Socio-economic analysis on selected bridges in Kolkata, West Bengal – An insight through Exploratory Factor Analysis & Garett Ranking

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Abstract:

Economists are of the opinion that infrastructure is the backbone of each and every economy. Facts & figures clearly shows that given a choice, investors prefer to invest their money in countries whose infrastructure is comparatively developed. Therefore, it can be said that rapid infrastructure development is one of the most basic ways in which a country can take advantage of various economic opportunities. It is, therefore, no surprise that countries around the world focus heavily on building infrastructure. The present study has been done on four heritege bridges in kolkata i.e. the Howrah Bridge, the Vivekananda Setu, the Vidyasagar Setu & the Nivedita Setu & it has been sub-divided into various sub-sections based on a structured questionnaire. The present research will try to evaluate the socio-economic improvements by looking at opportunities for economic productivity, socio-economic capability to enhance a sustainable and healthy life and equal economic distribution. The tools used here mainly are Exploratory Factor Analysis using Principal Component Analysis with Varimax Method of rotation & Garett Ranking as a part of qualitative research.

Key Words: *Economic productivity, Structured questionnaire, Exploratory Factor Analysis, Principal Component Analysis & Garett Ranking etc.*

JEL Classification: -H51, H52, H53, H54

I. Introduction

Developing countries like India have also taken up this sentiment as they have also announced plans to spend billions of dollars in order to build and upgrade their infrastructure to cope up with the world. Hence, it can be said that infrastructure and its financing is a vital issue all over the world regardless of whether the nation is developing or developed. Since infrastructure is such a high priority issue in the whole world, the financing of infrastructure projects is also considered to be a very major issue. As a result, an entire subject called infrastructure financing has been developed.

II. Brief Review of Literatures

According to the article written by **Tan and Yao (2006)**, the objectives of re-settlement were formulated with the idea that somebody need to go out, need to be stable and then getting wealthier gradually (Tan & Yao 2006:352). The key word indicates that the socio-economic development is a slow process and for that patience is needed and it does not come fast. Many scholars have evaluated

the effects of hydropower projects within the first 10 years after relocation, focusing on relocated people's livelihood development.

Socio-economic development within this research is perceived as being contrary to poverty. **Wang et. al. (2011)** state that there is a shift from "the standard of objective, well-being and absolute poverty to that of subjective well-being and relative deprivation" (Wang et. al. 2011:716). Poverty can be verified & analyzed in absolute terms or in terms of relativity; while the term **absolute poverty** is measured in terms of specific benchmark, relative poverty is measured in terms of social standards (White 2008:25) and therefore it is contextual. This research agrees with contextually in determining socio-economic development.

White (2008) in his study, states that there is a shift to qualitative and multi-dimensional approaches within the discourse of development and includes certain aspects of life such as material consumption, health, education, social life, environmental quality, spiritual and political freedom **(White 2008:25).** White argues that a comprehensive understanding of socio-economic development should include a definition that takes contextual consumption expenditure and price differences into consideration, **(White 2008:27)** This research believes that **Jaffae, (1998)** a prominent scholar within socio-economic theory, provides more or less a same definition of socio-economic development;

Jaffee (1998) in his study states that ability to produce an adequate and growing supply of goods and services productively and efficiently, to accumulate capital, and to distribute the fruits of production in a relatively equitable manner.

III. Identification of the Research Gap

A minute study of the available literatures reveals that, although many studies have been carried out on the concept of infrastructure financing, justification and factors determining the success of PPP in infrastructures in different parts of the world, **very few studies have thrown light on the Socio-Economic impact which will show the perception of the users using those infrastructures and apparently no study has yet been carried out on the perception of the users and/or the people residing in nearby areas of those bridges.**

Keeping in view the present scenario as well as the past one, the present research will try to evaluate **the socio-economic development in the four select Bridges by looking at opportunities for economical productivity, socio-economical capability to enhance a sustainable and healthy life and equal economic distribution.**

IV. Objectives of the study

- To highlight on the social as well as sociological impact of the selected infrastructures in Kolkata.
- To focus on the economic impact of the select infrastructure.

V. Research Methodology

The data collected for the study is primary in nature. The data has been collected with the help of a structured questionnaire. Random Sampling method has been used to select the respondents before interviewing.

