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Social-Economic Effects and Political Satisfaction from Pedestrian Footbridges in Rural Areas

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Abstract- It is generally accepted that having a proper river crossing point has a positive effect on rural inhabitants. Such crossing points would increase the ability of communities to access their social services, markets, jobs, and thereby lead to raising their standard of living. In line with this objective, Rwanda has been promoting the construction of pedestrian footbridges in rural areas, and with different partners, different pedestrian footbridges have already been constructed. It is very crucial that all institutions involved in the construction of pedestrian footbridges, both public and private, consider the financial benefits of pedestrian footbridges and some significant direct and indirect effects on the rural communities. The Objective of this study was to identify all possible benefits that may be generated by pedestrian footbridges to understand the potential range of their impacts in rural areas and the likely responses from those people impacted by the project. The study also proposed a comprehensive approach for estimating the economic impacts of a pedestrian footbridge in rural areas. The methodology involved community interviews conducted during site visits to identify and predict possible impacts due to the lack and availability of safe access via pedestrian footbridges.

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I. Introduction

Adequate access to social-economic facilities and services, as hospitals, schools, and shopping centers, etc., for many people living in rural areas, has been one of development goals in developing countries. One of the most affordable and viable alternatives means against rural isolation is the construction of pedestrian footbridges. The protection of people as they go about their everyday lives in their neighborhoods or workplaces may be influenced by improvement in transportation systems [1].

A pedestrian-friendly environment can be transformed by unsafe river crossing points or changes in traffic habits that place residents at higher risk of injury or death. Such changes need consideration of adequate and safe crossing points for pedestrians, animals, bicycles, and motorcycles.

As a developing country, Rwanda is committed to addressing the problem of inadequate pedestrian footbridges in rural areas, resulting from its geographical conditions. In partnership with districts and other public and private institutions, an International Non-Governmental Organization, Bridges to Prosperity (B2P), which is specialized in the design and construction of pedestrian footbridges, has been constructing pedestrian footbridges for the past nine years. B2P's contribution has resulted in 95 bridges implemented in different districts of Rwanda to serve over 400,000 people. Per an agreement with the Government of Rwanda, over 100 more are to be completed over the next three years [2].

Although the immediate impacts of Pedestrian footbridges in rural areas, such as transport costs, travel time, and improved safety, are clear, there are long-term impacts such as increased profitability of farmers and business revenue change, as well as increased employment in the agricultural and non-agricultural sectors. It should be also emphasized that the development of rural infrastructure, whether physical or nonphysical, not only improves local economic capacity, but also plays a direct and indirect role in reducing poverty [3].

It is necessary that all institutions involved in the construction of pedestrian footbridges, both public and private, are well aware of the value and benefits of the pedestrian footbridges to rural communities which may have significant indirect effects on rural communities, which could result from the direct effects. It is clear that while a pedestrian footbridge can allow the crossing of respective obstacles by communities, it boosts their economy and the national economy in general. As a result, it directly affects the political trust of the communities and the development of the country. Therefore, a comprehensive approach for estimating the social-economic effects of a pedestrian footbridge in

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rural areas is indispensable to understand the importance of investment in rural pedestrian infrastructure.

The aim of social-economic impact assessment is to enable the government and other key stakeholders to recognize and better predict the potential social-economic impacts from proposed projects, strategies, and services for human populations and communities [4].

Some researchers have conducted studies on how pedestrian footbridges can improve rural economies. [5] concluded that the construction of new pedestrian footbridge crossings links rural and underserved communities in developing countries worldwide with the services they need.

Some potential indirect effects, such as general economic conditions of an area or region, the availability of municipal services, like sewer and water, the tax incremental, and the quality of life, could occur beyond the project's actual right of way [6].

Pedestrian footbridges have a demonstrated impact well beyond the two communities they connect. A study of the total geographic area served by one single pedestrian footbridge in Rwanda resulted in an average of 33 unique villages covering 47 square kilometers of mountainous terrain when considering the reported origins and destinations. An average catchment area of 17 villages was then estimated with the adjustment to reflect only journeys in service of livelihoods, health, and education [7]. A study about the methods to identify pedestrian footbridge needs in rural areas of Liberia and Rwanda recommended a mixed approach that combines both sophisticated remote methods with streamlined field-based methods that consider the existing local knowledge and expertise and cataloged the extensive need for safe access throughout rural areas, as well as the destinations that deemed critical by communities, but difficult to reach due to seasonally impassible rivers [8].

