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An Economic Analysis of Selected Road Projects in NOIDA, India

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Abstract:

NOIDA which is a part of national capital region of India located near to Delhi frequented with heavy traffic jams due to ever increasing vehicle population. In order to sort out the traffic problems in the city, NOIDA authority are building-up new flyovers, bridges and underpasses at various locations of the city. As a well-developed transportation network is vital to the economic development of the area. High quality road network increases the potential of any economic system by helping both consumer and producer. Traffic congestions are major bottleneck of smooth functioning of a city transportation network. With increase in vehicle population commuters spends more time in traffic jam and loses precious time which could have been utilised in productive activities otherwise. It also causes wasteful fuel expenditure which directly affects the country's exchequer. Thus creation of new road infrastructures as well as periodic maintenance of the existing one has long term economic benefits. The economic benefits are calibrated by carrying out cost-benefit analysis of the expenditures incurred and benefits created vide Economic Internal Rate of Return (EIRR). The robustness of the projects is confirmed by carrying out a sensitivity analysis in changed costs condition. NOIDA authority have planned to cconstruct a north – south underpass (2 numbers) of length 0.6 km on Har Singar Marg at MP-2 Road intersection in X-ing of Sector – 25 &25 A and Sector-31 & 32 A and an elevated road 2 of length 2.2 km on Tulsi Marg intersection between sector 27 &19 up to Spice Mall. Here an attempt has been made to carry out an economic analysis of the above-mentioned projects. A factor of 0.85 has been adopted to convert financial costs into economic costs. The EIRR for underpass estimated

to be 20.17% and elevated roads to be 17.90%. The sensitivity analysis proved the robustness of the projects. Overall the proposed investment programmes are found to be economically viable.

Key words: EIRR, economic viability, sensitivity analysis, traffic congestion, Idling fuel consumptions, VOC, time savings

1.0 Introduction

Noida, short for the New Okhla Industrial Development Authority, is a city in India under the management of the New Okhla. Industrial Development Authority (also called NOIDA). It is part of National Capital Region of India located about 20 kilometers (12 mi) southeast of New Delhi. As per provisional reports of Census India, population of Noida in 2011 is 642,381 of which male and female are 352,577 and 289,804 respectively (Census 2011, India). However, the population of Noida expected to reach 25,00,000 in 2031 (Population projection statistics of Master Plan of Noida -2021). The total area of the city is 203 sq. kilometer (78 sq. mile) with a population density of 2,463 per sq. kilometer (6,380 per sq. mile). It is located in Gautam Buddha Nagar district of Uttar Pradesh state and is ranked best city in India. It replaced Mumbai as the second best realty destination. It has emerged a hot spot for IT and IT-enabled services (ITeS) industry with many large companies setting up their businesses here. It is becoming the preferred destinations for companies offering IT, ITeS, BPO, BTO and KPO services in various domains such as banking, financial services, insurance, pharma, auto, FMCG and manufacturing. It is a major hub for multinational firms outsourcing IT services. Many large software and business process outsourcing companies have their offices in the city. Energy and Power Utility companies have their corporate offices in the city. Many other companies have their Indian branch offices here. The city got Special Economic Zone status so the city is also the head office of the Software Technology Park, which was established

by the Government of India to promote the software industry. It is a major hub of industry. It has quickly emerged as a hub for automobile ancillary units. Various MNCs and major manufacturers have their corporate offices in the city. It is also a hub for major news channels and studios. Commercial activities have also risen in recent years, with a spate of new malls and multiplexes. Developments in industry, commerce and trade have led this city to be a model city (Wikipedia 2015). The actual and proposed land use pattern in 2010 and 2021 respectively in Noida is given in Table 1 below. The first development of Noida could be guessed from the Table 1 as 61.6% of the proposed land use Master Plan 2021 has already been developed in 2010.

