

RESEARCH ARTICLE

The impact of sustainable infrastructure development in the sector of environment, livelihood, access and ownership in Nepal

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ABSTRACT

Sustainable infrastructure is new building and refurbishment that promotes environmental, social and economic gains now and for the future. The attitude of the people plays a vital role to implement the sustainable infrastructure developmental activities which is directly related to the environmental, socioeconomic, ownership, livelihood and sustainability aspects of the project area. The development of sustainable infrastructure in the contest of Nepal is a sweet slogan but the implementation part is very weak. This study proved that the impact due to sustainable infrastructure development activities is insignificant. The players of infrastructure industry as well as environmental activist have to play vital role to convert the sweet slogan in reality.

Key words: Sustainability, sustainable development, sustainable infrastructure, road and bridge infrastructure, labor based technology, stakeholders, sustainability approaches.

INTRODUCTION

Sustainable infrastructure development is generally used to describe the application of sustainable development to the construction industry. The construction industry is defined as all who produce, develop, plan, design, build, alter, or maintain the built environment, and includes building material suppliers and manufacturers as well as clients, end users and occupiers. Therefore, sustainable infrastructure development could be best described as a subset of sustainable development, which encircles matters such as tendering, site planning and organization, material selection, recycling, and waste minimization (Ding, 2001).

There are six principles for the sustainable infrastructure development (Miyatake, 1996):

- Minimization of resource consumption;
- Maximization of resource reuse;
- Use renewable and recyclable resources;
- Protect the natural environment;
- Create a healthy and non-toxic environment; and
- Pursue quality in creating the built environment.

Three ways by which the civil engineering and construction industry can act to realize sustainable infrastructure development are creating built environments, restoring damaged and/or polluted environments; and improving arid environments (Miyatake, 1996).

With specific reference to the construction industry covering both buildings and civil engineering works, the Agenda 21 provides the following description of sustainable construction: *Sustainable construction means that the principles of sustainable development are applied to the comprehensive construction cycle from the extraction and beneficiation of raw materials, through planning, design and construction of buildings and infrastructures, until their final deconstruction and management of the resultant waste. It is a holistic process aiming to restore and maintain harmony between the natural and built environment, while creating settlements that affirm human dignity and economic equity.*

The development of infrastructure is one of the main drivers of growth in an economy (UN-ESCAP, 2007). Its development, which is involved with large-scale and long-term construction, has a direct impact on a nation's well-being by providing infrastructures essential for daily living such as roads and bridges, rails, water, electrical supply and telecommunications. Indeed, the infrastructure industry is often considered the backbone of a country's economy. Therefore, its continued development is critical to sustain the economy, cater for increased population and enhance the general prosperity of a nation.

Sustainable infrastructure is new building and refurbishment that promotes environmental, social and economic gains now and for the future (Shelbourne, 2006). This, within the broader concept of Sustainable Development, is about creating a better quality of life for everyone, now and generations to come. It means recognizing that our economy, environment and social well-being are interdependent.

The attitude of the people plays a vital role to implement the sustainable infrastructure developmental activities. The position of the people in this matter should be identified and some plans and programs should be developed from the bottom to uplift their position in this matter. People's participation is the major part to make every program successful. It takes a long time to see the result of sustainability; people want to see the quick result. In this situation the awareness on the people should be

major activity of each and every institution which is dedicated to sustainable infrastructure development.

Engineers Australia (2005) contends that an infrastructure is sustainable if it meets environmental sustainability (eg. reducing greenhouse emissions, lowering pollutant levels in storm-water and effluent discharge into rivers and oceans). Resources are limited and need to be managed: through conservation, reuse and renewable strategies; through social sustainability (eg. reducing commuter times, increasing road safety, improving air quality and providing access to broadband communication to all citizens); and through economic sustainability (eg. ensuring that taxation and regulatory systems promote new private sector investment in all infrastructure capable of generating adequate returns of investment).