The possibility of creating a sustainable national Pedestrian footbridge program with the support of a comprehensive Pedestrian footbridge management system was documented in 2020 by Claude Munyaneza. and Leopold Mbereyaho. Analysis of condition data, determination of the ranking and priority of bridge maintenance activities, as well as evaluation of the alternatives of preservation or replacement create an environment where Pedestrian footbridges may be effectively built and maintained [9].

In 2020, Brooks and Donovan published their findings of a study about the impact of new bridges in rural Nicaragua, which found that lack of reliable outside market access can have a significant effect on rural economies' long-term agricultural decisions, and infrastructure benefits go beyond the ability to move products more efficiently through space. Pedestrian footbridges improve accessibility to labor markets, which may decrease distortions in the agricultural sector [10]. Such access to local businesses increases the safety within the community and generally enhances the quality of life for residents [11]. This results in both social capitals as well as economic fairness evaluations which have significant effects on political trust [12].

The Objective of this study was to identify all possible benefits resulting from pedestrian footbridge construction to understand the range of potential impacts of a new pedestrian footbridge in rural areas and the likely responses of those impacted by the projects, to highlight rural pedestrian and motorcycle transport as an effective strategy for rural economic development. The study also proposed a comprehensive approach for estimating the economic impacts of a pedestrian footbridge in rural areas.

II. Methods

a) *Methodology Description*

In addition to the literature review, which provided an opportunity to understand the situation globally and locally and note the gaps, the methodology used in this study involved community interviews and feedback analysis. Interviews and discussions with 980 people, including 30 local leaders, ten bridge builders from B2P, and 940 local communities who are mostly the beneficiaries of constructed pedestrian footbridges in different districts, were held to understand and determine how they are impacted by the pedestrian footbridges. The questionnaire was structured so that information concerning changes of lives before and after the construction of pedestrian footbridge as well as expectations before the project were acquired. Observations made during the site visits helped to identify or predict the impacts of blocked access, and safe crossings. Microsoft Excel analysis tools developed the estimating approach of pedestrian footbridge benefits for rural communities with established formulas. During the site visit, five pedestrian footbridges under the operation stage were selected. The analysis involved the social and economic effects. Social effects were analyzed into four main categories such as accessibility and connectivity, health and safety, an increase of income and reduction of cost, and cultural well-being. The economic effects were analyzed in two main categories: economic impact from user cost and the overall economic benefits.

Using statistical analysis software of Rao soft, five pedestrian footbridges were all assessed for their social-economic and political satisfaction effects. Finally, one bridge was taken as a case study for the economic impact assessment.

b) *Identification and Analysis of Estimated Effects*

A Synthesis of interviews, background information, and observations made during the site visits were included in this process. This required the

identification and prediction of effects without the pedestrian footbridge and with the pedestrian footbridge in the area. This study focused on identifying social-economic impact during the operation stage of a pedestrian footbridge, to gain an understanding before and following pedestrian footbridges construction.

c) *Community Interest*

The community interest for this study has been informed by several sources. Several interested people were selected because they identified as directly benefiting from the constructed bridges. Additionally, most used the bridges to access their daily social-economic activities. For analyzing the effects of the project during the construction stage, the communities who participated in all construction stages were also considered.

The community of interest was further informed by a demographic analysis of a wider geographic study area, identifying social and community infrastructure and facilities within the study area, particularly those close to the bridge. The demographic study area was selected to analyze the characteristics of residents and communities within the catchment who were most likely to experience effects as a result of the bridge and assist in the identification of potential community groups that may have been affected by the bridge project, particularly those which are not in direct proximity to the bridge project.

Input from the wider community of interest was then sought through further engagement with identified community groups and the general public. This included feedback provided by face-to-face interviews and open day discussions and feedback.

d) *Social-Economic Impact Assessment Criteria*

Referring to the relevant categories of the International Association for Impact Assessment (IAIA) framework [13], the following framework has been established for assessing the potential impacts that may result from a Pedestrian footbridge project:

Way of Life:

- Impacts on accessibility, connectivity, living habits, and mobility
- Changes to ways of crossing (walking and cycling)

Well, Being:

- Changes to wellbeing
- Health and safety

Financial:

- Change of market price
- Benefit increase from agriculture productivity
- Making Money

e) *Rating of Effects*

In assessing effects, each effect has been given an overall rating of impacts. A four-point scale has been applied, and the ratings applied are:

- Significant positive
- Moderate positive
- Minor positive
- Insignificant

In applying the overall rating of the effects, consideration was given to: the project stage of the effect (construction, operational, or both), who is affected (directly affected, neighbors, wider community), the probability of occurrence (high, medium, or low), and the magnitude of the impact (high, medium, low), and the significance of the affected feature (local, regional, national) [14].