Table 1: Proposed Land Use in Master Plan -2021 and Actual Land Use in 2010

Sl. No.	***Land Use***	***Proposed Area for 2021***	***Actual Development in 2010***	***Percentage (%) of Planned Area of 2021***
1	Residential	5,334	3,357.64	62.95
2	Commercial	564	101.89	18.06
3	Industrial	3,001	1,267.14	42.22
4	Institutional	1,219	813.28	66.72
5	Transportation	2,211	1,804.31	81.61
6	Recreational	1,513	1,761.90	116.45
7	Agriculture	1,001	-	-
8	Water body	121	104.5	86.36
Total		***14,964***	***9,210.74***	***61.61***

Source: Noida Master Plan -2021.

A well connected transportation network ensure a faster and more reliable travel times. This is important as time spent in traffic jam resulted in wasteful expenditure on fuel, out of pocket expenses as well as time which could have been utilized in other productive activities. A high quality road network is important for high level of economic performance. It helps in sustained economic growth, increases the productivity, helps in increment in regional development and increases

competitiveness. The infrastructure projects brings economic benefits in long-term by raising the productivity, innovation, lower prices, increases the income and overall creates more jobs thus bring more boom to the economy. A well-plan transportation network helps the business to expand. It allows businesses to manage their inventories and transport goods more cheaply and efficiently as well as access a variety suppliers and markets for their products making it more making it more cost-effective for manufacturers to keep productions in and out (*An Economic Analysis of Transportation Infrastructure Investment, 2014*). Thus, the priority to reduce the infrastructure bottleneck is important for any government. This requires creation of more and more road infrastructures and maintenance of the existing one. Benefit-cost analysis totals the annual user benefit derived from the road project and compares these benefits to total costs related to construction (*Evaluating Roads as Investments, The University of Kansas, 2008).*In this context an economic analysis of cost-benefit has been carried out to find out the economic viability of certain selected road projects in the city of NOIDA.

Road Infrastructure in the Study Area: Noida features three main expressways. One is the DND Flyway, which connects Noida and Delhi, runs across the river Yamuna, and receives heavy traffics from office-goers in the city. The second is the Noida-Greater Noida Expressway and the third is the Yamuna Expressway which connects Noida to Agra via Mathura. There is a plan to connect three expressways such as the Delhi eastern peripheral Road, Upper Ganga Canal Expressway and the Ganga Expressway with the city. The area adjacent to the NGN Expressway has seen heavy residential development in recent years. It also has many wide 6-Lane roads across the city. Construction on the double-decker elevated road on MP-II road, a 4.8 km road has already been

started and is expected to be completed by 2017. Noida has been put on the fast track for the Delhi Metro.

The proposed development site is located in Noida. The proposed development site is located towards the geographical center of the Noida development area and is currently served by a reasonably developed road network together with significant public transport facilities, primarily in the form of the blue Line of the Delhi Metro which terminates at Noida City Centre. The existing strategic road network serving the development site is the major east-west and north-south corridors located in proximity to the site, together with those roads located further from the development site but also potentially impacting of traffic flow associated with the development. The important strategic roads in the locality of the development site include:

Noida-Greater Noida Expressway: This road comprises a dual 3-lane highway connecting Noida to Greater Noida.

Yamuna Expressway: This road is a dual 3-lane expressway connecting the Noida – Greater Noida Expressway to Agra.

DND Flyway: This dual 4-alne expressway connects Noida with Delhi and crosses the Yamanu River via the Noida Toll Bridge.

Dadri Road: This road is a major arterial road connecting between Noida and Greater Noida, and is located to the east of the Noida – Greater Noida Expressway.

Noida – Greater Noida Link Road: This road is the extension of Golf Marg and connects Golf Marg within Greater Noida;

NH24 Bypass: This major arterial road is a strategic east-west corridor located to the north of Noida.

