SAVi Sustainable Asset Valuation

Sustainable Asset Valuation (SAVi) of the Bus Rapid Transit Project in Senegal

A focus on transport infrastructure

SUMMARY OF RESULTS

IISD International Institute for Sustainable Development

MAVA FONDATION POUR LA NATURE

BOS Bureau Opérationnel de Suivi du Plan Sénégal Emergent

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About SAVi

SAVi is a simulation service that helps governments and investors value the many risks and externalities that affect the performance of infrastructure projects.

The distinctive features of SAVi are:

- Valuation: SAVi values, in financial terms, the material environmental, social and economic risks and externalities of infrastructure projects. These variables are ignored in traditional financial analyses.
- Simulation: SAVi combines the results of systems thinking and system dynamics simulation with project finance modelling. We engage with asset owners to identify the risks material to their infrastructure projects and then design appropriate simulation scenarios.
- Customization: SAVi is customized to individual infrastructure projects.

For more information on SAVi:

www.iisd.org/savi

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Glossary

Debt Service Coverage Ratio (DSCR): A measure of the cash flow available to pay current debt obligations. The ratio states net operating income as a multiple of debt obligations due within one year, including interest and principal.

Development planning: A range of public and private planning and decision-making processes (e.g., ranging from a national land-use plan to the annual budgetary process, and including infrastructure projects as well as sectoral policy formulation exercises) that typically involve trade-offs between competing demands for scarce resources and which have implications for the environment.

Econometrics: A methodology that measures the relation between two or more variables, running statistical analysis of historical data and finding correlation between specific selected variables.

Feedback loop: Defined by Roberts et al. (1983) as "a process whereby an initial cause ripples through a chain of causation ultimately to re-affect itself."

Geographic Information System (GIS): A system designed to capture, store, manipulate, analyze, manage and present all types of geographical data. Put simply, GIS is the merging of cartography, statistical analysis and computer science technology.

Green economy: An economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011).

Indicator: An instrument that provides an indication, generally used to describe and/or give an order of magnitude to a given condition.

Internal Rate of Return (IRR): An indicator of the profitability prospects of a potential investment. The IRR is the discount rate that makes the net present value (NPV) of all cash flows from a particular project equal to zero. Cash flows net of financing give us the equity IRR.

Loan Life Coverage Ratio (LLCR): A financial ratio used to estimate the ability of the borrowing company to repay an outstanding loan. It is calculated by dividing the NPV of the cash flow available for debt repayment by the amount of senior debt outstanding.

Methodology: The underlying body of knowledge for the creation of different types of simulation models. It includes theoretical foundations for the approach, and often encompasses both qualitative and quantitative analyzes and instruments.

Model transparency: A transparent model is one for which equations are available and easily accessible and it is possible to directly relate structure to behaviour (i.e., numerical results).

Model validation: The process of deciding whether the structure (i.e., equations) and behaviour (i.e., numerical results) are acceptable as descriptions of the underlying functioning mechanisms of the system and data.

Net Present Value (NPV): The difference between the present value of cash inflows net of financing costs and the present value of cash outflows. It is used to analyze the profitability of a projected investment or project.

Optimization: Simulation that aims at identifying the best solution (with regard to some criteria) from some set of available alternatives.

Policy Cycle: The process of policy-making, generally including issue identification, policy formulation, policy assessment, decision making, policy implementation and policy monitoring and evaluation.

Scenarios: Expectations about possible future events used to analyze potential responses to these new and upcoming developments. Scenario analysis is thus a speculative exercise in which several future development alternatives are identified, explained, and analyzed for discussion on what may cause them and the consequences these future paths may have on our system (e.g., a country or a business).

Simulation model: A model is a simplification of reality, a representation of how the system works, and an analysis of (system) structure and data. A quantitative model is built using one or more specific methodologies, with their strengths and weaknesses.

Spatial aggregation/disaggregation: Aggregated simulation models provide a single value for any given simulated variable (e.g., population and agricultural land). Spatial models instead generate results at the human scale and present them on a map, e.g., indicating how population and agricultural land would be geographically distributed within the boundaries of the country.

Stock and flow variables: A stock variable represents accumulation and is measured at one specific time. A *flow* variable is the rate of change of the stock and is measured over an interval of time.

System dynamics (SD): A methodology to create descriptive models that focus on the identification of causal relations influencing the creation and evolution of the issues being investigated. Its main pillars are feedback loops, delays and non-linearity through the explicit representation of stocks and flows.

Vertical/horizontal disaggregation of models: Vertically disaggregated models represent a high degree of sectoral detail; horizontal models instead include several sectors and the linkages existing among them (with a lesser degree of detail for each of the sectors represented).

Abbreviations

AFTU	Association de Financement des Professionnels du Transport Urbain
BAU	business as usual
BOS	Bureau Opérationnel du Suivi
BRT	Bus Rapid Transit
CAPEX	capital expenditure
CBA	cost–benefit analysis
CETUD	Conseil Exécutif des Transports Urbains de Dakar
CLD	causal loop diagram
DDD	Dakar Dem Dikk
DSCR	debt service coverage ratio
IRR	equity internal rate of return
NPV	equity net present value
FTE	full-time equivalent
GDP	gross domestic product
LLCR	loan life coverage ratio
SAVi	sustainable asset valuation tool
SD	system dynamics

Part I: Introduction

The Bureau Opérationnel du Suivi (BOS), the executive agency responsible for the monitoring of the Plan Senegal Emergent, requested a SAVi assessment on the Bus Rapid Transit (BRT) project. The BRT is a new public transportation project that is set up to improve mobility in and around Dakar, and is one of the flagship projects of the Plan Senegal Emergent. The BRT is expected to improve the capital's economic performance as well as making the labour market more accessible to those living further away. At the same time, the cleaner public transportation system will make a positive environmental contribution by reducing the use of alternative, more polluting modes of transportation and by limiting Senegal's GHG emissions from the transport sector.