III. Results

a) *Results from the Interview*

i. *Demographic Profile of Respondents*

As mentioned in section 2, the total number of participants for this study was 980 people, including 30 local leaders, ten bridge builders from B2P, and 940 local communities. They are mostly the beneficiaries of the constructed pedestrian footbridge in the area. Their demographic profile was considered into three main categories, as summarized in Table 1 below. These include the age distribution, gender composition, and primary occupation.

Table 1: Demographic Profile for Participants

Age Distribution		Percentage	Gender Composition		Primary Occupation			
Age group	Number	%	Male	Female	Agriculture	Business people	Salaried Employee	Students
4_12	54	5.51	32	22	0	0	0	54
13_21	47	4.80	16	31	12	2	1	32
22_30	179	18.27	105	74	129	30	18	2
31_39	245	25	108	137	187	36	22	0
40_48	233	23.78	104	129	204	16	13	0

49_57	155	15.82	77	78	140	9	6	0
58+	67	6.84	32	35	62	4	1	0
TOTAL	**980**	**100**	**474**	**506**	**734**	**97**	**61**	**88**

ii. *Social-Economic Effects of Pedestrian Foot bridges In Rural Areas*

As mentioned in section 2, five pedestrian footbridges built by Bridges to Prosperity were selected for the assessment. Table 1 summarizes the overall main findings from the interviews, discussions with different surrounding communities, and the observations made during site visits of those five pedestrian footbridges. The table summarizes the effect and overall rating (the magnitude of the effect), the percentage of similarity feedback, and further comments that were considered for assigning each effect with its rating.

Table 2: Results from Interview, Discussions, and Observations

Effect	Positive Overall rating	% Similarity Feedback from Respondents	Situation before the construction of Pedestrian footbridge in the area.
Way of Life (Accessibility and Connectivity)			
Access to schools	Significant Positive	97%	During the rainy season, students were not able to attend the schools. some were not able to go back home and stay at school.
Access to Markets	Significant Positive	98%	During the rainy season, Communities could not attend the local markets and even sometimes they could not back home, until the water in the river get low.
Access to Health/ Hospital center	Significant Positive	96%	During the rainy season, Communities could not go to health centers and hospital due to high water level over the existing log timber bridge.
Access to Church	Significant Positive	94%	The attendance to churches was low during the rainy season. Communities couldn't cross when the river is flooded.
Access to Drinking water	Moderate Positive	95%	Some communities from one side use the bridge to fetch drinking water from the other side of the river.
Access to Public Offices	Moderate Positive	93%	Some communities use the bridge to go the sector and cell offices.
Access to Public Transport	Significant Positive	97%	It was difficult to access the bus station during rainy season, and the bridge made consistent access possible.
Saving Walking/Travel Time	Significant Positive	100%	The alternative safe crossing points are far from the residences and the social-economic facilities. The average distance is about 9km from nearest village to the nearest facility.
Well-being (Health and Safety)			
Saving lives	Significant Positive	98%	Before the bridge was constructed, many people died while crossing the river.
Decrease of injuries	Significant Positive	98%	Before the bridge was constructed, many people were injured while crossing the river.
General improvements to pedestrian and cyclist safety	Moderate Positive	96%	People of all ages were able to cross safely during bridge construction
Reducing infant and maternal mortality	Moderate Positive	94%	Since the health center is far from the alternative safe crossing point, before the bridges, some mothers were insisting on giving birth at home by preventing to cross the river.
Ability to pay the health insurance (Mutuel de Sante)	Significant Positive	92%	The bridges increased the economic revenue, which gave the communities the ability to pay their "mutuel de sante"
Financial (Income and Cost)			
Economic benefit from farming goods	Significant Positive	99%	Pedestrian footbridges allowed farmers to bring their products on their expected local markets, which increased the price.
Additional economic benefits from products and farming goods	Significant Positive	97%	Pedestrian footbridges allowed the farmers to bring all their products to market.
Economic benefits from additional worker jobs	Significant Positive	98%	Pedestrian footbridges allowed the workers to access their daily activities and earn additional income.
Business revenue change	Significant Positive	95%	Pedestrian footbridges increased the traffic flow, therefore the customer flowed to surrounding businesses.