Traffic Volume Characteristics: The analysis of the travel demand matrix by distance of travel indicates that nearly 75 per cent of the demand is concentrated for a travel distance of less than 3 km. Only about 4.6 per cent of the trips are for a

distance of more than 10 km. More than 91% trips are made for work, education and shopping purposes. More than 91% trips are made for work, education and shopping purposes. It has been found that walk trips are higher which is due to high intra sector movements. All this is shown in Table 2. It is observed that 80 per cent of the traffic falls along the Noida-Delhi corridor. It revealed that higher volumes of traffic enter the city in the morning hours whereas in the evening hours the traffic leaves the city. So this is an indication of commutation by workers from neighbouring areas to workplaces in Noida. The traffic surveys also revealed that personalized motor vehicles have a significant share of 40 to 50 per cent (Table 3). As regard the goods movements, transportation survey has revealed that there is a high inflow of building material to Noida and a high outflow of industrial goods from Noida.

Table 2: Trip Length (Person Trip)

Sl. No.	***Distance***	***Number of Trips***	***%***
1	Less than 1 Km	290,117	60.1
2	1 to 3 Km	31,436	6.5
3	3 to 5 Km	75,407	15.6
4	5 to 10 Km	63,385	13.1
5	Above 10 Km	22,396	4.6
Total		***482,741***	***100.0***

Source: Noida Master Plan -2021(Draft).

Table 3: Travel Mode

Sl. No.	***Mode of Travel***	***Number of Trips***	***%***
1	Car	47,975	9.9
2	2 Wheeler	62,256	12.9
3	IPT Modes	46,231	9.6
4	Bus	60,408	12.5
5	Walks	219,232	45.4
6	Others	46,641	9.7
Total		***482,743***	***100.0***

Source: Noida Master Plan -2021(Draft).

Traffic Forecast: Net State Domestic Product (NSDP) of Noida has been based on some relevant economic indicators of Gautam Buddha Nagar district in comparison with Uttar

Pradesh (UP) state, as time series NSDP data for Noida was not available. This economic indicator broadly includes percentage of urban population, density, literacy rate, road length per thousand hundreds of population etc. NSDP growth rates for the project roads have been determined by establishing relationship between state NSDP growth rate and ratio of socio-economic indicators.

Transport Demand Elasticity: Since the regions of UP influence the pattern of flows on the current links in the project influence area, appropriate weights have been applied to net NSDP to reflect the relative importance of region. The weights have been derived from the relevant socio economic indicators as described above. It has been found that Noida accounts 7 percent NSDP whereas state of Uttar Pradesh accounts 6.5 percent in the year 2014. It has been observed that Noida have a relatively higher percentage of workers in sectors other than agriculture. Development activity on large scales is taking place in NOIDA. Thus while calculating the elasticity for the future, the current and future developmental activities have been considered. This has been done for all categories of vehicles. It is generally understood that as economic development takes place, there is change in the spatial distribution of activities and corresponding changes in transport demand elasticity. As regions become more and more self-sufficient, the need for long-distance transport diminishes. In line with the suggestions of the World Bank and the ADB, it is assumed that elasticity decline in future time periods and approach unity**.** The transport demand elasticity (projection) is given in Table 4.

Table 4: Transport Demand Elasticity With respect to NSDP

Time Period	***Car***	***Bus***	***Truck***	***2-Wheeler***
Up to 2012	1.4	1.1	1.2	1.2
2012-2017	1.3	1.0	1.1	1.1
2017-2022	1.1	0.9	1.0	1.0
Beyond 2022	1.0	0.9	0.9	1.0

Calculated by the author

Perspective Growth Rates of Weighted NSDP: Given the transport demand elasticity, the growth rates of traffic on road by different modes have been projected on the basis of growth rates of NSDP. This is shown in Table 5.

Table 5: Perspective Growth Rates of NSDP

Time Period	*NSDP (%)*
Up to 2012	7.0
2012-2017	6.4
2017-2022	5.9
Beyond 2022	5.4

Calculated by the author

Projected Traffic Growth Rates: The future growth rates of NSDP along with the projected elasticity of transport demand have been used to derive average rates of traffic growth over the future. Besides car, bus, truck and two-wheelers the slow-moving vehicles have also been considered and a certain growth rate for this category was also taken into consideration. Slow-moving freight traffic comprises animal-drawn vehicles for short-haul from rural areas to urban center and market towns. The growth rates of the economy have been multiplied by the projected transport demand elasticity to arrive at average rates of growth for the future. The final projected rates of growth of traffic calculated are given in Table 6.

