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Economic Analysis for Construction of Bridge for a Poverty Driven Rural Area in Kurigram District of Bangladesh

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Abstract The aim of this study is to find out the suitability of bridge for a poverty driven rural area in Bangladesh in the context of social and economic aspects. The study employed Participatory Rural Appraisal (PRA) approach to capture social benefit and also applied Benefit Cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR) assessing economic aspect. From PRA appaisal it is known that people of the Bridge areas strongly supported construction of Bridge as they perceived that the Bridge has a positive impact on socio-economic condition by changing existing communication system through construction of the proposed bridge. From the Economic Analysis, it is found that the BCR is 1.91, NPV is Tk. 17,645 Lakh and IRR is 31% which thus indicate positive returns of this proposed project. In addition, by construction of the proposed 1490m long bridge over the Teesta river, the travel distance from Chilmari Upazila of Kurigram District to Dhaka would be reduced by about 160 km. The Bridge has a social acceptance and hence it would enhance better communication that would result better economy of study area as well as the nation.

Keywords: *Focus Group Discussion (FGD), Benefit Cost Ratio (BCR), Net Present Value (NPV) and Economic Internal Rate of Return (EIRR)*

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1. Introduction

Rural transport is critical to socio-economic development and poverty reduction in Bangladesh (Planning Commission, GoB, 2016) [8]. An improved road communication system reduces road user costs and costs of production and thus facilitates socio-economic development of the country. On the other hand, Tolls will be levied on all major bridges on the National Road Network (Ministry of Communications, GoB, 2004) [6]. The country faces an enormous challenge to deliver the vision of a transport system that supports sustainable development (Ministry of Communications, GoB, 2008) [7]. Then a new approach is needed, bringing together the public and private sectors in a partnership which benefits everyone. Poverty level of Kurigram district is 63.7% (BBS, 2011) [4] and also it is a disaster prone northeastern district of Bangladesh. Most miseries in the life of the people are river erosion and this rendered a large number of people homeless, landless, asset less and also in loss of valuable belongings. There is widespread unemployment scenario in the absence of mills and factories in those districts. Only option for a large number of people is selling the manual labors mainly in the agriculture sector which is mainly limited to a single season as such labor class people have nothing to do in the other seasons when cultivation and harvesting period is over. Vast unemployment during off firm seasons brings untold sufferings and misery to the life of people of these areas by common starvation or low calorie intake far below the nutritional requirement, which is widespread known as 'Monga'.

Among others, lack of rural transport network is the major impediment for socio-economic development of these areas. Major parts of the localities of these areas are isolated from each other by the natural barriers by the river system of Teesta, Brahmaputra and Jamuna. Gaibandah and Kurigram districts are being separated by the river Teesta. The important rural infrastructures and institutions those are vital for rural development like rural transport networks, growth centers, hat-bazar, Union Parishad Complex, health centers, educational institutions located nearby the Teesta river are being separated from each other due to barrier by the river Teesta. The construction of Teesta bridge between Sundargong Upazilla of Gaibandha district and Chilmari Upazilla of Kurigram district will establish linkage among the isolated communities, existing transport networks and other rural institutions. Besides, a new transport link will emerge in the region which will shorten the distance of travel between Kurigram district including Bhurunga mari land port with the capital city. The network needs a major

bridge on the river Teesta on Panchpir Bazar-Chilmari Upazilla HQ road. There are important growth centers on both sides of the river which generate huge number of traffic across the river. The bridge is expected to improve road connectivity on a regional scale. The distance of travel from Chilmari Upazila to Dhaka would be reduced by about 160 km.

The bridge is expected to improve road connectivity on a regional scale. This type of study yet not conducted for this area. The outcomes of the study will help to make decision on impact on investment for this type of development works.

2. Objectives of the Study

The objective of the study is to know social viability and also assess economic aspects of construction of bridge for a poverty driven rural area in Bangladesh through Benefit Cost Ratio (BCR), Net Present Value (NPV) and Economic Internal Rate of Return (EIRR).