Parkin (2000), define sustainable construction as a construction process which is carried out by incorporating the basic objectives of sustainable development. The Government Construction Clients' Panel (GCCP, 2000) Sustainable Construction Action Group (2000) describes sustainable construction as the set of processes by which a profitable and competitive industry delivers built assets (buildings, structures, supporting infrastructure and their immediate surroundings which: (i) enhance the quality of life and offer customer satisfaction, (ii) offer flexibility and the potential to cater for user changes in the future, (iii) provide and support desirable natural and social environments and (iv) maximize the efficient use of resources.

Nepal possesses a rich diversity in flora, fauna and ecosystems. This diversity is a reflection of Nepal's unique geographical position and variations in altitude and climate. The extreme altitudinal gradient, from 60 meters above sea level in the South-Eastern Terai, to 8,848 meters at Mt. Sagarmatha (Mt. Everest), the highest point in the world, has resulted in the appearance of eleven bio-climatic zones ranging from tropical to subalpine and alpine climates within very short distances. There are several inner Himalayan valleys with desert conditions, such as the upper Kaligandaki and Bheri valleys located at altitudes above 3,600 meters. Nepal has an extensive river system with water resources that hold tremendous potential for large scale hydropower and irrigation development. However, Nepal is also highly vulnerable to natural disasters including earthquakes because the northward movement of the Indian plate is approximately perpendicular to the Himalayan collision belt. Studies

over the past 40 years indicate that this movement is exerting a compressive stress in some transverse faults in the region, heightening the risk of a major earthquake in the near future (UNESCO, 2013).

The building and construction industry engages in three broad areas of activity (ABS, 2009):

- Residential building (houses, flats, etc.)
- Non-residential building (offices, shops, hotels, etc.) and
- Engineering construction (roads, bridges, water and sewerage, etc.).

The building and construction activity is undertaken by both the private and public sectors in Nepal. While the private sector is engaged in Residential building construction, the public sector plays a key role in initiating and undertaking engineering construction activity, and building activity relating to health and education. In the Nepalese Constitution, infrastructure, public works and main roads and bridges are the responsibility of the states.

In Nepal, economic growth has long been emphasized as a core element of its development strategy. Despite sustainable efforts to build the development of infrastructure to stimulate economic growth, but still the country is in a vicious cycle of poverty and underdevelopment. Land use has been changing rapidly in Nepal to meet increasing demands for shelter, food, fuel wood and security. Now it is dire need to have the national sustainable building strategy. The following objectives are somehow useful for the coming years as follows are:

- Satisfy the basic building materials, technologies and socio-cultural needs of the people of Nepal, of both the present and future generation.
- Ensure the sustainable use of Nepal's land and renewable resources.
- Maintain the essential ecological and life support systems and process such as building material regeneration, material recycling and promotion of alternative energies; energy saving and protection and cleansing water and air.

The strategy is therefore based on sustainable building principles, which reflect the real value of the building technologies expressed in terms of human needs (Thapa, 2003, p. 4).

Sustainability can be achieved as long as some very basic issues are examined, developed and implemented.

Prior to the modernist movement, the majority of planners, architects, engineers, artisans etc had a national understanding of relationship between the built form and the natural environment. To achieve sustainability, smooth amalgamations of traditional practices and modern technologies can be developed and implemented (Thapa, 2003, p. 6). The objective of this study is the identification of impact on environment, livelihood, access and ownership in the infrastructure development, by:

- Identifying the elements on environment, livelihood, access and ownership in the infrastructure development.
- Conducting surveys and discussions with related stakeholders to identify the related impacts.

The alternative hypothesis used in this study was: "*There is positive impact from sustainable infrastructure development in the sector of environment, livelihood, access and ownership in infrastructure development and maintenance in Nepal.*" It is recognized that the rural infrastructure development often causes challenges in the pursuit of sustainability goals at the project level. These challenges need to be ascertained so that measures can be taken to address them. In this way also, the understanding of the gap between sustainability and their actual realization at the project end level can be enhanced to peruse environment, livelihood, access and ownership.