Table 6: Projected Growth Rates of Traffic (in %)

Time Period	*Car*	*Bus*	*Truck*	*2-Wheeler*
Up to 2012	9.8	7.7	8.4	8.4
2012-2017	8.4	6.4	7.1	7.1
2017-2022	6.5	5.3	5.9	5.9
Beyond 2022	5.4	4.8	5.4	4.8

Calculated by the author

Road Projects Considered for the Economic Analysis: The local road network in the locality is seen that the site is bordered by Golf Marg in the south, Shivalik Marg in the east, Tulsi Marg

in the north and Har Singer Marg in the west. In addition, Sectors 32 and 25A are divided by Ashok Marg.

Golf Marg is a dual 3-lane major arterial road, forming key east-west corridor in Noida, bordering the south side of the site. Golf Marg experiences heavy traffic flows during peak periods, with the flow being marginally eastbound during the morning (AM) Peak and marginally higher west bound during the evening (PM) Peak.

The Blue Line viaduct columns are located in the central median of the road, while in the vicinity of the Blue Line stations, columns and entrance structures are located on the outer edges of the carriageway limiting future widening.

Har Singar Marg is a dual 3-lane arterial road, running north-south, bordering the west side of the development site.

Shivalik Marg is a dual 3-lane arterial road running north-south, bordering the east side of the development site.

Ashok Marg is a dual 3-lane major arterial road, forming key east-west corridor in Noida, located between Sector 32 and Sector 25A.

Tulsi Marg is a dual 2-lane arterial road running in an east-west alignment. Existing development fronting the road comprises varied commercial and residential properties, including a number of undeveloped sites.

Noida authority hired the services of engineering consultancy to study the feasibility of construction of underpasses and elevated roads in Golf Marg, Har Singar Marg, Shivalik Marg, Ashok Marg and Tulsi Marg within the city. Here, the economic analysis has been carried out in order to know the economic viability of construction of new underpasses and elevated road in some selected sections.

The review of literature highlights some past studies on studying economic viability of some road infrastructure projects. The next part describes the detail approach and methodology of carrying out the economic analysis. The

approach is followed by costing pattern which mainly describes about the capital and maintenance costs. These costs have been derived from engineering cost estimates. Project benefits points out the benefits accrue from reduced fuel consumptions due to improvement of roads i.e. idling fuel consumption and time savings to road users due to reduction in delays. Further, the economic analysis of calculation of EIRR is followed by a sensitivity analysis and conclusion.

2.0 Review of Literature:

Every nations benefit from a well performing transportation network. It helps the business enterprises to manage their inventories and transport, access suppliers and market for their products. The consumer gets the benefit from lower priced goods, workers by better access to work place etc. Peoples and firms derive benefits from shared access of inputs and production due to an efficient transportation network (Marshall, 1890). Contemporary research reveals the high economic gain from expenditure of public capital (Aschauer, 1989). Recent research literatures point out the importance of the public investment on the basis of their contributions to economy. Further it also emphasized the importance of keeping the assets in good conditions through maintenance and repairs (Kahn and Levinson, 2011, Gramlich, 1994). A research report of Texas Transportation Institute highlights that American commuters in urban areas collectively spent 5.5 billion hours in traffic jam which means a loss of week time by an average commuter. Further these commuters stuck in traffic congestion spent 120 billion USD for purchase of extra 2.9 billion gallon of extra fuel (Schrank et. al. 2011). A well maintained roads, other driving alternatives and access to public transportation network can save the life through reduction of accidents. The road bottlenecks cause a loss of 7.8 billion USD annually for truck transportation industries by causing a loss of 243 million