Saving money for travel cost	Significant Positive	99%	Pedestrian footbridges decreased the travel distance for motorcyclists and bicyclists with their passengers.
Reduction of accident cost	Moderate Positive	90%	Accidents were reduced due to the presence of Pedestrian footbridge.
Reduction of operational costs for motorcycles and bicycles	Minor Positive	80%	The cost to repair the motorcycle and bicycles was reduced due to shorter travelling distances.
Reduction of delay cost	Significant Positive	98%	Working hours were increased due to time saving as a result of the shorter travelling and walking distance.
Government tax	Significant Positive	87%	Taxes from agriculture production were increased, as a result of the increases in investments and yields.
Change to Well-being and Cultural well being			
Increased trust between community and government	Significant Positive	96%	The social and cultural coherence and the economic growth, resulted from having Pedestrian footbridge in community rural areas gave them great pleasure and much confidence and appreciation of their leaders.
Interaction and visits of friends and relatives	Significant Positive	99%	Pedestrian footbridges facilitated the communities to visit each one another.
Improvement of crossing way of disability people	Significant Positive	96%	Following Pedestrian footbridge construction, people with disabilities were able to cross the river safely.
Work occupation of local communities	Moderate Positive	94%	Attendance to work increased following Pedestrian footbridge construction.
Decrease of family conflicts	Moderate Positive	90%	Due to work occupation, the conflicts in the family has been decreased.
Increase of school attendance of new students	Minor Positive	94%	Footbridge facilitated the students to attend schools without fail.
Success of students	Moderate Positive	93%	the increase of student attendance, and short walking distance affected the overall student results.

b) Economic Impact Analysis of Pedestrian Footbridge

Cost categories of the economic impact of the pedestrian footbridge are summarized in Figure 1. As shown by the figure, the economic impact was quantified using user cost for motorcycles and bicycles, user cost for pedestrians, economic benefit, and business revenue change. The scope of analysis presented in this study is limited to the duration of one year.

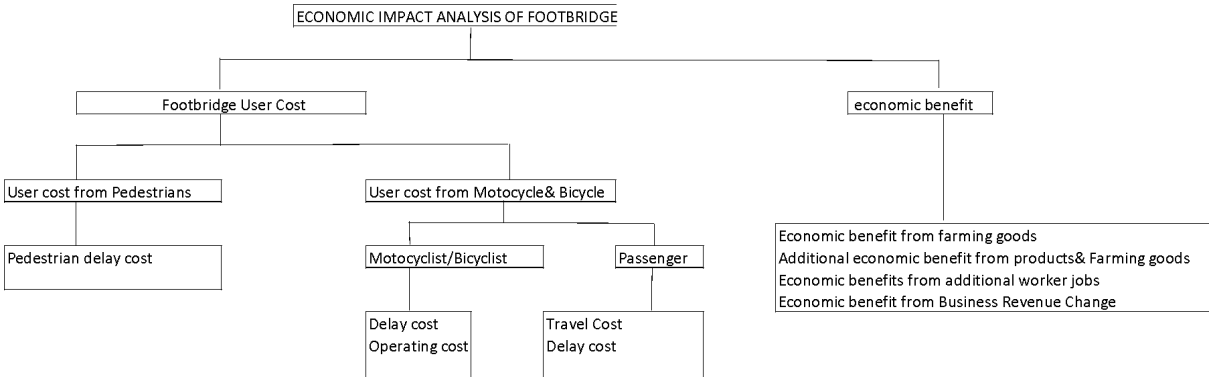

Figure 1: Economic Impact Analysis Pedestrian footbridge

i. *Economic Impact from user Cost*

As shown in Figure 1, the economic impact from User Cost is evaluated from Bicycle/Motorcycle user cost and pedestrian user cost. They include motorcyclist/bicyclist, passenger, and pedestrians' costs. The Motorcyclist/Bicyclist cost is comprised of the travel cost (fuel cost, etc.), the delay cost (the Amount of profit that a motorcyclist or bicyclist loses when they are late to get to their destination), and the Operating cost (Tire or tube replacement, general mechanical repair, etc.). The passenger cost comprises of the delay cost (the Amount of profit that a passenger loses when they are late to get to their destination) and the travel cost (transport charges, etc.). The Pedestrian cost comprises of the delay cost (the Amount of profit that a pedestrian loses when they are late to get to their destination). Equations developed by [15] have been considered, modified, and from there, the following equations 1 to 12 were developed.