MATERIALS AND METHODS

Only by use of appropriate methodologies and method of research, applied with rigor, can the body of knowledge for construction be established and advanced with confidence (Fellow & Liu, 1997). Therefore, each element in the research the theoretical and conceptual framework guiding the study, sample characteristics, data collection approaches and procedures, and the analysis and interpretation of data is equally important in the overall plan for the conduct of the study. A well organized research methodology that follows logically form the specific aims and demonstrates the integration of each these aims throughout the research plan is crucial component of successful application.

The methodology used for this study was questionnaire survey. The main objective of the questionnaire survey was to address the critical sustainability approaches by identifying the best practices in the real projects in Nepal, which covers the projects of snowy mountain (Himali) region, Mountain region and plain (Tarai)

region. Almost data was primarily quantitative as the research, at this phase, sought to understand the measures taken and processes involved at project level to address sustainable infrastructure development.

The fact that the desired investigation required a close understanding of what was happening at project level, and had to rely on the interpretation of data (by collecting information from, and experiencing, the project environment) made this investigation not only suited to a quantitative approach, which requires structured and standardized quantities. Furthermore, the identification of good practice at the project required the more mature lines of enquiry provided by the qualitative approach. A questionnaire survey is one of the most cost effective ways to involve a large number of people in the process in order to achieve better results, as recommended by McQueen and Knussen (2002). Pilot survey and Cronbach's Alpha test of questionnaire were also done during this study.

Data Analysis and Presentations

The purpose of this survey is to investigate the impact on environment, livelihood, access and ownership in the infrastructure development and find the perspectives of clients and users towards these impacts. The questionnaire survey was conducted in 3 regions of Nepal (Himal, Mountain and Tarai) with 5 rural bridge projects. Eastern, Central and Western part of Nepal was also covered by the survey. Table 1 gives the overlook of the survey area of Nepal. The study covered all region and locations of the nation, so that the survey is reliable and credible.

RESULTS AND DISCUSSION

Basic factual data was collected relating to the respondents personally with the clients and users of bridges. This data is presented in this section. The size

of the response across available response categories is indicated in both percentage (%) and raw numeric terms. Table 2 indicates most respondents (85 %) are from users' side, 15 % are from clients.

The percentage of male and female respondents is 71 % and 29 % respectively. As the regional basis the respondent percentage of Himal, Mountain and Tarai are 27 %, 33 % and 40 % respectively. The total number of respondents was 299. Among them 81 from Himal, 100 from Mountain and 118 from Tarai and 44 clients and 255 users were taking part in this study. As the type and regional basis of the respondents is quite respectable, opinions and views obtained through the survey can be regarded as important and reliable. Majority of respondents had reasonable experience in respective bridge construction which further shows that respondents are sufficiently experienced enough to provide data which are credible. The survey was conducted in five districts which represent all the 3 geographical regions of Nepal (Table 3).

In Tarai Region the District was Bankey, in Mountain Region the Districts were Panchthar and Illam, and in Himali Region the Districts were Rasuwa and Solukhumbu. The Districts covers Eastern, Central and Western part of Nepal also. The female participation (29%) is encouraged. Tarai, Mountain and Himali participation 40%, 33% and 27% is according to population distribution. The distribution of sample is homogeneous and representative so that the outputs are reliable.

The responding clients and users indicated that the project was aware of the impact on environment, livelihood, access and ownership in the infrastructure development. Many components were measured to find out these impacts: Maximum utilization of local skilled manpower with further skill trainings (Table 4) and Use of locally available construction materials (Table 5) were highly significant.