Management of the project falls under the aegis of the Executive Council of Transport Urban Dakar (CETUD). The CETUD has also been consulted during the SAVi assessment and was particularly important in providing accurate project data.

The BRT infrastructure consists of an 18.3 km separate lane/corridor for buses involving 23 BRT stations, three terminals (Petersen, Grand Medine and Guédiawaye) and a fleet of 144 buses. The BRT will cover the area between Dakar Plateau and Guédiawaye (see Figure 1). The Petersen terminal will be located in Plateau and will connect the BRT to the rest of the Dakar urban transport system. The terminal will be located at the existing Petersen bus station, which receives more than 50,000 people per day. The Grand Medina terminal is located near the road that goes in the direction of the airport. Finally, the Guédiawaye terminal will be located in front of the Guédiawaye mosque and include a bus terminal, taxi stand and (in future) a car park.

The BRT has four components:

- BRT infrastructure, fleet and systems
- Public transport network restructuring and road works
- Capacity building and project management
- Road safety

Upon project completion in 2023 it is expected that the BRT will be able to transfer up to 300,000 passengers per day.

The total cost of the project is estimated at EUR 369,490,000, financed by the World Bank, the European Bank, the Senegalese Government and the Green Climate Fund. Project financing was approved in 2017. The project is currently in the procurement stage after it released a general procurement notice and subsequent invitations for prequalification, invitation for bids and expressions of interest for various parts of the project in 2018.

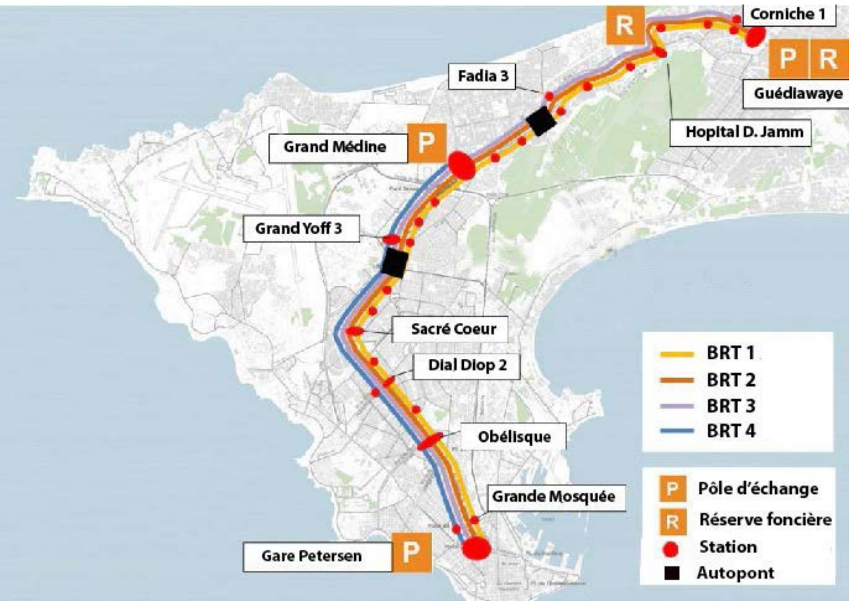

Figure 1. Map of the BRT trajectory

Source: CETUD, 2015.

The SAVi assessment on the BRT was used to provide BOS with information on the added value of the BRT compared to a scenario where the BRT would not be implemented. Because demand for new public transportation projects is difficult to forecast, the SAVi assessment also includes two scenarios to calculate the financial impact of over-and underestimating demand respectively. The SAVi assessment includes the valuation of six externalities related to the project, as well as projections for employment.

Part II: Externalities and Scenarios

The SAVi assessment consists of:

- A valuation of six externalities related to the project, as well as the inclusion of the BRT project preparation costs.
- A simulation of four scenarios: a scenario without BRT, one with the BRT, and two sensitivity scenarios where the demand for the BRT drops or increases compared to the general BRT scenario. The sensitivity scenarios were added because demand for new transportation projects is difficult to estimate, and this SAVi assessment gives information to BOS on how an under- or overestimation of demand will impact the costs and revenues of the project.
- A comparison of the costs and benefits of the project, across the different scenarios.
- A simulation of the employment impact of the BRT project.
- A simulation of the impact of the inclusion of externalities on project finance indicators.

1. Externalities and Project Preparation Costs for an Integrated SAVi Assessment

The SAVi assessment considers the monetary valuation of project-related externalities. This includes costs and monetized impacts related to the project preparation and operations phase. Table 1 lists all externalities and project preparation costs considered for the assessment. The assessment of the built-in externality assessment in SAVi is directly related to the size of the asset to be implemented.