Pedestrian Delay Cost is calculated:

$$PDC = (WT_{CAP} - WT_{CB}) * ADT_P * IDY_P * HR_p \quad (1)$$

Where 'WT_{CAP}' is the walking time by crossing the alternate crossing point (the nearest other safe crossing point); 'WT_{CB}' is the walking time by crossing the bridge; 'ADTp' is average daily pedestrian traffic; 'IDY_P' is the impassable days per year for pedestrians (when the river is flooded and not impassable), and 'HR_P' the hourly rate for pedestrians.

The formulas for user cost from Motorcyclist and Bicyclist were developed as follows:

Motorcyclist Travel Cost:

$$MTC = [(TT_{CAPM} - TT_{CBM}) * ADT_M * IDY_M * TR_M)] \quad (2)$$

Motorcyclist delay Cost:

$$MDC = [(TT_{CAPM} - TT_{CBM}) * ADT_M * IDY_M * HR_M)] \quad (3)$$

Bicyclist delay cost:

$$BDC = [(TT_{CAPB} - TT_{CBB}) * ADT_B * IDY_B * HR_B] \quad (4)$$

Motorcycle Operating Cost:

$$MOC = (TT_{CAPM} - TT_{CBM}) * ADT_M * IDY_M * MOC \quad (5)$$

Bicycle Operating Cost:

$$BOC = (TT_{CAPB} - TT_{CBB}) * ADT_B * IDY_B * BOC \quad (6)$$

Motorcycle passenger travel Cost:

$$MPTC = [(TT_{CAPMPS} - TT_{CBMPS}) * ADT_{MPs} * IDY_{MPS} * TR_{MPS}] \quad (7)$$

Motorcycle passenger delay Cost:

$$MPDC = [(TT_{CAPMPS} - TT_{CBMPS}) * ADT_{MPs} * IDY_{MPS} * HR_{MPS}] \quad (8)$$

Bicycle Passenger Travel Cost:

$$BPTC = [(TT_{CAPBPS} - TT_{CBBPS}) * ADT_{BPS} * IDY_{BPS} * TR_{BPS}] \quad (9)$$

Bicycle Passenger delay Cost:

$$BPDC = [(TT_{CAPBPS} - TT_{CBBPS}) * ADT_{BPS} * IDY_{BPS} * HR_{BPS}] \quad (10)$$

where,

Table 3: Abbreviation Definitions

Abbreviation	Definition
ADT_M	Average daily motorcycle traffic
ADT_B	Average daily bicycle traffic
ADT_{BPS}	Average daily bicycle passenger traffic
ADT_{MPS}	Average daily motorcycle passenger traffic;
BOC	Bicycle operating cost
HR_B	Hourly rate for bicycles,
HR_M	Hourly rate for motorcycles
HR_{MPS}	Hourly rate for motorcycle passenger
HR_{BPS}	Hourly rate for bicycle passenger.
IDY_M	Impassable days per year for motorcycle (when the river is flooded and not passable)
IDY_B	Impassable days per year for bicycles (when the river is flooded and not impassable)
IDY_{MPS}	Impassable days per year for motorcycle passenger (when the river is flooded and not impassable)
IDY_{BPS}	Impassable days per year for bicycle passengers (when the river is flooded and not impassable)
MOC	Motorcycle operating cost,
TT_{CAPM}	Motorcycle's traveling time by crossing the alternate crossing point (the nearest other safe crossing point)
TT_{CBM}	Motorcycle's traveling time by crossing the bridge
TR_M	Travel rate for motorcycles
TT_{CAPB}	Bicycle's travel time, incurred by crossing the alternate crossing point (the nearest other safe crossing point)
TT_{CBB}	Bicycle's travel time by crossing the bridge;
TR_B	Travel rate for bicycles
TT_{CAPMPS}	Motorcycle passenger's traveling time by crossing the alternate crossing point (the nearest other safe crossing point);
TT_{CBMPS}	Motorcycle passenger's traveling time by crossing the bridge
TR_{MPS}	Travel rate for motorcycle passenger
TT_{CAPBPS}	Bicycle passenger's traveling time by crossing the alternate crossing point (the nearest other safe crossing point
TT_{CBBPS}	Bicycle passenger's traveling time by crossing the bridge
TR_{BPS}	Travel rate for bicycle passenger;

ii. *Business Revenue Change*

The formulas for business revenue changes resulting from the construction of a new Pedestrian footbridge were developed using the theory created by [14]. The business revenue change when the community gets a safe crossing point is a component of economic impact on surrounding businesses. The business revenue increase (BRC) is directly affected by the increase in customer number (IC). It is also a function of average expenditure per household (AE). The number of weeks per year that could be impossible to cross the river without a bridge when it is flooded (IW) means impassable weeks per year.

$$BRC = IC * AE * IW \quad (11)$$

A significant parameter in the quantification of revenue change of a Pedestrian footbridge is the influence area. In this study, the bridge influence area was estimated based on the study conducted by Bridges to Prosperity, as denoted in section 1 above, which was resulted in an average of 17 villages directly served by a single Pedestrian footbridge.