Table 1 : Questionnaire survey locations and respective bridge projects

S.N.	Districts	Region	Name of the Project	Area	Remarks
1	Bankey	Tarai	Duduwa Nala Bridge	Western	
2	Rasuwa	Himali	Bhote Koshi Bridge	Central	
3	Solukhumbu	Himali	Solu Khola Bridge	Central	
4	Illam	Mountain	Karphok Khola Bridge	Eastern	
5	Panchthar	Mountain	Nibu (Siwa) Khola Bridge	Eastern	

Sources: Field study, 2013

Table 2 : Number of Respondents according to their type and regional basis

Region	Respondent Type				Total (299)		
	Clients (44)		Users (255)		M	F	%
	M	F	M	F			
Himali	5	1	48	27	53	28	27
Mountain	19	-	65	16	84	16	33
Tarai	16	3	59	40	75	43	40
Total	40	4	172	83	212	87	100
%	15		85		71	29	

Respondent Type	Region			Total
	Himal	Mountain	Tarai	
Client	6	19	19	44
Users	75	81	99	255
Total	81	100	118	299
%	27	33	40	100

Sources: Field study, 2013

Table 3: Distribution of Respondents by their district, gender and project area

District	Himal (81)		Mountain (100)		Tarai (118)		Total (299)	
	M	F	M	F	M	F	M	F
Banke	-	-	-	-	75	43	75	43
Rasuwa	30	18	-	-	-	-	30	18
Solukhumbu	23	10	-	-	-	-	23	10
Panchthar	-	-	43	8	-	-	43	8
Ilam	-	-	41	8	-	-	41	8
Total	53	28	84	16	75	43	212	87
%	27		33		40		71	29

Sources: Field study, 2013

Table 4: Maximum utilization of local skilled manpower with further skill trainings

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	17	6	2	8	11	44	122	2.77
Users	25	33	13	94	90	255	956	3.74
Total	42	39	15	102	101	299	1078	3.6
%	14	13	5	34	34	100		

Sources: Field study, 2013

Table 5: Use of locally available construction materials

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	2	3	2	11	26	44	188	4.27
Users	38	53	17	81	66	255	849	3.32
Total	40	56	19	92	92	299	1037	3.46
%	13	19	6	31	31	100		

Sources: Field study, 2013

Table 6: Conservation and development of natural heritage

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	6	7	3	14	14	44	155	3.52
Users	16	43	36	72	88	255	938	3.13
Total	22	50	39	86	102	299	1093	3.65
%	7	17	13	29	34	100		

Sources: Field study, 2013

Table 7: Effect on travel time and the fare of the public transport.

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	1	1	3	7	32	44	200	4.54
Users	16	27	16	64	132	255	1034	4.05
Total	17	28	19	71	164	299	1224	4.09
%	6	9	6	24	55	100		

Sources: Field study, 2013

Table 8: Employment of Local people in the bridge construction

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	2	4	2	12	24	44	184	4.18
Users	5	21	9	60	160	255	1114	4.36
Total	7	25	11	72	184	299	1298	4.34
%	2	8	4	24	62	100		

Sources: Field study, 2013

Table 9: Employment generation for the local people

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	0	10	2	14	18	44	172	3.9
Users	17	26	28	60	124	255	1013	3.97
Total	17	36	30	74	142	299	1185	3.96
%	6	12	10	25	47	100		

Sources: Field study, 2013

Table 10: Minimization of erosion and sediment

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	3	6	2	20	13	44	166	3.77
Users	29	42	12	58	114	255	951	3.72
Total	32	48	14	78	127	299	1117	3.73
%	11	16	5	26	42	100		

Sources: Field study, 2013

Table 11: Protection of agricultural land

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	3	6	2	20	13	44	166	3.77
Users	29	42	12	58	114	255	951	3.72
Total	32	48	14	78	127	299	1117	3.73
%	11	16	5	26	42	100		

Sources: Field study, 2013

Table 12: Protection of water quality in water bodies

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	1	6	3	19	15	44	173	3.93
Users	28	35	9	66	117	255	974	3.81
Total	29	41	12	85	132	299	1147	3.83
%	10	14	4	28	44	100		

Sources: Field study, 2013

Table 13: Control of polluted run-off on site

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	4	10	3	16	11	44	152	3.45
Users	46	39	23	78	69	255	850	3.33
Total	50	49	26	94	80	299	952	3.18
%	17	16	9	31	27	100		