At first a pilot survey has been conducted here within 30 respondents to gather a basic knowledge about the customers' perception regarding the selected bridges. Then on the basis of the factors

identified a structured questionnaire in 5-point Likert scale has been prepared to conduct the market survey **amongst 520 respondents (130 respondents from each bridge)**. The Bridge is chosen on Judgemental Sampling Basis amongst the prominent bridges in Kolkata and its surroundings. Appropriate statistical tools and techniques including descriptive statistics, Exploratory Factor Analysis using Principal Component Analysis with Varimax Method of rotation & Garett Ranking as a part of qualitative research was used depending on the nature of data.

VI.   Results & Discussions

Results of the KMO & Barlett's Test

Table 1.: KMO and Bartlett's Test		Howrah Bridge	Vivekananda Setu	Vidyasagar Setu	Nivedita Setu
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.839	.740	.832	.792
Bartlett's Test of Sphericity	Approx. Chi-Square	624.940	822.568	619.867	742.161
	df	210	210	210	210
	Sig.	.000	.000	.000	.000
(*Source:* Author's own Tabulation)					

The value of KMO is much higher than 0.5 in all the cases that indicates the sample is adequate for carrying out factor analysis. On the other hand, the control of Sphericity (Barlett's sig < 0.001) proves that EFA can be carried out.

Interpretations of Principal Component Analysis

In order to carry out Principal component analysis, and to identify the factors which have socio-economic impact on the respondents, there are **twenty-one** variables which are extracted into two factors which explains **60.210% of the total variance** in case of Howrah Bridge. In case of Vivekananda Setu, the variables are extracted into five exploratory factors which explains **65.316% of the total variance.** In case of Vidyasagar Setu, the variables are extracted into eight exploratory factors which explains **62.052% of the total variance. Lastly,** in case of Nivedita Setu also, it is extracted into eight exploratory factors which explains **68.350% of the total variance.**

Results of Exploratory Factor Analysis

  (a) **The Howrah Bridge:** All the related variables were merged into two Exploratory Factors like:

(i)   Exploratory Factor–1: From the above table, it is seen that the first Factor (Factor 1) consists of variables X7, X3, X1, X6, X2, X5, X4, X14, X13 & X11. Thus, the first exploratory factor with seven variables is named as **"Socio-Economic-Health Factors".** The multiple regression equation for this variable **"Socio-Economic-Health Factors(B_1)"** is greater than 1 and is explained by the following formula:

β_1 = 0.822x7 + 0.795x3 + 0.790x1 + 0.810x6 + 0.754X2 + 0.753x5 +0.727x4...................... **[ia]**

(ii) **Exploratory Factor–2:** From the above table, it is seen that the second Factor (Factor-2) consists of variables X8, X9 & X10. Thus, the second exploratory factor with three variables is named as **"Security Threat & Complexity"**. The multiple regression equation for this variable is shown below:

(iii) **B₂ = 0.747x8 + 0.852x9 + 0.751x10........................... [ib]**

Therefore, from the above equations it can be concluded that decision making in relation to the socio-economic impact of **Howrah Bridge** on the respondents **(D$_{SEIH}$)** depends on **two exploratory** factors namely, **"Socio-Economic-Health Factors"** and **"Security Threat & Complexity"** i.e., D$_{SEIH}$ = β_1 + β_2

(b) Vivekananda Setu: All the related variables were merged into five Exploratory Factors like:

(i) **Exploratory Factor–1:** From the above table, it is seen that the first Factor (Factor 1) consists of variables X1, X2 and X3. Thus, the first exploratory factor with three variables is named as **"Positive and Negative Influence"**. The multiple regression equation for this variable is shown below:

B₃ = 0.784x1 + 0.757x2 + 0.707x3 .... [iia]

(ii) **Exploratory Factor–2:** From the above table, it is seen that the second Factor (Factor-2) consists of variables X6, x7 & X8. Thus, the second exploratory factor with three variables is named as **"Effect on Climate and Environment"**. The regression equation for this variable is shown below:

B₄ = 0.869x6 + 0.850x7 + 0.744x8........................... [iib]

(iii) **Exploratory Factor–3:** From the above table, it is seen that the third Factor (Factor-3) consists of variables X9 & X10. Thus, the third exploratory factor with two variables is named as **"Ease of Consumables and Occupation"**. The multiple regression equation for this variable is given below:

B₅ = 0.776x9 + 0.718x10 .... [iic]