The increase in a number of customers, as shown in Eq. 17, is a function of number of households that would not be able to cross without the bridge when the river is flooded (HCWB) and the percentage area influenced by the bridge (I), and the average frequency per week of patronizing businesses in area (F).

$$IC = HCWB * I * F \quad (12)$$

I and F are estimated using survey data or just by estimating.

c) *Estimation of Economic Benefit Per Year Per Pedestrian Footbridge for Gashyushya Suspension Bridge Case Study*

i. *Gashyushya Trail Bridge Profile*

The Gashyushya pedestrian footbridge is a suspension bridge built in 2019 by a non-Government organization, Bridges to Prosperity, in collaboration with the Muhanga district. The communities surrounding the Gashyushya pedestrian footbridge are primarily occupied by Agriculture of different crops mainly, potatoes and bananas. For accessing their market, they must cross the Makurungwe River. Community members also have to cross the river to access their social-economic facilities like schools, medical care, and jobs.

During the rainy season, the Makurungwe river frequently becomes violent and stays flooded and fast for three days at a time. So, before the construction of the Gashyushya pedestrian footbridge, it was too dangerous to cross during such period, which resulted in innumerable missed opportunities and has caused multiple injuries in attempted crossings and in at least one reported death per year. The Gashyushya pedestrian footbridge provides safe, year-round access for over 3,000 members of the Murama, Munini, and surrounding communities, providing enhanced access to opportunity to empower the communities out of poverty.

Figure 2: Community crossing the river (Before the construction of Gashyushya Pedestrian footbridge)

Figure 3: Community crossing the Gashyushya Pedestrian footbridge

ii. *Economic Impact from Pedestrian Footbridge user Cost*

Tables 2 and 3 summarize the results of the economic impact from the Gashyushya Suspension Bridge constructed in Muhanga District in terms of user cost. Most of the data were estimated from the participants' feedback during the interview and discussion, in addition to the observations made during the site visit. The average daily traffic for pedestrians (ADT_P), the average daily traffic for motorcycles (ADT_M), and the average daily traffic for bicycles (ADT_B) were estimated from the traffic count survey during seven days.

Table 4: Estimated Values for User Cost Parameters

Parameter	Value		Parameter	Value
ADT_B	82 bicycle/day		IDY_P	112 days
ADT_{BPS}	16 passengers/day		TR_M	900 Rwf
ADT_M	53 Moto/day		TR_{MPS}	2,000 Rwf
ADT_{MPS}	32 passengers/day		TT_{CAPB}	0.75h
ADT_P	664 people/day		TT_{CAPBPS}	0.8h
HOC_B	200 Rwf		TT_{CAPM}	0.25h
HOC_M	400 Rwf		TT_{CAPMPS}	0.25h
HR_{BPS}	350 Rwf		TT_{CBBPS}	0.3h
HR_M	500 Rwf		TT_{CBM}	0.05h
HR_P	660 Rwf		TT_{CBMPS}	0.05h
HR_{MPS}	350Rwf		WT_{CAP}	2.0 h
IDY_M	112 days		WT_{CB}	0.3h
IDY_{MPS}	112days			

Table 5: Total user Cost

Parameter's Name	Parameter's Abbreviation	Value (RWF)	Equation used
Bicyclist delay cost	BDC	1,974,560	Equ. 4
Bicycle operating cost	BOC	918,400	Equ. 6
Bicycle passenger delay cost	BPDC	313,600	Equ.10
Bicycle passenger travel cost	BPTC	358,400	Equ. 9
Motorcyclist delay cost	MDC	593,600	Equ. 3
Motorcycle operating cost	MOC	474,880	Equ. 5
Motorcycle passenger delay cost	MPDC	250,880	Equ. 8
Motorcycle passenger travel cost	MPTC	1,433,600	Equ. 7
Motorcyclist travel cost	MTC	1,068,480	Equ. 2
Pedestrian delay cost	PDC	57,652,000	Equ. 1
Total user cost	**TISC**	**57,652,000**	

iii. *Economic Benefit*

The approach used by Rotary International for analyzing the economic benefit for their funded projects was used in this study. It is composed of three main types of benefits, which are the economic benefit from farming goods, the additional economic benefit for products and farming goods, and the economic benefit from additional worker jobs. Table 4 summarizes the results from the Gashyushya Suspension Bridge analysis. The estimated values were from the discussion with local communities and the observations during site visits.