hours of delays in USA (White & Grenzeback, 2007). A 2005 survey report of Economic Development Research Group concluded that because of the long time shipping business group at added cost re –orient their supply chain, plan more inventories, open up more distribution centre. The construction of flyovers, bridges and underpasses is considered as an effective way of managing traffic and avoiding the traffic delays. It helps in reducing unnecessary wastage of fuel while waiting in the traffic signal (Goyal et.al. 2009). The report of John Isbell (2006) revealed that to compensate the shipping delays in USA, Nike spent an addition 4 million USD per week to carry out an extra 7 to 14 days inventory. Similarly, the report of John Bowe (2006) pointed out that the Trans Pacific Services; USA spent additional 4 million USD per annum to increase its containers and chassis by 1300. Investment in transportation not only ensures more economic activities but geographical distribution of the same. A study by Weinstein (1999) on the impact of LRT on living standard point out that public expenditure on infrastructures increases the property value thus increases the living standard of the community living in the vicinity. This was confirmed by Haugwout (2002) in his study on productivity and welfare aspects of public infrastructure investments. This was further confirmed by other researchers that property values increases multiple times when it is located near public transit system in their study in Sacramento, Chicago, San Diego and St.Louis (Landis, 1995, Gruen, 1997, Cervero et.al., 2002 and Garett, 2004). The economic impact of smart investment in infrastructure creates millions of jobs. These jobs are created across a wide variety of different industries. For example, road building not only requires construction workers, but also grading and paving equipment, gasoline or diesel to run the machines, smaller hand tools of all sorts, raw inputs of cement, gravel, and asphalt, surveyors to map the site, engineers and site managers, and even accountants to keep track of costs. This

was confirmed through a study by Bureau of Labor Statistics, USA (2012). Transportation cost is a major expenditure that is accounted after expenditure on housing. Thus reduction of fuel consumption due to maintenance of roads helps the peoples to spend less money on transportation expenditure. Further improvement in transportation system reduces the cost associated with congestion and additional wear and tear caused by poor road conditions.

The deteriorated roads accelerate the depreciation of vehicles and the need for repairs because the stress on the vehicle increases in proportion to the level of roughness of the pavement surface. Further, the tire wear and fuel consumption increase as roads deteriorate since there is less efficient transfer of power to the drive train and additional friction between the road and the tires (TRIP Study 2013). Further the above-mentioned study estimates that the average motorist in the USA pays $377 each year in additional vehicle operating costs as a result of driving on roads in need of repair, which varies by major urbanized area. Vlieger et. al. (2000) pointed that the road and conditions and traffic behavior affects the fuel consumption. Construction of modern roundabouts can improve the vehicular traffic flows and will reduce the fuel consumption by cutting down the idle time at intersections (Mandavilli et. al., 2003). In order to quantify fuel consumption a study was conducted by Gandhi et. al. (1983). Latter the Automotive Research Association of India collected extensive data from city of Mumbai, Chennai, Bengaluru and Pune to develop to standardized idle fuel consumption (Badusha and Ghosh, 1999).

3.0 Objective:

The objective of the paper is to carry out the economic viability of under-mentioned proposed underpasses and elevated roads and also to confirm the robustness of the project by making a sensitivity analysis.

- *Construction of proposed north –south underpass (2 numbers) on Har Singar Marg at MP-2 Road intersection in X-ing of Sector – 25 &25 A and Sector-31 & 32 A. The length of the underpass is 0.6 km.*
- *Construction of proposed elevated road 2 on Tulsi Marg intersection between sector 27 &19 up to Spice Mall. The length of the elevated road is 2.2 km.*

4.0 Methodology and Approach

Economic viability for the proposed north-south underpass 2 on Har Singar Marg at MP-2 Road intersections in Sector 25 & 25A and Sector 31 & 32A as well as proposed elevated road on Tulsi Marg Intersection between sector 27 & 19 up to Spice Mall in Noida have been assessed within the broad framework of *Cost-Benefit Analysis* generally used for appraisal of public investment projects. In economic evaluation, benefits are computed for the economy as a whole rather than for an individual entity that has made the investment. In case of financial analysis the profits become the major factor for evaluation whereas in economic analysis the benefits to the economy are the main criteria for evaluation. The economic analysis involves comparison of project costs and benefits in economic terms under the "with" and "without" project conditions and determination of the Economic Internal Rate of Return (EIRR) of the project using discounted cash flow technique. This shows the return which the society could expect from the proposed investment during the project life, i.e. the benefit period. The feasibility of the project is determined by comparing the EIRR with the current accounting rate of return of 12%. This represents the opportunity cost of capital and is considered an appropriate minimum criterion for economic viability by both the Government of India and international funding agencies like the World Bank and the Asian Development Bank (ADB).