Table 1. Externalities and project preparation costs considered in the SAVi assessment

Project preparation costs	• Compensation payments • Reinstallation payments
Externalities	• Discretionary spending • Value of time saved • Avoided cost of transport • Avoided cost of pollution • Avoided cost of GHG emissions • Avoided cost of accidents

DISCRETIONARY SPENDING

The discretionary spending from labour income represents the amount of money that flows back into the economy in the form of additional consumption. Discretionary spending is assumed to be a share of the annual labour income (30 per cent). This approach estimates the beneficial socioeconomic impacts stemming from employment generation, and allows the indication of the expected economic and social return of an asset. The number of FTEs generated by the BRT project and the annual income was estimated by CETUD (2016) in their *Analyse économique du projet propose par SFI*. The assessment of discretionary spending is calculated based on the number of jobs provided by each transportation mode and a monthly salary depending on the respective mode of transport—between CFA 100,000 (USD 171)[1] and CFA 258,718 (USD 441) per person per month, as indicated in the assessment provided by CETUD (CETUD, 2017a). For the use of private vehicles, no salary is assumed.

[1] USD values are indicated in brackets. Exchange rate from 08.05.2019. Source: https://www.oanda.com/currency/converter/

VALUE OF TIME SAVED

The value of time saved represents the economic value of improved mobility resulting from the BRT project. In line with CETUD (2016), a value of time saved of CFA 450 per hour saved (USD 0.77) was assumed for the assessment in this report. The value of time saved is estimated in real terms, which means this assessment does not apply a growth rate to the value of time saved over time. The results of the SAVi model were validated against the results provided by CETUD (2016), for both CFA 450 (USD 0.77) and CFA 600 per hour (USD 1.02) respectively.

AVOIDED COST OF TRANSPORT

The costs of transportation represent the amount of money spent per year on transport. The assessment covers six different transportation modes: Bus Dakar Dem Dikk (DDD), Bus Association de Financement des Professionnels du Transport Urbain (AFTU), taxi, private vehicles, multimodal and the BRT. The cost of transportation is the sum of the amount of money spent across all six modes of transport. The BRT will lead to avoided costs of transportation. The following assumptions were used to estimate the avoided cost of transportation of the current public transport fleet:

Table 2. Assumptions for the calculation of transportation cost

Mode of transport	Cost of transport per vehicle-km (CFA)	
	2020	2030
Bus DDD	1,500	1,500
Bus AFTU	596	727
Taxi	176	215
Private vehicle	105	128
Multimode	600	600

AVOIDED COST OF POLLUTION

As the shift in the transportation sector takes place, it is estimated that the BRT project brings benefits in terms of avoided costs of air pollution. The valuation of emissions represents the monetized value of $PM_{2.5}$, SO_2 and NO_x emissions related to burning fossil fuels. Emissions related to burning fossil fuels have many adverse impacts, including respiratory diseases, cardiac diseases, impacts on agriculture yields and many more. The valuation of emissions is based on the socioeconomic impact study by CETUD and estimated per vehicle-km at CFA 12.5 (USD 0.02) in 2015, with an annual increase of 2 per cent until 2030. SAVi computes these costs by multiplying the vehicle-km of each transport mode by the per vehicle-km cost of pollution.

AVOIDED COST OF GHG EMISSIONS

The BRT project will shift modes of transport from individual cars, taxis, multimode, minibuses and DDD to the BRT. That shift is accompanied by a reduction in GHG emissions as the BRT is a cleaner mode of transportation. The cost of emissions is computed by multiplying the emissions generated by each transport mode by the cost of emissions per ton. The costs of emissions in the SAVi BRT model increase linearly from CFA 24,080/ton CO_2 in 2020 (USD 41) to CFA 28,896/ton CO_2 in 2030 (USD 49), after which they remain constant. This is based on the assumptions by CETUD (2016).

AVOIDED COST OF ACCIDENTS

The costs of accidents are calculated based on the number of accidents and their economic valuation. The assessment considers three different types of accidents: light, medium and fatal. Fatal accidents are accidents where a human life is lost and are valued the highest of the three. Table 2 provides information about the monetary value by type of accident. CETUD (2016) provided an estimation for each accident category per vehicle kilometre, which was multiplied with the monetary value, with an annual increase of 2.5 per cent per year.

Table 3. Valuation of Accidents

Type of accident	Economic Valuation (CFA million)
Light accident *(light injury)*	2,4
Medium accident *(heavy injury)*	18
Fatal accident *(death)*	90

2. Scenarios

Table 4 provides an overview of the scenarios simulated for the SAVi BRT assessment.

Table 4. Scenarios simulated for the BRT SAVi assessment

Scenario	Assumptions
Scenario 0: Business as Usual	• No BRT project is implemented

Scenario 1: BRT	• The BRT project is implemented
	  • Capital investment: CFA 103,623,835,648 (USD 176,829,000)
	• Demand: 118,137,600 trips/year (in 2020) up to 202,000,000 trips/year (in 2043)
	  • Revenues: CFA 565,537,013,760 (USD 965,061,000)
	  • Operation and maintenance cost (including capital investment of rolling stock): CFA 386,578,972,672 (USD 659,678,000)

Scenario	Assumptions

Scenario 2: BRT with low demand	• The BRT project is implemented
	  ◦ Capital investment: CFA 103,623,835,648 (USD 176,829,000)
	• Demand: 118,108,760 trips/year (in 2020) up to 151,500,000 trips/year (in 2043)
	  ◦ Revenues: CFA 448,832,569,344 (USD 765,911,000)
	  ◦ Operation and maintenance cost (including capital investment and O&M cost of rolling stock): CFA 328,507,551,744 (USD 560,582,000)