Table 6: Estimate of economic benefit per year per Pedestrian footbridge

Parameter' name	Parameter's Symbole	Value	Equation
Estimated number of bridge users crossing per day (A): **people/day**	A	664	N.E
Estimated number of kilos of farming goods crossing per day(B): **kilos/day**	B	9,960	N.E
Estimated differential sales price between selling product on one side versus newly accessed side(C): **Rwf/kilo**	C	15	N.E
Estimated additional kilos of products/farming goods not otherwise sold without access to other side per annum(D): **kilos/annum.**	D	25,550	N.E
Average price of products sold per kilo(E) **Rwf/kilo**	E	250	N.E
Estimated number of worker crossings per day that would otherwise not be able to access job on newly accessed side(F): **Number**	F	26	N.E
Estimated wages earned by workers per day that would otherwise not be able to gain access to jobs without bridge(G) **RWf /day**	G	1,500	N.E
Number of days that footbridge is used per year by farmers and workers(H): **days**	H	325	N.E
Economic benefit from farming goods(I). **Rwf /day** (Multiply B by C)	I	149,400	(B*C)
Additional economic benefit for products and farming goods(J). **Rwf /day** (Multiply D by E then divide by 365)	J	17,500	[(D*E)/365]
Economic benefit from additional worker jobs(K): **Rwf /day** (Multiply F by G)	K	39,000	(F*G)
Total economic benefit for farming goods and workers(L): **Rwf /day** (Add I + J + K)	L	205,900	(I+J+K)
Estimated economic benefit per year for this footbridge: **Rwf /annum** (Multiply L by H)	M	**66,917,500**	(L*H)

iv. *Business Revenue Change*

As said earlier in this section, the business revenue changes when a community receives a safe crossing point is a component of economic impact on surrounding businesses. The business revenue increase (BRC) is directly affected by the increase in customer number (IC). It is also a function of average expenditure per household (AE). The number of weeks per year that could be impossible to cross the river without a bridge when it is flooded (IW) means impassable weeks per year. Table 5 below summarize the results from the interviews and observations during the site visit of the Gashyushya suspension bridge.

Table 7: Business revenue Increase per year per Pedestrian footbridge

Parameter's name	Parameter's Abbreviation	Value	Equation
number of households that would not be able to cross without the bridge when the river is flooded (Households)	HCWB	2000	
percentage area influenced by the bridge (percentage)	I	50%	
average frequency per week of patronizing businesses in the area (visit per week)	F	2	
average expenditure per household (Rwf/visit/househpold)	AE	700	
Impassable weeks per year (Weeks/year)	IW	16	
number of customers	IC	2000	(WCWB*I*F)
The business revenue increase (Rwf)	BRC	**22,400,000**	(IC*AE*IW)

d) Total Economic Benefit Per Year Per Pedestrian Footbridge.

The total economic benefit from a constructed pedestrian footbridge is the summation of benefit from bridge user cost, farming goods, increase of employment, and the business revenue change. Table 6 summarizes the results of the Gashyushya Suspension Bridge.

Table 8: Total economic benefit per year per Pedestrian footbridge

Benefit Description	Symbol	Amount (Rwf)	Percentage of the Total Benefit
Total user cost per year	UC	57,652,000	39.22%
Economic benefit from farming goods and increase of employment per year	EB	66,917,000	45.53%
Business revenue increase per year.	BR	22,400,000	15.25%
Total economic benefit per year for Gashyushya Suspension Footbridge	FB	**146,969,000**	**100%**

e) Political Satisfaction Effect of Pedestrian Footbridge In Rural Areas

Out of the total population interviewed, 96% showed that having a pedestrian footbridge in their rural areas gave them great pleasure and much confidence and appreciation of their leaders. Pedestrian footbridge increased the benefit from gross domestic products, which changed the economic situation in rural areas. Pedestrian footbridges increased the economic prosperity of a rural communities. Pedestrian footbridge in the traditional footpaths helps rural communities not only to access the social-economic facilities but also motivate and increase community hope and efforts, which affect the trustworthiness of the government to prioritize the population.

f) Discussion

i. *Results Validation*

The results from interviews and discussion are presented in Table 1. About 90% of participants were pedestrian footbridge beneficiaries in one way or another. These included the bridge users who cross it regularly to access their social-economic facilities, as well as others whose lives improved as a result of the overall economic benefit and business revenue change due to the pedestrian footbridges in their areas. There are some others who made and who are making money from the construction and use of pedestrian footbridge in their rural areas, where we can say for example the motorcyclists and cyclists.

