loads of driving conditions, construction disturbance, energy consumption, air pollution and lighting are related to the second common factor.

Table 6. The factor load matrix table

	component	
	1	2
Traffic jam	.801	-.071
Personnel safety	.739	.163
Traffic control	.856	.277
Construction efficiency	.555	.529
Construction quality	.675	.345
Driving conditions	.497	.564
Construction unit cost	.508	.445
Construction Disturbs Residents	.472	.592
Energy consumption	.098	.851
Air pollution	.302	.761
Lighting	.010	.744

Therefore, we named the first common factor as objective factors (construction and traffic factors), and named the second common factor as subjective factors (personnel and environmental factors). In this way, the influencing factors of urban road construction at night can be considered and analyzed in two dimensions: subjective and objective.

3.4. Factor Discussion

Traffic control factors, traffic congestion factors and personnel safety factors are closely related. Workers in construction companies believe that without good traffic control, it will lead to traffic congestion on the road surface and threaten the lives of construction workers. These three complement each other to make the external environment stable.

The first main factor reflects traffic congestion, personnel safety, traffic control, construction efficiency, construction quality and construction unit cost in urban night road construction, and its contribution rate to the total variance is 48.261%, which is the highest among the factors, indicating that the objective factors of road construction have a significant impact, and construction companies should pay more attention to the impact of road construction at night on construction and traffic.

The second main factor reflects driving conditions, construction nuisance, energy consumption, air pollution and lighting, and its contribution rate to the total variance is 13.025%, which is low in the factor contribution rate, indicating that the current stage is subjective. and environmental factors have a relatively low impact on night time construction. Construction companies do not pay much attention to the impact of road construction at night on personnel and the environment.

4. Conclusion

Through literature review and expert interviews, this study constructs a model of influencing factors of urban road night construction including 11 factors, and designs a questionnaire based on this to explore road construction enterprises' recognition of these influencing factors. The results of statistical analysis and factor analysis show that this factor can be divided into two major factors: supervisory factor and objective factor. This study draws the following conclusions.

(1) Among the influencing factors of night time construction on urban roads, personnel safety, construction quality, lighting and traffic control are the most important factors that construction companies need to consider when

considering whether to use night time construction.

(2) Under the conditions of social economy and construction methods at the present stage, air pollution and energy consumption are the least concerned factors when construction companies consider whether to adopt the method of night construction. However, with the development of social economy, air pollution and energy consumption will also become factors that construction companies have to consider.

(3) Road construction at night can be carried out better only under the premise of ensuring the safety of construction workers, sufficient lighting, and a complete traffic control plan.

At the same time, there are still some limitations in this study. Due to limited time and samples, this study only investigated construction companies, ignoring management companies, supervision companies and other road construction participants. This study did not analyze and consider each region of China separately. It is hoped that future researchers can analyze and compare the different status quo in different regions.

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