Scenario 3: BRT with high demand	• The BRT project is implemented
	  ◦ Capital investment: CFA 103,623,835,648 (USD 176,829,000)
	• Demand: 118,166,440 trips/year (in 2020) up to 252,500,000 trips/year (in 2043)
	  ◦ Revenues: CFA 682,242,998,272 (USD 1,164,210,000)
	  ◦ Operation and maintenance cost (including capital investment of rolling stock) CFA 526,756,438,016 (USD 898,884,000)

Part III: Results

This section describes the results of the SAVi assessment. It includes the integrated cost–benefit analysis, accompanied by details on each of the sections of the CBA and the financial indicators resulting from the project finance model.

1. Integrated Cost–Benefit Analysis

The SAVi assessment generates an integrated cost–benefit analysis (Table 5) that includes the project investment and O&M costs, costs of financing, project preparation costs, externalities and revenues across the three scenarios, relative to the BAU scenario.

Table 5. Integrated cost–benefit analysis

		BRT	BRT - Low demand	BRT - High demand
Investment				
Investment in BRT infrastructure	mn CFA	103,624	103,624	103,624
Investment in rolling stock	mn CFA	54,218	45,879	62,931
O&M cost rolling stock	mn CFA	332,361	282,629	463,825
Additional project-related costs				
Cost of financing	mn CFA	58,975	58,975	58,975
Compensation payments	mn CFA	3,152	3,152	3,152
Reinstallation payments	mn CFA	1,213	1,213	1,213
Subtotal (1) – Sum of investments & additional costs	**mn CFA**	**553,543**	**495,472**	**693,720**
Revenues	**mn CFA**	**565,537**	**448,833**	**682,243**
Subtotal (2) - Net profits	**mn CFA**	**11,994**	**(46.639)**	**(11.477)**
Externalities				
Discretionary spending	mn CFA	95,737	70,160	121,313
Value of time saved	mn CFA	541,065	424,614	657,517
Avoided cost of transport	mn CFA	1,455,114	1,146,107	1,764,121
Avoided cost of pollution	mn CFA	38,769	30,012	47,504
Avoided cost of GHG emissions	mn CFA	17,751	13,020	22,430
Avoided costs of accidents	mn CFA	31,226	24,682	37,771
Subtotal (3) - Sum of added benefits	**mn CFA**	**2,179,662**	**1,708,595**	**2,650,656**
Total net benefits	**mn CFA**	**2,191,656**	**1,661,956**	**2,639,179**

The integrated CBA in Table 5 shows that the implementation of the BRT project under scenario 1 generates a net profit of mn CFA 11.994,00 (USD 20,5 million).

There are significant positive externalities arising from the implementation of the BRT. The main benefits are obtained from avoided cost of transportation and time savings. Depending on the scenario, the avoided costs of transportation range between CFA 1.15 trillion (USD 1.96 billion) for the BRT - low demand scenario and CFA 1.76 trillion (USD 3.01 billion) for the BRT - high demand scenario. The value of time saved ranges between CFA 424.6 billion (USD 725 million) and CFA 657.5 billion (USD 1.12 billion) for the low-demand and high-demand scenario respectively.

The discretionary spending from labour in the transportation sector is lowest when the demand for BRT is the highest (Scenario 3). As Table 9 demonstrates, there is a net job loss resulting from the implementation from the BRT, but an overall positive impact for the economy based on additional spending from other jobs that might not be directly related to the transportation sector.

The following tables and figures provide more detail on selected results from the SAVi assessment.

Table 6. Cumulative values of externalities across different scenarios

	Unit	BAU	BRT	BRT - Low demand	BRT - High demand
Cumulative externalities					
Discretionary spending	mn CFA	184,303	280,040	254,463	305,616
Value of time saved	mn CFA	0	541,065	424,614	657,517
Cost of pollution	mn CFA	341,581	302,732	311,489	293,997
Cost of GHG emissions	mn CFA	179,787	161,855	166,587	157,177
Cost of accidents	mn CFA	237,101	205,874	212,419	199,329
Total value of externalities	**mn CFA**	**942,772**	**1,491,566**	**1,369,572**	**1,613,636**

Table 6 shows the cumulative values for externalities from period 2019 to 2043. The implementation of the BRT yields benefits across all categories: it reduces the total investment costs in the transportation sector, yields higher spending from income, saves time, reduces cost of accidents, air pollution and emissions.