3. Literature Review

There were hardly possible to find out works on this issue due to nature of this study. However, some institutions based findings will be presented here. The basic approach to the economic analysis has been to determine the economic value of the costs and benefits over the entire life of the subprojects (ADB, 1997) [1]. Using domestic price numeraire, the financial costs of investments in infrastructure and operation and maintenance (O&M) are converted to economic costs by shadow pricing their tradable and non-tradable components, including labor, using the following assumptions: (i) shadow exchange rate factor, (ii) shadow wage rate factor of unskilled labor, (iii) shadow wage rate factor of skilled labor, and (iv) shadow price factor for other non-tradable. The cutoff point of Economic Opportunity Cost of Capital (EOCC) is usually 12 percent (ADB, 1997) [1]. A sensitivity analysis for economic analysis would be carried out for (i) a 20% increase in project cost; (ii) a 20% decrease in project benefits; and (iii) both a 20% increase in project cost estimate and a 20% decrease in project benefits (ADB, 2001) [2].

A road infrastructure project involves three types of cost in its useful life and they are construction cost, maintenance cost and road user cost (LGED, 2009) [5]. Travel Time Costs (TTC) also referred to as Values of Time are an important component of road user costs. The concept of travel time costs is based around the premise that time spent in traveling has an “opportunity cost” and could be used in an alternative activity which also produce or may produce some significant utility popularly known as benefit.

The Economic Analysis of Jamuna Bridge based on Road User Cost (RUC) Savings method found that Economic Internal Rate of Return (EIRR) of the Project is estimated at 18.2%. On the other hand, Economic Analysis of Padma Bridge found that EIRR is 20%.

4. Methodology

The fundamental concept of economic gains for construction of a bridge have been calculated based on Travel Time Cost (TTC), Vehicle Operating Cost (VOC), savings in costs associated with operation of Boat Service and capitalized value of land to be reclaimed or protected by river training works. Travel time is saved for two reasons. One is shortening of route length and another is improved of roughness. The basic concept of shortening of route length is expressed by the following figure.

Figure 1. Shortening of Route Length

The selection of the study area for this study is easy accessibility and availability of the community who have been suffered from updated communication network for a poverty driven area. Kurigram district is located in the Northwest Region of Bangladesh, covers a gross area of slightly over 2,296 sq.km and extends over 9 Upazilas with 74 Unions. The district is about 320 km from the capital city, Dhaka and is accessible by road, rail and waterways.

To evaluate social viability of the bridge, Focus Group Discussion (FGD) have been conducted for some specific indicators. The cost benefit ratio is widely used for capital expenditure decisions which is calculated by the following formula.

$$BCR = \frac{\text{Present Value of benefts}}{\text{Present value of costs}}$$

$$\sum_{i=1}^{n} \frac{B_i}{(1+r)^i} \div \sum_{i=1}^{n} \frac{C_i}{(1+r)^i}.$$

Under the NPV method, the present value (PV) of all cash inflows from the project is compared against the initial investment (I). The Net Present Value (NPV), which is the difference between the present value and the initial investment (NPV = PV-I), determines whether or not the project is an acceptable investment. Under the method, if the net present value is positive (NPV>0 or PV>I), the project should be accepted. NPV has been calculated by using the following relationship:

$$\text{NPV} = (\text{B}_1 - \text{C}_1)/(1+\text{r})^1 + (\text{B}_2 - \text{C}_2)/(1+\text{r})^2 + \ldots\ldots\ldots\ldots + (\text{B}_\text{n} - \text{C}_\text{n})/(1+\text{r})^\text{n}.$$

Internal Rate of Return (IRR) is the rate of interest that equates the initial investment (I) with the present value (PV) of future cash inflows. That is at IRR, I = PV or NPV. Under the internal rate of return method, the decision rule is : accept the project if IRR exceeds the cost of capital; otherwise, reject the proposal. IRR is a discount rate (r) which makes NPV equal to zero (0).

$$or, \quad \sum_{i=1}^{n} \frac{B_i - C_i}{(1+r)^i} = 0.$$

Economic analysis has been carried out in order to confirm economic viability of bridge construction. It is accepted that the project is economically feasible if the calculated IRR is higher than the Opportunity Cost of Capital (OCC) i.e. 12%., BCR is higher than 1.0 and NPV is positive. The basic approach to the economic analysis has been to determine the economic value of the costs and benefits over the entire life of the project. For the economic evaluation of this project, VOC approach is used. Road user costs (RUC) are the costs borne by the people through use of the road network facility. A road infrastructure project involves three types of cost in its useful life. They are construction cost, maintenance cost and road user cost. VOC is the physical costs of operating a vehicle such as fuel, spare parts, depression, crew costs, etc. Travel Time Costs (TTC) also referred to as Values of Time are an important component of road user costs. ACC is the physical costs of an accident measuring the value of injuries and fatalities.