Sources: Field study, 2013

Table 14: Preservation of areas of natural and cultural significance

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	2	9	5	14	14	44	161	3.65
Users	20	51	31	83	70	255	897	3.51
Total	22	60	36	97	84	299	1058	3.53
%	7	20	12	33	28	100		

Sources: Field study, 2013

Table 15: Conservation of highly valued resources

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	0	13	3	14	14	44	161	3.65
Users	42	45	39	58	71	255	836	3.27
Total	42	58	42	72	85	299	997	3.33
%	14	19	14	24	29	100		

Sources: Field study, 2013

Table 16: Application of labor based technology for environment management

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	2	3	6	16	17	44	175	3.97
Users	13	50	30	89	73	255	924	3.62
Total	15	53	36	105	90	299	1099	3.67
%	5	18	12	35	30	100		

Sources: Field study, 2013

Table 17: Participation of local people in bridge project

Group	Scale values					Total Responses	Weighted Value	Mean Weight
	1	2	3	4	5			
Clients	2	1	7	9	25	44	186	4.22
Users	6	17	18	43	171	255	1121	4.39
Total	8	18	25	52	196	299	1307	4.37
%	3	6	8	17	66	100		

Sources: Field study, 2013

Table 18: Overall significance test regarding regarding impact on environment, livelihood, access and ownership in the infrastructure development

Group	Means	Std. Deviation	t Value	p Value	Sig. if p < 0.05
Client	53.795	10.998	Equal variances assumed 0.997 Equal variances assumed 1.174	0.320	Insignificant
User	52.705	9.853		0.245	

(H1 is rejected when p value is greater than 0.05)

Table 4 indicates 64% of the respondents were agreed that there was maximum utilization of local skilled manpower with further skill trainings and only 27% were not convinced on it. Here the data shows that the project was aware of using local manpower with necessary skilled trainings and they believe in local support for the success of the project. 62% of the respondents were agreed that the projects were using locally available construction materials which were available in the site and 32% were not agreed on it (Table 5). It was not possible to have all types of construction materials in the rural area. Data shows the bridge projects were using the construction materials available in the area.

Other key aspects for the impact on environment, livelihood, access and ownership in the infrastructure development were conservation and development of natural heritage, positive effects on travel time & the fare of the public transport, provide employment for local people in the bridge construction, employment generation for the local people, minimization of erosion & sediment, protection of agricultural land, protection of water quality in water bodies, control of polluted run-off on site, preservation of areas of natural and cultural significance, conservation of highly valued resources, application of labor based technology for environment management and participation of local people in bridge project. All the aspects were analyzed thoroughly and the data are presented accordingly as follows:

Table 6 shows the results, which suggest that 63% of the respondent agreed or strongly agreed that the projects has dedicated to the conservation and development of natural heritage, that means the conservation of natural heritage is one of the important component. 24% of the respondents were disagreeing on it. This means the projects were aware in the conservation and development of natural heritage.

Table 7 indicates 79% of the respondents were agreed that there were positive effects on travel time and the fare of the public transport and only 15% were not

convinced on it. Here the data shows that the travel time and the fares of public transport were decreased by the project activities. 86% of the respondents were agreed that the projects were creating employment for local people in the bridge construction and 10% were not agreed on it (Table 8). It was not possible to create employment to all, but the data shows the projects were aware of employment creation for local people. 72% of the respondents were convinced that the bridge projects were able for employment generation to the local people (Table 9), 18% denied on it. That means the employment opportunities were increased due to the construction of bridges. Bridges were playing the role of employability in the life of the people.

In some cases, the construction projects invite erosions and sediments. Here 68% of the respondents were satisfied about minimization of erosion and sediment from the bridge projects and 27% were not satisfied on it (Table 10). This indicates most of the bridges were dedicated for the minimization of erosion and sediment.