Table 7. Vehicle km travelled per year per mode of transportation

Mode of transportation	Scenario	2020	2030	2040
Bus DDD	BAU	32,318,394	43,608,932	58,843,880
	BRT	30,702,474	39,248,040	52,959,496
	BRT vs BAU	-5.00%	-10.00%	-10.00%
Bus AFTU	BAU	77,382,024	104,415,656	140,893,600
	BRT	57,649,616	51,163,704	69,037,904
	BRT vs BAU	-25.50%	-51.00%	-51.00%
Taxi	BAU	163,867,824	221,115,504	298,362,976
	BRT	150,758,400	185,737,040	250,624,928
	BRT vs BAU	-8.00%	-16.00%	-16.00%
Private vehicles	BAU	343,758,560	463,851,616	625,899,648
	BRT	338,602,176	449,936,064	607,122,688
	BRT vs BAU	-1.50%	-3.00%	-3.00%
Multimode	BAU	40,966,956	55,278,872	74,590,744
	BRT	36,870,264	44,223,104	59,672,604
	BRT vs BAU	-10.00%	-20.00%	-20.00%
BRT	BAU	0	0	0
	BRT	13,949,995	17,549,990	18,899,990
	BRT vs BAU	N/A	N/A	N/A
Total	BAU	658,293,758	888,270,580	1,198,590,848
	BRT	628,532,925	787,857,942	1,058,317,610
	BRT vs BAU	-4.5%	-11.3%	-11.7%

Table 7 represents outcomes from the SAVi model on the projections of changes in the other modes of transportation due to the implementation of the BRT. They are consistent with the projections generated by CETUD (2016). By 2040, the amount of vehicle-km travelled in the BRT scenario is 11.7 per cent lower compared to the BAU.

Figure 2 further illustrates this finding: as expected, all BRT scenarios reduce the amount of vehicle-km travelled, which in turn has benefits in terms of air pollution and GHG emissions.

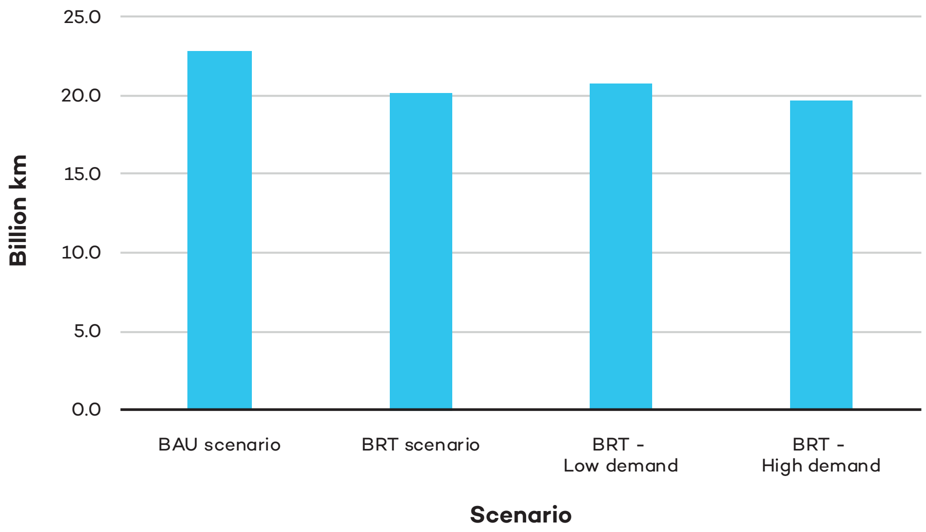

Figure 2. Cumulative vehicle-km travelled

Figure 3 shows that congestion increases over time in all scenarios. This is driven by population growth and projected economic growth. In the BRT scenario, congestion increases during the construction phase, and drops below the BAU scenario when the BRT is fully operational in 2021. In the long run, the BRT is projected to decrease the total time spent in traffic by approximately 30 per cent.

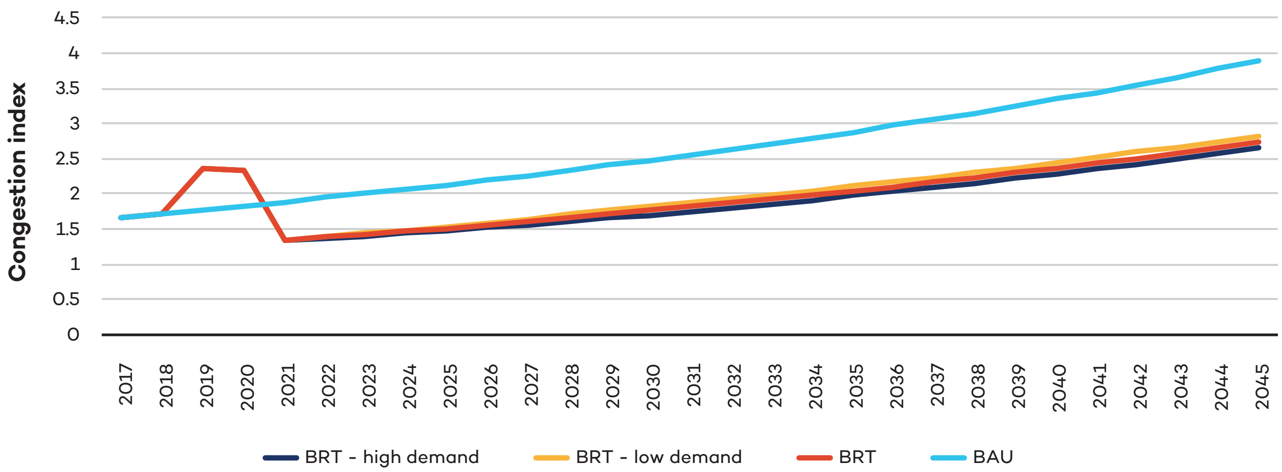

Figure 3. Congestion in the different scenarios

Table 8. GHG Emissions

Scenario	Unit	2020	2030	2040	Cumulative (Ton) in 2043
BAU	Ton/Year	179,861.4	242,696.5	327,483.3	8,649,990.1
BRT	Ton/Year	180,103.1	219,835.4	291,041.7	8,070,933.1
versus BAU	%	0.1%	-9.4%	-11.1%	-6.69%
BRT - Low demand	Ton/Year	180,107.0	230,094.8	299,710.2	8,225,281.7
versus BAU	%	0.1%	-5.2%	-8.5%	-4.91%
BRT - High demand	Ton/Year	180,099.2	209,576.0	282,667.9	7,918,130.1
versus BAU	%	0.1%	-13.6%	-13.7%	-8.46%