In economics, opportunity cost of capital (OCC) means the next best alternative forgone. In some cases, OCC may be zero if no net-benefit accrues from the next best alternative investment, or may be even less than zero if the next best alternative project gives the negative net benefits. Shadow price (also known as accounting price) is the intrinsic or true value of a factor or product. A UN Report defines shadow price in terms of the opportunity cost of a factor or a product. The shadow price of a factor such as capital, labor or foreign exchange represents its opportunity cost or the loss to the economy that would result from a reduction in its supply by one unit. The sensitivity analysis of the possible effects of adverse changes on a project. Values of key variables are changed one at a time, or in combinations, to assess the extent to which the overall project result, measured by the economic net present value, would be affected. The Standard Conversion Factor (SCF) ratio of the economic price value of all goods in an economy at their border price equivalent values to their domestic market price value. It represents the extent to which border price equivalent values, in general, are lower than domestic market price values. The SCF will generally be less than one. Discounting factors are used to take account of the time value of money (independent of inflation). The values of the costs and benefits have to be calculated for each year of the implementation period and as well as for each year of the analysis period, which is set to be 20 years. Annual Average Daily Traffic (AADT) is the average daily traffic on a roadway link for all days of the week during a period of one year, expressed in vpd (vehicles per day). It is the total volume of vehicle traffic of a road for a year divided by 365 days.

5. Selection of Study Area

Chilmari Upazila of Kurigram District came into existence on the 15th April, 1983. The Upazila occupies an area of 225 sq.km. It is located between $25^0 26'$ and $25^0 40'$ north latitudes and between $89^0 38'$ and $89^0 48'$ east longitudes. The Upazila consists of 6 unions, 48 mouzas and 133 villages. The distribution of population of each union are given in Table 1.

Table 1. Union-wise Population Characteristics of Chilmari Upazila

Sl. No	Name of Union	Area (sq.km)	Households	Population			Literacy Rate (%)	Sex Ratio
				Male	Female	Total		
1	Ashtamirchar	75.01	4077	8681	9020	17701	23.5	96
2	Chilmari	26.94	2024	3418	3484	6902	32.7	98
3	Nayerhat	52.00	2574	5069	5450	10519	24.2	93
4	Ramna	20.89	7188	13684	15045	28729	41.2	91
5	Raniganj	25.83	5405	9705	10808	20513	40.3	90
6	Thanahat	24.37	9698	18857	19620	38477	50.4	96
Total		**225.04**	**30966**	**59414**	**63427**	**122841**	**39.7**	**94**

Source : BBS Community Series, 2012.

According to the population census 2011 the total population of the Upazila is 1,22,841 of which 59,414 are males and 63,427 are females. The sex ratio of the Upazila is 94 males per 1000 females. In the Upazila, there are 30,966 households. It is found that in the Upazila, 91.3% of the dwelling households live in kutcha houses, 2.8% in Jhupri houses, 5.4% in semi-pucca houses and 0.60% in pucca houses. Tubewell is the dominant (96.2%) source of drinking water in the Upazila. In the Upazila, 58.3% households use sanitary latrine. Only 23.3% of the dwelling households have electricity connection. In Chilmari Upazila, 50.52% households do not have agricultural land but 67.85% of the dwelling households depend on agriculture as the main source of household income. Literacy rate for this upazila is 39.7% and poverty level for this upazila is 69% in 2005 and 61% in 2010.

Figure 2. Location of Project Area

6. Results and Discussions

6.1. Construction Cost and Maintenance Cost

The cost of construction is spread over a period of 3 years in the following manner based on annual phasing of the projects implementation. Distribution of Cash Flows in the implementation period is given in Table 2.