The main steps followed are:

i) Estimation of future traffic on the existing and proposed facilities
ii) Estimation of capital and maintenance costs (both regular and periodic) at economic prices
iii) Estimation of economic benefits
iv) Comparison of annual streams of costs with benefits and estimation of EIRR

The project is further subjected to sensitivity analysis by assessing the effects of adverse changes in the key variables on the base EIRR. This helps to gauge the economic strength of the project to withstand future risks and uncertainties.

5.0 Project Cost and Scheduling

The project cost consists of two main components: capital and maintenance costs. All financial costs have been converted into economic costs, excluding taxes and duties, by applying a factor of 0.85 as suggested by the Ministry of Road Transport and Highways and ADB/World Bank and is generally used for economic evaluation of highway projects in India.

(A) Construction of proposed north –south underpass (2 numbers) on Har Singar Marg at MP-2 Road intersection in X-ing of Sector – 25 &25 A and Sector-31 & 32 A.

The capital cost comprises cost of civil works for roads. The construction cost of the above-mentioned underpass (0.6 Km) is estimated at INR 330 million. The cost in economic terms is estimated at INR 280.50 million. The Project is considered to be operational by the year 2013. The investment has been phased over 12 months, in 2012, as presented below:

Table 7: Capital Cost Phasing of Underpass in Xing of Sector 25, 25A & 31, 32A

Year	*Phasing (%)*	*Cost in Million INR*	
		Financial Terms	*Economic Terms*
2012	100	330	280.50

The routine maintenance cost for the above underpass works out to INR 0.5 million for the first year and thereafter assumed to increase at the rate of 5% per annum.

(B) Construction of proposed elevated road 2 on Tulsi Marg intersection between sector 27 &19 up to Spice Mall.

The construction cost is estimated at INR 1,600 million. The cost in economic terms is estimated at INR 1,360 million. The Project is considered to be operational by the year 2013. The investment has been phased over 12 months, in 2012, as presented below:

Table 8: Capital Cost Phasing of Elevated Road in Sector 27 & 19 up to Spice Mall

Year	*Phasing (%)*	*Cost in Million INR*	
		Financial Terms	*Economic Terms*
2012	40	640	544
2013	60	960	816
Total (100%)		1,600	1,360

The routine maintenance cost for the Elevated Road 2 works out to be INR 6.8 million for the first ten years (i.e. 0.5% of total capital cost) and thereafter assumed to increase to 1% of total capital cost for the rest of the project periods.

5.1 Project Benefits

Construction of underpass road would help in both capacity enhancement and improvement of speeds for vehicular traffic. Thus, commissioning of the project is expected to result in direct and indirect benefits to users of the proposed underpass facility and the vehicles remaining on the surface. The present analysis considers quantification of direct benefits such as:

i) Savings in Vehicle Operating Cost (VOC) to road traffic due to decrease in congestion levels;
ii) Time savings for passengers and goods in transit;
iii) Savings in time due to elimination of stopped vehicular delays at junctions;
iv) Fuel savings due to reduction in idling fuel consumption at junctions.

Har Singar Marg and Elevated road 2 on Tulsi Marg (elevated road between the road of sector -27 & 19 up to Spice Mall) passes through urban areas where vehicular traffic is required to stop at a number of intermediate junctions. Implementation of the new facility will lead to removal of delays for the traffic using the underpass road and considerable reduction in delays for traffic remaining on the existing road network system. The intensity of delay (in vehicle hours) has been estimated for the cardinal years based on total traffic passing through the underpass and average delays. Reduced delays in the *with project* situation as compared to the *without project* situation would lead to net time savings at section. The project will also result in benefits accruing due to reduction in accidents and improved environmental conditions. However, these benefits are difficult to quantify and hence are not included in the viability analysis.