Protection of agricultural land is directly related to the livelihood of the people and it contributes to the ownership feeling also. Each and every construction projects should be aware of protecting agriculture lands. Table 11 indicates 72% of the populations agreed that the agricultural lands were protected and 20% were not agreed on it.

Protection of water quality in water bodies plays a vital role in the health, sanitation and environment. Each and every project should be aware of protection of water quality. 72% of the respondents were satisfied about the protection of water quality and 24% were not satisfied on it (Table 12).

Control of polluted run-off on site is the major challenge of any project. This challenge should be faced by the project for the contribution of environmental aspects. Table 13 denotes the satisfactory data in the control of polluted run-off on site. 58% of the respondents were in favor and 33% were against it.

61% of the respondents are agreed that the preservation of areas of natural and cultural significance were done effectively and 27% respondents were disagreeing on it (Table 14). The preservation of areas of natural and cultural significance helps to develop environment, livelihood, access & ownership towards the project. The data shows that projects were strong in environment, livelihood & access and ownership development.

Conservation of highly valued resources is the strong part to develop environment, livelihood and ownership feeling towards projects. These resources can generate income sources and employment to the people. The data shows 53% of the respondents were in fever of conservation of highly valued resources and 33% were not in fever about the conservation (Table 15). As a whole the conservation parts were satisfactory.

Table 16 denotes about the application of labor based technology for environment management. Peoples' participations play a vital role for environmental management. It promotes labor based technology. 65% of the population agreed that the projects activities were appreciable towards the application of labor based technology for environment management and 23% population were disagreeing on it. Projects activities towards the application of labor based technology for environment management were satisfactory. 83% of the respondents are agreed that the participation of local people in bridge project were maximum and 9% were against this (Table 17). The participation of local people in the projects develops ownership towards projects. The data shows the positive reinforcement towards the participation of local people in bridge projects.

Test of significance for impact on environment, livelihood, access and ownership in the infrastructure development was done with two populations who agree with the proposed approaches. Based on the populations' percentage who agrees with the approaches χ^2 value, p value and conclusions with significance and insignificance were calculated using SPSS. Individual and overall test of significance were made accordingly. Regarding the individual test, table 4 and 5 are highly significance whether the p value is less than 0.05 and regarding other remaining 12 individual tests, in the remaining tables, the p value is greater than 0.05, so that it seems these are insignificance.

Overall significance test regarding impact on environment, livelihood, access and ownership in the infrastructure development (Table 18) was done

accordingly. Mean, standard deviation, t value and p value were calculated using SPSS and the p value found greater than 0.05. Here it is proved that the alternative hypothesis "There is positive impact from Sustainable infrastructure development in the sector of environment, livelihood, access and ownership in the infrastructure development and maintenance in Nepal" is insignificance. The impact on environment, livelihood, access and ownership in sustainable infrastructure development is insignificance in the perspectives of clients and users. They are really not committed to develop environment, livelihood, access and ownership for sustainable infrastructure development.

CONCLUSION

In terms of environment, livelihood, access and ownership; the construction projects made the livelihood and lifestyle of the people improved including the surrounding environment as it connects business and other activities. Environment protection is the duty of local people first; to some extent the project contributed to flood control, forest and animal conservation, nature & environment and cultivated land conservation. Education, health, communication, employment opportunities, employment generations and transportation became easy. Urbanizations initiated in many places, but the budget of the construction was focused mainly in construction activities rather than the sustainability aspects of the construction projects.

Sustainable infrastructure development sectors have several specific advantages. First, it can ensure coordination of three key elements to the growth of labor-intensive sectors in the economy—namely, natural resource management, infrastructural development, and basic services—to improve human capabilities and productivity of labor. Second, it can raise demand for wage goods in the economy, which can be enhanced through labor-intensive industrialization. Finally, it can provide guarantee of employment and thereby ensure full employment. By providing work at the minimum wage, with decent working conditions as well as social protection (Hirway et al., 2008,

The establishment of the framework, through answering the research question, achieved the objective which was *Identification of impact on environment, livelihood, access and ownership in the infrastructure development*

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