Table 2. Distribution of Cash Flows in the Implementation Period

Year	Distribution	Financial (Tk. in Lakh)	Economic (Tk. in Lakh)
2016-2017	20%	5960.00	5066.00
2017-2018	50%	14900.00	12665.00
2018-2019	30%	8940.00	7599.00
Total	**100%**	**29800.00**	**25330.00**

Maintenance cost is spread in the analysis period based on criteria presented in the following Table 3. Routine maintenance are done every year, seal coat in every five years and overlay done in every ten years.

Table 3. Rates for Maintenance Cost (Tk. in million)

Sl No.	Maintenance Type	Cost per Kilometer		Total Cost	
		Financial	Economic	Financial	Economic
1	Routine Maintenance	0.05	0.04	0.10	0.08
2	Seal Coat	1.30	1.11	2.60	2.22
3	Overlay	5.94	5.05	11.88	10.10

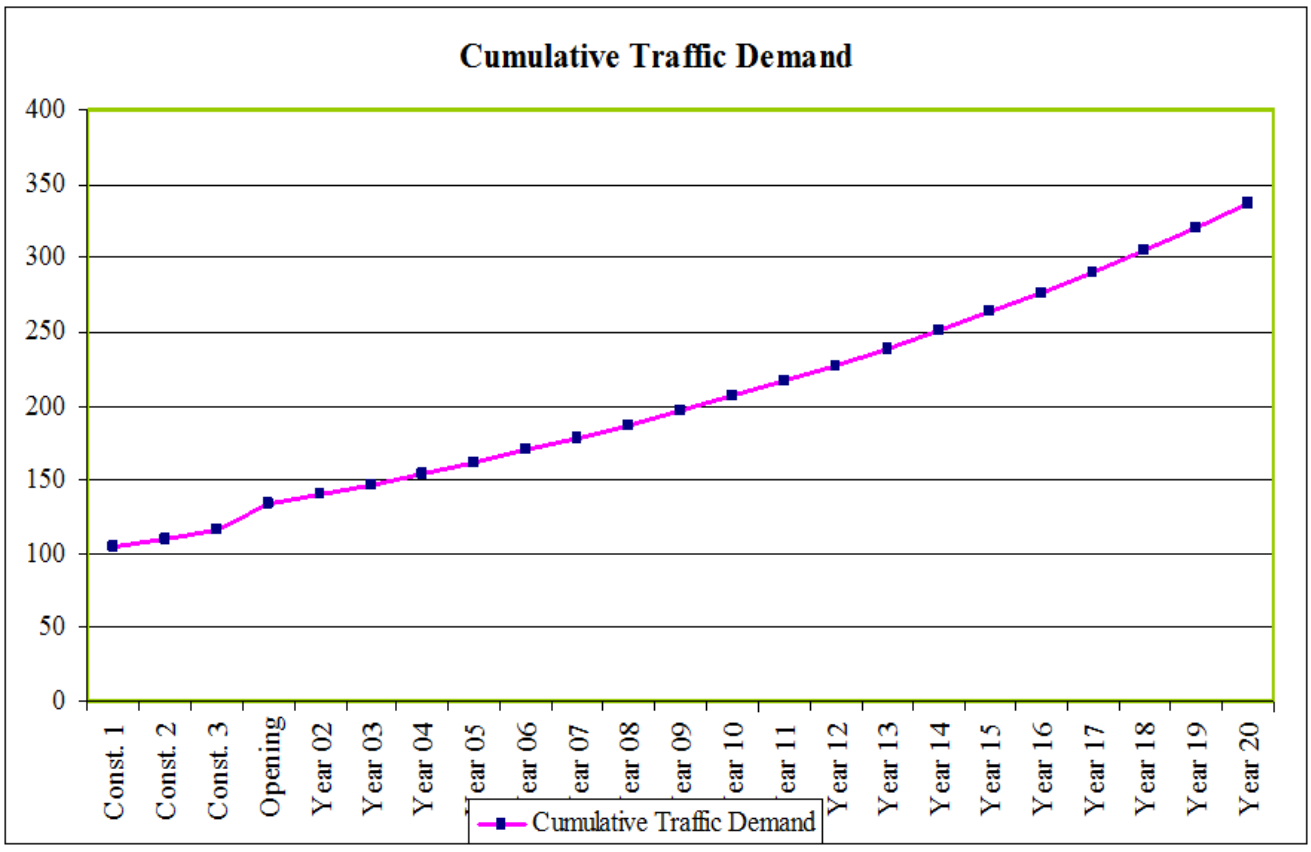

Figure 3. Traffic Projections

6.2. Travel Time Cost

Besides, a new transport link will emerge in the region which will shorten the distance of travel between Chilmari and Sundarganj and also the distance will shorten with 160 km including the connection of Panchpir Bazar to Rangpur Road connection at Shiber Hat Bazar.