Table 8 shows that in every scenario with BRT there is a reduction in GHG emissions across the lifecycle of the project. The longer the BRT is running, the larger the reduction. In 2040, the BRT helps reducing between 8.5 per cent and 13.7 per cent of emissions compared to the BAU, depending on the demand scenario. In 2020 there is a light increase in GHG emissions in the BRT scenarios. This is caused by the higher congestion due to the construction phase of the BRT.

Table 9. Projected employment in 2043

Mode of transport	Unit	BAU	BRT	% difference
Bus DDD	FTE	4,184.6	3,766.1	-10%
Bus AFTU	FTE	6,165.8	3,021.2	-51%
Taxi	FTE	2,331.6	1,958.5	-16%
Private vehicles	FTE	0.0	0.0	N/A
BRT	FTE	0.0	2,171.4	N/A
Total	**FTE**	**12,682.0**	**10,917.3**	**-14%**

The implementation of the BRT will also impact employment in the transportation sector. Table 9 shows how employment under the different modes of transport changes. We see job losses for all transportation providers, especially in the sector of the AFTU buses (51 per cent). Projected job creation from the BRT will not directly compensate for the jobs lost in the other transportation modes. However, we need to consider this projection in relation to how the BRT will add discretionary spending to the economy.

Table 10 shows that, despite the net job loss related to the BRT, the cumulative discretionary spending over the lifetime of the project is 15.6 per cent higher than under the BAU. Indeed, the BRT will enhance mobility for the citizens in and around Dakar, which means they also have better access to the job market, resulting in a positive contribution to the Senegalese economy. Projected employment was calculated based on the vehicle kilometres travelled per transportation mode and the number of trips per mode, multiplied by an employment per vehicle-km travelled multiplier (CETUD, 2016).

Table 10. Cumulative Discretionary Spending

BAU	BRT	Difference (%)
CFA 268,053 mn	CFA 309,814 mn	15.6

Table 11. Accidents

	Unit	2020	2025	2030	2035	2040
BAU						
Light accidents	Accidents/Year	307	356	414	481	559
Medium accidents	Accidents/Year	190	220	256	297	345
Fatal accidents	Accidents/Year	34	39	45	53	61
Total accidents	**Accidents/Year**	**530**	**616**	**715**	**831**	**965**
BRT						
Light accidents	Accidents/Year	286	309	359	417	484
Medium accidents	Accidents/Year	177	191	222	258	299
Fatal accidents	Accidents/Year	31	34	39	46	53
Total accidents	**Accidents/Year**	**495**	**534**	**620**	**720**	**837**
BRT vs BAU	**Accidents/Year**	**-35**	**-82**	**-95**	**-110**	**-128**
BRT vs BAU	**%**	**-6.6%**	**-13.3%**	**-13.3%**	**-13.3%**	**-13.3%**

The number of accidents is calculated by multiplying the vehicle-km travelled per mode of transportation with an estimated number of accidents (per 1,000 km travelled). This number is based on the valuation of CETUD's (2016) socioeconomic impact analysis. In the BRT scenarios, the BRT takes over a share of transportation by other modes. It reduces the total vehicle-km travelled (see Figure 2) which in turn leads to a reduction in annual accidents as a result of increased safety. Over time the BRT leads to more than a 13 per cent reduction in accidents.

Table 12 and 13 provide an overview of externalities per passenger and passenger-km travelled.

Table 12. Externalities per passenger transported by the BRT over the project lifecycle

Indicator	Unit	BAU scenario	BRT scenario	BRT - Low demand	BRT - High demand
Cumulative number of passengers transported	mn passengers	19,815	23,787	22,890	24,684
Externality per passenger					
Discretionary spending	CFA/ passenger	-9.3	-11.77	-11.12	-12.38
Value of time saved	CFA/ passenger	0	-22.75	-18.55	-26.64
Cost of transport	CFA/ passenger	341.15	243.62	251.78	209.14
Cost of pollution	CFA/ passenger	17.24	12.73	13.61	11.91
Cost of GHG emissions	CFA/ passenger	9.07	6.8	7.28	6.37
Cost of accidents	CFA/ passenger	11.97	8.65	9.28	8.08
Total value per passenger	**CFA/ passenger**	**370.13**	**237.28**	**252.28**	**196.48**
Total vs BAU	**%**	**0.00%**	**-35.89%**	**-31.84%**	**-46.92%**

Table 13. Externalities per passenger-km travelled

		BAU scenario	BRT scenario	BRT - Low demand	BRT - High demand
Discretionary spending	CFA / passenger-km	-0.91	-1.38	-1.25	-1.51
Value of time saved	CFA / passenger-km	0	-2.67	-2.09	-3.24
Cost of transportation	CFA / passenger-km	33.4	28.57	28.42	25.45
Cost of pollution	CFA / passenger-km	1.69	1.49	1.54	1.45
Cost of GHG emissions	CFA / passenger-km	0.89	0.8	0.82	0.77
Cost of accidents	CFA / passenger-km	1.17	1.01	1.05	0.98
Sum of externalities and costs	**CFA / passenger-km**	**36.24**	**27.82**	**28.49**	**23.9**

In Table 13, under the BAU scenario the externalities per passenger-km total CFA 36.24 (USD 0.06), whereby the largest share comes from the cost of transport. In the BRT scenarios, the externalities per passenger-km decrease the more the BRT is used, which means that the BRT contributes to mitigating some of the negative impacts from transportation.