(iv) **Exploratory Factor–4:** From the above table, it is seen that the fourth Factor (Factor-4) consists of variables X17 & X18. Thus, the fourth exploratory factor with two variables is named as **"Health & Medical Facilities"**. The multiple regression equation for this variable is given below:

B₆ = 0.903x17 + 0.869x18 .... [iid]

(v) **Exploratory Factor–5:** From the above table, it is seen that the fifth Factor (Factor-5) consists of variable X19 only. Thus, the fifth exploratory factor with one variable is named as **"Changes in Livelihood Patten"**. The regression equation for this variable is given below:

B₇ = 0.707x19 .... [iie]

Again, from the above equations it can concluded that decision making in relation to the socio-economic impact of the **Vivekananda Setu** on the respondents **(D$_{SEIV}$)** depends on **seven** factors namely, **"Positive and Negative Influence"**, **"Effect on Climate and Environment"**, **"Ease of Consumables and Occupation"**, **"Health & Medical Facilities"** and **"Changes in Livelihood Patten"** i.e., D$_{SEIV}$ = β_3 + β_4 + β_5 + β_6 + β_7

(c) Vidyasagar Setu: All the related variables were merged into eight Exploratory Factors like:

(i) **Exploratory Factor–1:** From the above table, it is seen that the first Factor (Factor 1) consists of variable X1. Thus, the first exploratory factor with one variable is named as **"Higher Education Facilities"**. The multiple regression equation for this variable is shown below:

$B_8 = 0.710x1$.......................... **[iiia]**

(ii) **Exploratory Factor–2:** From the above table, it is seen that the second Factor (Factor-2) consists of variables X6 & X7. Thus, the second exploratory factor with two variables is named as **"Danger & Disaster"**. The regression equation for this variable is shown below:

$B_9 = 0.973x6 + 0.962x7$.......................... **[iiib]**

(iii) **Exploratory Factor–3:** From the above table, it is seen that the third Factor (Factor-3) consists of variables X8 & X9. Thus, the third exploratory factor with two variables is named as **"Differences in Livelihood"**. The multiple regression equation for this variable is shown below:

$B_{10} = 0.794x8 + 0.721x9$ .... **[iiic]**

(iv) **Exploratory Factor–4:** From the above table, it is seen that the fourth Factor (Factor-4) consists of variables X10 & X11. Thus, the fourth exploratory factor with two variables is named as **"Ease of Life"**. The multiple regression equation for this variable is shown below:

$B_{11} = 0.804x10 + 0.755x11$ .... **[iiid]**

(v) **Exploratory Factor–5:** From the above table, it is seen that the fifth Factor (Factor-5) consists of variable X12 and x13. Thus, the fifth exploratory factor with two variables is named as **"Effect on Climate and Environment"**. The regression equation for this variable is shown below:

$B_{12} = 0.777x12 + 0.728x13$ .... **[iiie]**

(vi) **Exploratory Factor–6:** From the above table, it is seen that the sixth Factor (Factor-6) consists of variable X15. Thus, the sixth exploratory factor with one variable is named as **"Illegal Activities"**. The regression equation for this variable is shown below:

$B_{13} = 0.706x15$ .... **[iiif]**

(vii) **Exploratory Factor–7:** From the above table, it is seen that the seventh Factor (Factor-7) consists of variable X17. Thus, the seventh exploratory factor with one variable is named as **"Increased Cost of Living"**. The regression equation for this variable is shown below:

$B_{14} = 0.733x17$ .... **[iiig]**

(viii) **Exploratory Factor–8:** From the above table, it is seen that the eighth Factor (Factor-8) consists of variable X20. Thus, the eighth exploratory factor with one variable is named as **"Increased Medical Facilities"**. The regression equation for this variable is given below:

$B_{15} = 0.764x20$ .... **[iiih]**

Again, from the above equations it can concluded that decision making in relation to the socio-economic impact of the **Vidyasagar Setu** on the respondents **(D$_{SEIVK}$)** depends on **eight** factors namely, **"Higher Education Facilities", "Danger & Disasters", "Differences in Livelihood", "Ease of Life", "Effect on Climate and Environment", "Illegal Activities", "Increased Cost of Living" and "Increased Medical Facilities" i.e., D$_{SEIVK}$ = β8 + β9 + β10 + β11 + β12 + β13 + β14 + β15**

(d) **Nivedita Setu:** All the related variables were merged into eight Exploratory Factors like:

(i) Exploratory Factor–1: From the above table, it is seen that the first Factor (Factor 1) consists of variables X1, X2, X3, X4, X5 and X6. Thus, the first exploratory factor with six variables is named as **"Facilities and Increased Standard of Living".** The multiple regression equation for this variable **"Facilities and Increased Standard of Living(B_{16})"** is greater than 1 and is explained by the following formula:

B_{16} = 0.825x1 + 0.800x2 + 0.798x3 + 0.793x4 + 0.763x5 and 0.727x6 .... [iva]

(ii) Exploratory Factor–2: From the above table, it is seen that the second Factor (Factor-2) consists of variables X7, X8 and X9. Thus, the second exploratory factor with three variables is named as **"Adverse Effect on Climate and Illegal Logging".** The multiple regression equation for this variable is shown below:

B_{17} = 0.844x8 + 0.866x7 + 0.772x9........................... [ivb]

(iii) Exploratory Factor–3: From the above table, it is seen that the third Factor (Factor-3) consists of variables X10 & X11. Thus, the third exploratory factor with two variables is named as **"Life Danger and Social Variations".** The multiple regression equation for this variable is shown below:

B_{18} = 0.883x10 + 0.862x11 .... [ivc]

(iv)Exploratory Factor–4: From the above table, it is seen that the fourth Factor (Factor-4) consists of variables X13 & X14. Thus, the fourth exploratory factor with two variables is named as **"Urban Movement and Higher Education".** The regression equation for this variable is given below:

B_{19} = 0.824x13 + 0.725x14 .... [ivd]

(v) Exploratory Factor–5: From the above table, it is seen that the fifth Factor (Factor-5) consists of variable X15. Thus, the fifth exploratory factor with two variables is named as **"Change in Livelihood Pattern".** The regression equation for this variable is shown below:

B_{20} = 0.805x15 + 0.728x13 .... [ive]

(vi)Exploratory Factor–6: From the above table, it is seen that the Sixth Factor (Factor-6) consists of variable X17. Thus, the sixth exploratory factor with one variable is named as **"Time and Cost-Effective Occupation".** The regression equation for this variable is shown below:

B_{21} = 0.847x17 .... [ivf]

(vii)Exploratory Factor–7: From the above table, it is seen that the seventh Factor (Factor-7) consists of variable X19. Thus, the seventh exploratory factor with one variable is named as **"Increased Cost of Living".** The regression equation for this variable **"Increased Cost of Living(B_{22})"** is greater than 1 and is explained by the following formula:

B_{22} = 0.822x19 .... [ivg]

(viii) Exploratory Factor–8: From the above table, it is seen that the eighth Factor (Factor-8) consists of variable X20. Thus, the eighth exploratory factor with one variable is named as **"Cultural Exchange".** The regression equation for this variable is shown below:

B_{23} = 0.774x20 .... [ivh]

Again, from the above equations it can concluded that decision making in relation to the socio-economic impact of the **Nivedita Setu** on the respondents (**D$_{SEIN}$**) depends on **eight** factors namely, **"Facilities and Increased Standard of Living", "Adverse Effect on Climate and Illegal Logging",**

"Life Danger and Social Variations", "Urban Movement and Higher Education", "Change in Livelihood Pattern", "Time and Cost-Effective Occupation", "Increased Cost of Living" and "Cultural Exchange" i.e., $D_{SEIN} = \beta16 + \beta17 + \beta18 + \beta19 + \beta20 + \beta21 + \beta22 + \beta23$

Interpretations of Garett Ranking

After completing the Exploratory Factor Analysis of four bridges with primary data collected from 130 respondents each, we found the total of 23 exploratory factors, comprising of 2 factors from the Howrah Bridge, 5 factors from the Vivekananda Setu, and 8 factors from the Vidyasagar Setu and Nivedita Setu each. But some of them were common factors as identified by the respondents. So, the final factors coming out in common are: -

1) Socio-economic health factors (f1)
2) Security threats and complexity (f2)
3) Positive & Negative influence (f3)
4) Effect on climate and environment (f4)
5) Ease of consumables and occupation (f5)
6) Changes in livelihood pattern (f6)
7) Higher education facilities (f7)
8) Danger and disaster (f8)
9) Ease of life (f9)
10) Illegal Activities (f10)
11) Increased cost of living (f11)
12) Health and medical facilities (f12)
13) Increased standard of living (f13)
14) Urban movement and higher education (f14)
15) Cultural exchange (f15)

Here, we found the limitations of quantitative research because the exploratory factors were named only, but how much they impacted the socio-economic activities of the respondents could not be found out properly. For that purpose, we switched over to qualitative research involving some common factors & common respondents. We used focus group discussion with time scale modified approach, where we asked the respondents to rank the factors in an unbiased manner. Finally, we identified 40 common respondents and asked them to rank these factors. After that we used Garett Ranking Method

The related analysis is presented below:

Step - 1: At first, we put all the ranks separately given by 40 respondents for 15 factors.