6.3. Vehicle Operation Cost

After bridge construction the proposed route will shorten 160 km road distance. The new route will reduce the vehicle operating cost.

6.4. Savings from Boat Service

According to traffic count survey, it is found that on an average 10,000 persons are crossed the proposed bridge site each day. They pay Tk. 10 for Boat Service. Then total amount would be Tk.10 *10,000 Persons * 365 days = Tk. 365 Lakh.

All the above benefits are summarized below:

Sources of benefits		Tk. (Lakh)
a) Travel Time Cost	=	2400.92
b) Vehicle Operating Cost	=	6134.33
c) Savings in costs associated with operation of Boat Service	=	365.00
Total	=	**8900.25**

Table 4. Streaming of Costs and Benefits (Economic)

Year	Construction Cost (Tk. in Lakh)	Maintenance Cost (Tk. in Lakh)	Total Cost (Tk. in Lakh)	Benefit (Tk. in Lakh)
2016-2017	5066.00		5066.00	
2017-2018	12665.00		12665.00	
2018-2019	7599.00		7599.00	
2019-2020		126.65	126.65	8900
2020-2021		126.65	126.65	9345
2021-2022		126.65	126.65	9813
2022-2023		126.65	126.65	10303
2023-2024		253.30	253.30	10818
2024-2025		126.65	126.65	11359
2025-2026		126.65	126.65	11927
2026-2027		126.65	126.65	12524
2027-2028		126.65	126.65	13150
2028-2029		253.30	253.30	13807
2029-2030		126.65	126.65	14498
2030-2031		126.65	126.65	15222
2031-2032		126.65	126.65	15984
2032-2033		126.65	126.65	16783
2033-2034		253.30	253.30	17622
2034-2035		126.65	126.65	18503
2035-2036		126.65	126.65	19428
2036-2037		126.65	126.65	20400
2037-2038		126.65	126.65	21420
2038-2039		253.30	253.30	22490

Table 5. Cost Benefit Analysis (Economic)

Year	Undiscounted		Discount Factor	Discounted		Net Benefits	
	Costs	Benefits		Costs	Benefits	Undiscounted	Discounted
Imple 1	5066.00		0.87	4405.22	0	-5066	-4405
Imple 2	12665.00		0.76	9576.56	0	-12665	-9577
Imple 3	7599.00		0.66	4996.47	0	-7599	-4996
Opening	126.65	8900	0.43	54.75	3848	8774	3793
Year 2	126.65	9345	0.38	47.61	3513	9219	3466
Year 3	126.65	9813	0.33	41.40	3208	9686	3166
Year 4	126.65	10303	0.28	36.00	2929	10176	2893
Year 5	253.30	10818	0.25	62.61	2674	10565	2612
Year 6	126.65	11359	0.21	27.22	2442	11233	2414
Year 7	126.65	11927	0.19	23.67	2229	11801	2206
Year 8	126.65	12524	0.16	20.58	2035	12397	2015
Year 9	126.65	13150	0.14	17.90	1858	13023	1841
Year 10	253.30	13807	0.12	31.13	1697	13554	1666
Year 11	126.65	14498	0.11	13.53	1549	14371	1536
Year 12	126.65	15222	0.09	11.77	1415	15096	1403
Year 13	126.65	15984	0.08	10.23	1292	15857	1281
Year 14	126.65	16783	0.07	8.90	1179	16656	1170
Year 15	253.30	17622	0.06	15.48	1077	17369	1061
Year 16	126.65	18503	0.05	6.73	983	18376	976
Year 17	126.65	19428	0.05	5.85	898	19301	892
Year 18	126.65	20400	0.04	5.09	820	20273	814
Year 19	126.65	21420	0.03	4.42	748	21293	744
Year 20	253.30	22490	0.03	7.69	683	22237	676

Hence the economic indicators stand as BCR is 1.91, NPV is Tk. 17645 Lakh with discount rate 15% and EIRR is 31%.