5.2 Economic Viability

Annual cost and benefit streams are used to derive the net cash flow for the project. The Economic Internal Rate of Return (EIRR) and net present value (NPV) at 12 percent discount rate are determined using the discounted cash-flow technique.

(A) Economic Viability of construction of proposed north – south underpass (2 numbers) on Har Singar Marg at MP-2 Road intersection in X-ing of Sector – 25 &25 A and Sector-31 & 32 A.

The EIRR of the project is estimated as 20.17% and NPV @ 12% is Rs.156.82 million. The minimum rate of return acceptable for viability of transport infrastructure projects in India is 12 percent. As EIRR of the project is above 12 percent, the project is considered to be economically viable. The net cash flow statement for the project is presented in Table 9.

(B) Economic viability of construction of proposed elevated road 2 on Tulsi Marg intersection between sector 27 &19 up to Spice Mall.

The EIRR of the project is estimated as 17.90% and NPV @ 12% is INR 434.43 million. The minimum rate of return acceptable for viability of transport infrastructure projects in India is 12 percent. As EIRR of the project is above 12 percent, the project is considered to be economically viable. The net cash flow statement for the project is presented in Table 10.

Table 9: Net Cash flow Statement for Underpass in X - ing of Sector – 25 &25 A and Sector-31 & 32 A *(In million INR)*

Year	*Cost*				*Benefits*					*Net Benefits*
	Capital Cost	*Maintenance Cost*		*Total Cost*	*VOC Savings*	*Time Savings*	*Reduced Junction Delays*		*Total Benefits*	
		Routine	*Periodic*				*Time Savings*	*Fuel Savings*		
2012	0.00			0.00					0.00	0.00
2013	280.50			280.50					0.00	-280.50
2014		0.50		0.50	17.39	24.61	1.51	0.47	43.97	43.47
2015		0.53		0.53	17.85	25.71	1.64	0.51	45.71	45.18
2016		0.55		0.55	18.30	26.78	1.79	0.55	47.43	46.88
2017		0.58		0.58	18.68	27.77	1.96	0.60	49.01	48.44
2018		0.61		0.61	0.70	43.84	2.13	0.66	47.33	46.72
2019		0.64		0.64	0.10	42.56	2.33	0.72	45.70	45.07
2020		0.67		0.67	-0.88	41.25	2.54	0.78	43.69	43.02
2021		0.70		0.70	9.42	80.08	2.77	0.85	93.12	92.42
2022		0.74		0.74	9.69	81.31	3.02	0.93	94.95	94.22
2023		0.78		0.78	9.59	81.90	3.29	1.02	95.80	95.03
2024		0.81		0.81	9.38	82.28	3.59	1.11	96.36	95.54
2025		0.86		0.86	10.14	84.05	3.92	1.21	99.31	98.46
2026		0.90		0.90	10.90	85.83	4.27	1.32	102.33	101.43
2027		0.94		0.94	11.65	87.61	4.61	1.42	105.30	104.36
2028		0.99		0.99	12.41	89.37	4.98	1.53	108.29	107.30
2029		1.04		1.04	13.16	91.09	5.37	1.66	111.28	110.24
2030		1.09		1.09	14.87	94.27	5.80	1.79	116.72	115.63
2031		1.15		1.15	16.67	97.61	6.25	1.93	122.46	121.32
EIRR										***20.17%***
NPV@ 12%										***156.82***

Calculated by the author

Table 10: Net Cash flow Statement for Elevated Road in Sector – 27 & 19 up to Spice Mall

(In million INR)