The formulas to estimate the economic benefit year per pedestrian footbridge were developed from international theories for estimating the economic benefit for infrastructure projects. It was based on the existing factors that influence the economic growth in rural areas. The price of each factor was estimated from the information given by the local communities surrounding the pedestrian footbridge in the study.

ii. *Discussion of the Results*

Social-Economic Effects of Pedestrian footbridge in Rural Areas:

1) More than 97% of respondents confirmed that pedestrian footbridges in their rural areas were effectively changing their livelihoods both socially and financially [5]. This is understandable because pedestrian footbridge improves their accessibility to social-economic facilities like schools, markets, health centers, etc. During the rainy season, the river was impassable, and many activities were stopped until the water lowered.
2) What was also found is that pedestrian footbridge is not only beneficial to the surrounding communities but also to the wider communities [7]. During the site visit on market day, some communities attending the market indicated that people traveled from 10 – 15 kilometers away (two to three hours walking). This is mainly caused by the small number of social-economic facilities presented in some rural areas.
3) Gashyushya Suspension Bridge built by Bridges to Prosperity was taken as a case study to analyze the economic benefit per year. The total benefit resulting from bridge user cost represented about 39.22% of the total benefit of the bridge per annual. The Benefit from the farming goods and products in addition to the benefit from additional work jobs takes about 45.53 %, while the benefit from the business revenue changes represents about 15.25 %.
4) It has been found that in some areas, communities do not benefit from the constructed pedestrian footbridge due to the small number of bridges presented in the area, because there are need for pedestrian footbridges, but they are not known. There should be a better way to identify all needed pedestrian footbridges in rural areas [8]. Otherwise, some communities are having difficulties to cross a water point before they access the constructed Pedestrian footbridge.

Political Satisfaction Effects of Pedestrian footbridge in Rural Areas:

1) Pedestrian footbridge increased the government trustworthiness of the communities around the constructed pedestrian footbridge in rural areas. This is very understandable because one of the indicators of the political satisfaction of the population are the social and cultural coherence and economic growth, which are directly affected by infrastructure development
2) Pedestrian footbridges helped the communities not only to access their social-economic facilities but also to fulfill their needs and desire and increased

the benefit from gross domestic products, which increased the economic prosperity in their rural areas.

IV. Conclusion

The main objective of this study was to identify potential benefits and propose the comprehensive approach of estimating the economic benefits of a pedestrian footbridge in rural areas to better understand the potential impacts of the constructed pedestrian footbridges in rural areas and the likely responses of those impacted by the projects. With the detailed literature review, interviews, and discussion with different foot bridging stakeholders, the following results were achieved:

1. As per the majority of participants in this study, a pedestrian footbridge in rural areas have a significant social-economic effect which are directly affect the political satisfaction of local communities in rural areas.
2. Different formulas were developed, and one bridge was selected as a case study to analyze its economic benefit to the surrounding community. The total benefit resulted from the user cost, farming goods, and products, and benefit from the business revenue was estimated as One hundred and forty-six million and nine hundred and sixty-nine thousand Rwandan Francs (146,969,000 Rwf) per year. This number is a good example and proof of investment needs in the pedestrian footbridges, which affect not only the rural community but also the country's economy in general.
3. The present detailed bridge social-economic effects, which are conducted by Bridges to Prosperity before and after the bridge is built, could help to understand how communities are being impacted by pedestrian footbridges in rural areas.
4. All Pedestrian footbridge effects outlined in this study were adequate and comprehensive enough to support relevant authorities to prioritize the pedestrian footbridges wherever they are needed in the country.

Based on the above results, it is recommended that pedestrian footbridges could be prioritized not only to provide access to the rural communities but also to facilitate their economic growth to break the cycle of poverty. A further study would be welcome for a comparative investigation between the total cost of a new pedestrian footbridge with the total economic benefit of a pedestrian footbridge during its entire life span, to understand well how the investment in pedestrian footbridge can contribute to the entire economic growth of a country.

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