According to Project Appraisal Framework, Ministry of Planning 2005, the researchers have analyzed the following equity and efficiency indicators and found the respective results.

Broad Objective	Objective	Sub-Objectives	Impact Indicator
Equity	Social and Economic Development (SED)	Pro-poor economic growth (SED 1)	Poor people in the AOI (SED 1A)
			Poor among users (SED 1B)
			Job creation for local people (SED 1C)
		Gender Equity (SED 2)	Women among total users (SED 2A)
			Job creation for women (SED 2B)
	Resettlement (RTM)	Reducing the impact of Resettlement (RTM 1)	Total land take (RTM1A)
			Number of people to be resettled (RTM1B)
Efficiency	Transport Efficiency (TRE)	Economic Efficiency (TRE1)	Economic Internal Rate of Return (EIRR) (TRE1A)
		Reliability (TRE2)	Increase in availability (TRE 2A)
	Funding	Private Sector Finance	Financial Internal Rate of Return (FIRR) (FIA 1A)
	Multi-Modal Integration	Integration	Integration
	Safety	Safety	Accident Reduction

Source : Project Appraisal Framework, 2005.

Table 6. Appraisal Summary Table (AST)

Broad Objective	Impact Indicator	Quantitative Assessment (Basic Score)	Scaled Score	Weight	Weighted score
Equity	Poor people in the AOI (SED1A)	Poor people in the AOI (%)	6.59	1.00	6.59
	Poor people among users (SED1B)	Poor people among users (%)	6.78	0.60	4.07
	Job creation for local people (SED1C)	Job creation for local people	9.00	0.60	5.40
	Women among total users (SED2A)	% of Women among total users	6.55	0.50	3.28
	Job created for women (SED2B)	% of Job created for women	9.00	0.50	4.50
	Total land take (RTM1A)	Amount of land take over project cost	8.99	1.00	8.99
	Number of people to be resettled (RTM1B)	Number of people to be resettled	7.32	0.80	5.85
Efficiency	Economic Internal Rate of Return (TRE1A)	EIRR (%)	10.00	3.00	30.00
	Increase in Availability (TRE2A)	Increased availability (Days)	0.00	1.00	0.00
	Financial Internal Rate of Return (FIA1A)	FIRR (%)	12.00	1.00	12.00
	Integration	N/A		-	
	Accident Reduction	N/A		-	
Total				**10.00**	**80.67**

Total weight of the equity indicators is 5.0 and total weight of efficiency indicators is 5.0.

7. Conclusions and Recommendations

From Focus Group Discussion, it is conceived that people of the Bridge areas strongly supported construction of Bridge as they perceived that the Bridge has a positive impact on socio-economic condition by changing existing communication system through construction of the proposed bridge. It is broadly supported all classes people and stakeholders of Bridge area. There is no opposition to the proposed Bridge. All the villagers (100%) are interested to implement the Bridge project successfully. The bridge will provide significant travel time savings to the traffic in the region, particularly between Rangpur to the northwest of Bangladesh. The construction and operation of the bridge will result in significant economic benefits to the north-west region, in the form of increased production, goods and services, relocation and generation of new economic activities. Increased economic activity and consumption expenditure will lead to poverty alleviation in Rangpur region. Short-time employment generation will help the rural poor and help alleviate poverty.

Considering the level of score of the project (75.36) the project appears to be very good project. As seen in the appraisal summary table the project is very good in terms of efficiency as well as equity. Efficiency score is 41.50 while equity score is 33.86. The Project performed quite well in cost benefit analysis (BCR 1.58). It also seems to have good impact on environment creation because it is hoped to employ significant percent of local people. The project however did not have any prospect of attracting private sector investment. The reasons are primarily socio-economic. Arrangement for getting financial return would have adverse impact on the economic objectives of the project significant. On the multi-modal integration issue the project will have good impact in integration water transport network with road transport network. Currently the safety aspect of the road is very poor. If the project is implemented, the number of accidents will be significantly reduced.

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