Year	*Cost*				*Benefits*					*Net Benefits*
	Capital Cost	*Maintenance Cost*		*Total Cost*	*VOC Savings*	*Time Savings*	*Reduced Junction Delays*		*Total Benefits*	
		Routine	*Periodic*				*Time Savings*	*Fuel Savings*		
2012	0.00			0.00					0.00	0.00
2013	544.00			544.00					0.00	-544.00
2014	816.00			816.00	80.55	95.91	1.14	0.37	177.98	-638.02
2015		6.80		6.80	83.77	100.18	1.23	0.40	185.59	178.79
2016		6.80		6.80	87.13	104.53	1.33	0.43	193.43	186.63
2017		6.80		6.80	90.54	108.89	1.44	0.47	201.33	194.53
2018		6.80		6.80	34.80	162.21	1.55	0.50	199.06	192.26
2019		6.80		6.80	36.12	160.85	1.67	0.54	199.18	192.38
2020		6.80		6.80	36.42	159.05	1.81	0.59	197.86	191.06
2021		6.80		6.80	62.36	270.09	1.95	0.63	335.03	328.23
2022		6.80		6.80	66.34	275.38	2.11	0.68	344.50	337.70
2023		6.80		6.80	69.64	279.41	2.27	0.74	352.07	345.27
2024		6.80		6.80	72.93	283.11	2.45	0.80	359.29	352.49
2025		13.60		13.60	77.06	288.09	2.65	0.86	368.66	355.06
2026		13.60		13.60	81.27	292.89	2.86	0.93	377.95	364.35
2027		13.60		13.60	85.54	297.41	3.07	1.00	387.02	373.42
2028		13.60		13.60	89.86	301.57	3.30	1.07	395.80	382.20
2029		13.60		13.60	94.25	305.24	3.54	1.15	404.18	390.58
2030		13.60		13.60	102.03	315.37	3.80	1.23	422.44	408.84
2031		13.60		13.60	110.20	326.00	4.09	1.32	441.61	428.01
EIRR										***17.90%***
NPV@ 12%										***434.43***

Calculated by the author

5.3 Sensitivity Analysis

The robustness of the project's viability is further demonstrated by the sensitivity analysis. Because of the uncertainties surrounding many of the variables like traffic forecasts, cost changes due to detailed designing, inflation etc., a sensitivity analysis was carried out to test the economic strength of the project. The variations in the following parameters have been examined, considering them to be on the conservative side:

i) Increase in cost by 15 percent
ii) Decrease in benefits by 15 percent
iii) Increase in cost by 15 percent and decrease in benefits by 15 percent

The results of the sensitivity analysis are presented in Table 11 and 12.

(A) The sensitivity analysis of construction of proposed north –south underpass (2 numbers) on Har Singar Marg at MP-2 Road intersection in X-ing of Sector – 25 &25 A and Sector-31 & 32 A is presented in Table 11.

Table 11: Sensitivity Analysis of Construction of Underpass on Xing of Sector - 25, 25A & 31, 32A

Sl. No.	*Case*	*EIRR (%)*
1	Base Case	20.17
(i)	Increase in Cost by 15 percent	17.77
(ii)	Decrease in benefits by 15 percent	17.38
(iii)	Increase in cost by 15 percent and decrease in benefits by 15 percent	15.20

Calculated by author

(B) The sensitivity analysis of construction of proposed elevated road 2 on Tulsi Marg intersection between sector 27 &19 up to Spice Mall is presented in Table 12.

Table 11: Sensitivity Analysis of Construction of Elevated Road in Sector - 27 & 19 up to Spice Mall

Sl. No.	*Case*	*EIRR (%)*
1	Base Case	17.90
(i)	Increase in Cost by 15 percent	15.41
(ii)	Decrease in benefits by 15 percent	14.96
(iii)	Increase in cost by 15 percent and decrease in benefits by 15 percent	12.72

Calculated by author

6.0 Conclusion:

The EIRR of construction of proposed north –south underpass (2 numbers) on Har Singar Marg at MP-2 Road intersection in X-ing of Sector – 25 &25 A and Sector-31 & 32 A calculated to be 201.17%. The NPV @12% calculated to be INR 156.82 million. Similarly, EIRR for construction of proposed elevated road 2 on Tulsi Marg intersection between sector 27 &19 up to Spice Mall calculated to be 17.90%. The NPV@ 12% here calculated to be INR 434.43 million. Thus, both the projects are found to be economically viable. Further, sensitivity analysis proved the robustness of both the projects with change in costs.

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