Tables 12 and 13 show that the more people are transported by the BRT the lower the cost of pollution and cost of emissions per passenger and per passenger-km travelled.

2. Financial Analysis

The purpose of the financial analysis is to assess the financial viability of the BRT project and to demonstrate the financial impact of the environmental, social and economic externalities measured. Scenario 1 (BRT, baseline demand), Scenario 2 (BRT, low demand) and Scenario 3 (BRT, high demand) represent how the BRT would perform under a traditional financial assessment with different demand forecasts. Scenario 1E, Scenario 2E and Scenario 3E integrate the set of externalities measured earlier in their respective base scenario.

KEY FINDINGS

The environmental, social and economic externalities measured have a significant impact on the value of the BRT project. When they are integrated into the financial assessment, the financial performance indicators are enhanced.

The BRT project is not financially viable under the traditional financial assessment, irrespective of the expected passenger demand.

Table 14. Financial indicators

	IRR (%)	NPV (USD mn)	Min. DSCR (x)	Ave. DSCR (x)	Min. LLCR (x)
Scenario 1: BRT	2.17%	(51)	(1.80x)	0.76x	0.48x
Scenario 1E: BRT + externalities	37.69%	1,522	7.92x	10.88x	10.30x
Scenario 2: BRT with low demand	0.72%	(72)	(1.36x)	0.63x	0.36x
Scenario 2E: BRT with low demand + externalities	35.30%	1,188	6.14x	8.70x	8.35x
Scenario 3: BRT with high demand	3.38%	(31)	(2.25x)	0.88x	0.60x
Scenario 3E: BRT with high demand + externalities	39.72%	1,856	8.13x	13.07x	12.23x

The negative net present value (NPV) indicates that the discounted cash flows of the project cannot cover the capital and operating expenditures. In other words, the project is not a sound investment for either debt or equity investors. While the internal rate of return (IRR) is positive, it is below the expected market rate of return of projects with similar risk profiles in the region.

DSCR indicates the financial health of a project. DSCR lower than “1” means that the cash flows are insufficient to service the debt in that period. Both the average and minimum DSCR ratios are below the lockup ratio of 1.15x usually required by lenders.

LLCR also indicates the financial health of a project. LLCR lower than “1” means that the net present value of the remaining cash flows during the tenor of the debt is insufficient to service the outstanding debt amount with interest. In addition, the minimum LLCR is significantly below the lockup ratio of 1.10x usually required by lenders.

The minimum DSCR and LLCR are especially low for the BRT projects due to the cost of replacement of the entire bus fleet that was purchased at the beginning of the project. These numbers demonstrate that operating cash flows are insufficient to cover a one-time cost of this size.

The positive externalities of the BRT project are significant and make the project worthwhile

When the values of positive externalities are included in the financial assessment (Scenarios 1E, 2E and 3E), stakeholders are presented with a more enhanced valuation. The financial performance indicators improve across the board. While the cashflows of the project effectively remain unaltered, this assessment demonstrates that the positive economic multipliers enabled by the BRT make the project worthwhile.

As the financial impact of externalities is similar across the different passenger demand scenarios, only the results of the default demand scenarios, Scenario 1 and Scenario 1E, are discussed in detail.

The difference between Scenario 1 and Scenario 1E demonstrates the positive impact of socioeconomic externalities. All the key financial indicators measured improve significantly under Scenario 1E.

Avoided cost of transport, the amount of money passengers would otherwise spend on mobility, had the largest impact on the financial performance among the externalities measured. It would alone increase the IRR by 27.44 per cent under the default demand scenario. The economic value of time saved due to the improved mobility also has a significant impact, increasing the IRR by 14.38 per cent.

When all assessed socioeconomic and environmental externalities are integrated into the financial model the IRR jumps from 2.17 per cent to 37.69 per cent. This improvement in profitability is also reflected in the NPV, which increases from USD -51 million to USD 1.5 billion. This highlights the impact of externalities when being incorporated into the financial assessment. The improvement in credit ratios, namely the DSCR and LLCR, underscores this observation. However, it is important to note that these ratios were calculated for the sake of comparing the impact of externalities between assessed scenarios. Of course, the positive externalities analyzed will not have an actual impact on the project cash flows. Sufficient operating revenues still need to be generated at the project level in order to cover all the relevant costs.

Part IV: How SAVi for the BRT Project Was Built

Systems Thinking and System Dynamics

The SAVi analysis focuses on the assessment both positive and negative potential outcomes of the BRT project of Dakar, Senegal. The underlying dynamics of the transport sector in Dakar, including key variables, driving forces and feedback loops, are summarized in the causal loop diagram (CLD) displayed in Figure 4. The CLD was developed and customized to the local context in collaboration with local stakeholders, specifically with the Bureau Opérationnel de Suivi du Plan Sénégal Emergent (BOS), who also provided the necessary data to customize and parametrize the mathematical model. The CLD presented in Figure 4 is the starting point for the development of the mathematical (stock and flow) model.