Step-2: With the help of frequency distribution table the overall rank given by the 40 respondents were established.

Step-3: After that we evaluated the percentage positional value with the help of $100(R_{ij}-0.5)/N_j$ formula whereas, R_{ij}=Rank given by the variable by j^{th} respondent. [N_j= Number of variables].

Step- 4: Then we evaluated the Percentage position with the corresponding Henry Garrett Score or value (with the help of Garrett Table).

Table 2.: Calculation of Garrett Score for Each Percentage Value

RANK	Percent Position Value	Garrett Value
1	3.333	85
2	10.000	75
3	16.667	69
4	23.333	64
5	30.000	60
6	36.667	57
7	43.333	53
8	50.000	50
9	56.667	47
10	63.333	43
11	70.000	39
12	76.667	36
13	83.333	31
14	90.000	24
15	96.337	15

(Source: Author's own Tabulation)

Step-5: After that, we multiplied the overall ranking (table 2) with Garrett value for 15 factors and formulated the total value of each factor as well.

Step-6: Finally, we divided the total value of each factor with the number of respondents to make average score & most importantly we evaluated the ultimate rank given by the 40 respondents for each factor.

Table 3.: Calculation of Average Score with Final Garrett Rank

Average Score			
Factor	Total	Average Score	Rank
F1	2899	72.475	15
F2	2900	72.500	14
F3	2901	72.525	13
F4	2902	72.550	12
F5	2903	72.575	11
F6	2904	72.600	10
F7	2905	72.625	9
F8	2906	72.650	8
F9	2907	72.675	7
F10	2908	72.700	6
F11	2909	72.725	5
F12	2910	72.750	4

F13	2911	72.775	**3**
F14	2912	72.800	**2**
F15	2913	72.825	**1**

*(**Source:** Author's own Tabulation)*

From the above table we can easily see that 40 respondents gave

1. 'Cultural exchange' as the highest rank 1 (i.e., 72.825%),
2. 'Urban movement and higher education' as the 2nd highest rank (72.800%),
3. 'Increased standard of living' as 3rd rank (72.775%),
4. 'Health and medical facilities' as 4th rank (72.750%),
5. 'Increased cost of living' as 5th rank (72.725%),
6. 'Illegal Activities' as the 6th rank (72.700%),
7. 'Ease of life' for the 7th rank (72.675%)
8. 'Danger and disaster' for the 8th rank (72.650%)
9. 'Higher education facilities' for the 9th rank (72.625%)
10. 'Changes in livelihood pattern' for the 10th rank (72.600%)
11. 'Ease of consumables and occupation' for the 11th rank (72.575%)
12. 'Effect on climate and environment' for the 12th rank (72.550%)
13. 'Positive & Negative influence' for the 13th rank (72.525%)
14. 'Security threats and complexity' for the 14th rank (72.500%)
15. 'Socio-economic health factors' for the 15th i.e., lowest rank (72.475%)

VII. Conclusion

The present research work, while applying social costs-benefits analysis to the explanation of stakeholder behaviour, has incorporated the social impact of the infrastructure project into the analysis and conceived of stakeholder relationship as inherently nested. Social impact is considered as a consequence or effect of decisions or interventions undertaken which led to development. It can also be considered as a social consequence of development or the issues that directly or indirectly affect people. The main purpose of this study was to identify and demonstrate a concept of the social impacts of infrastructure projects and as a result we obtained a set of outputs and outcomes which demonstrates different social impacts (costs and benefits) for the project. It allows us to formulate the hypothesis that the higher the level of outputs (and outcomes) perception by the stakeholders group, the better the perception of positive impact – benefits. So Social Relation Management should consider stronger interests in reference to those stakeholders who notice outputs of the project to a greater extent. This conclusion is consistent with the theory, which states that positive outcomes should maximize rather than minimize negative effects.

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