BOX 1. READING A CAUSAL LOOP DIAGRAM

Causal loop diagrams include variables and arrows (called causal links), with the latter linking the variables together with a sign (either + or −) on each link, indicating a positive or negative causal relation (see Table 5):

- A causal link from variable A to variable B is positive if a change in A produces a change in B in the same direction.
- A causal link from variable A to variable B is negative if a change in A produces a change in B in the opposite direction.

Variable A	Variable B	Sign
↑	↑	+
↓	↓	+
↑	↓	-
↓	↑	-

Table 15. **Causal relations and polarity**

Circular causal relations between variables form feedback loops. These can be positive or negative. A negative feedback loop tends toward a goal or equilibrium, balancing the forces in the system (Forrester, 1961). A positive feedback loop can be found when an intervention triggers other changes that amplify the effect of that initial intervention, thus reinforcing it (Forrester, 1961). CLDs also capture delays and non-linearity.

The creation of a CLD has several purposes: first, it combines the team's ideas, knowledge and opinions; second, it highlights the boundaries of the analysis; third, it allows all stakeholders to achieve basic-to-advanced knowledge of the analyzed issues and their systemic properties. Having a shared understanding is crucial for solving problems that influence several sectors or areas of influence, which are common in complex systems. Since the creation of a CLD touches upon and relies on cross-dimensional knowledge, it supports developing a shared understanding of the dynamics that generate the problem and those that could lead to a solution. This shared understanding, achieved among all the parties involved in the decision-making process and implementation of interventions, can support the creation of private-public partnerships and increase effectiveness. As such, the solution should not be imposed on the system, but should emerge from it. In other words, interventions should be designed to make the system start working in our favour (i.e., of decision-makers and relevant stakeholders), to solve the problem, rather than generating it.

In this context, the role of feedback loops is crucial. It is often the very system we have created that generates the problem, due to external interference, or to a faulty design, which shows its limitations as the system grows in size and complexity. In other words, the causes of a problem are often found within the feedback structures of the system. Indicators are not sufficient to identify these causes and explain the events that led to the creation of the problem, we need to analyze causality and feedback loops. We are too often prone to analyze the current state of the system, or to extend our investigation to a linear chain of causes and effects, which does not link back to itself, thus limiting our understanding of open loops and linear thinking.

MODEL OVERVIEW

The SAVi BRT model was developed to assess the outcomes of implementing the BRT on the transport systems of Dakar. The variables forecasted include total vehicle-km travelled, time and money spent on transportation, air pollution and accidents. The model is calibrated using various data sources. For instance, the volume of travel (e.g., number of trips, total and by mode of transportation) is calibrated according to the forecasts provided by CETUD (2016). Costs and benefits of the BRT are instead calibrated based on information provided by BOS Senegal (CETUD, 2016; CETUD, 2017a; CETUD, 2017b; CETUD, 2017c; CETUD, 2017d; CETUD, 2017e).

The simultaneous existence of various feedback loops determines the behaviour of the system. In total, seven reinforcing (R) and three balancing (B) feedback loops have been identified as being the main drivers of transport demand and resulting impacts on the transport system.

- Reinforcing loops (R6) and (R7) capture how the transport sector contributes to employment and income generation, which increases consumption and consequently macroeconomic performance. These are the main drivers of growth for the sector and explain how infrastructure investment leads to employment creation and economic growth, which in turn leads to demand for infrastructure services.
- The loops (B1a), (B1b) and (B1c) represent how the capacity adjustment of the current transport providers increases congestion and leads to reduced consumption and GDP. As GDP grows, the demand for transportation increases, which prompts providers to increase their capacity to satisfy the growing demand.
- The overall increase in the number of vehicles on the road and the resulting GDP impacts are captured by the loop (B2). As GDP and the demand for transportation (number of passengers) increase, the overall number of vehicles on the road increases, which leads to increased congestion, pollution and accidents and curbs economic performance, since both the time spent on transportation and health care expenditures increase in the long run as outlined above.
- Reinforcing loop (R1) indicates that the BRT contributes to reducing time spent on transportation. It also reduces congestion, and fosters economic performance by curbing the demand for transportation from other sources. Due to its high capacity and dedicated lanes, the BRT is an attractive PT option within a similar price range as other transport providers that benefits through time savings for its users. If the BRT is well managed and its capacity expands as demand for mobility increases, the BRT will reduce demand for other transportation across all modes, which reduces system-wide congestion (R3) and contributes to reducing the time spent on transport (R1).

- The loop (R2) captures how the BRT increases its attractiveness for potential users through being faster and more environmentally friendly as opposed to other modes of transport. The usage of the BRT reduces accidents (R5), fuel consumption (R4) and air emissions, which reduce health costs and increase productivity and GDP, and hence leads to more demand for mobility and higher use of the BRT.
- The balancing loop (B3) highlights the beneficial impact of the BRT in reducing congestion for its users. By reducing congestion, the BRT contributes to spending less time on transportation, which will lead to an increasing demand for the BRT, away from other sources of transportation.

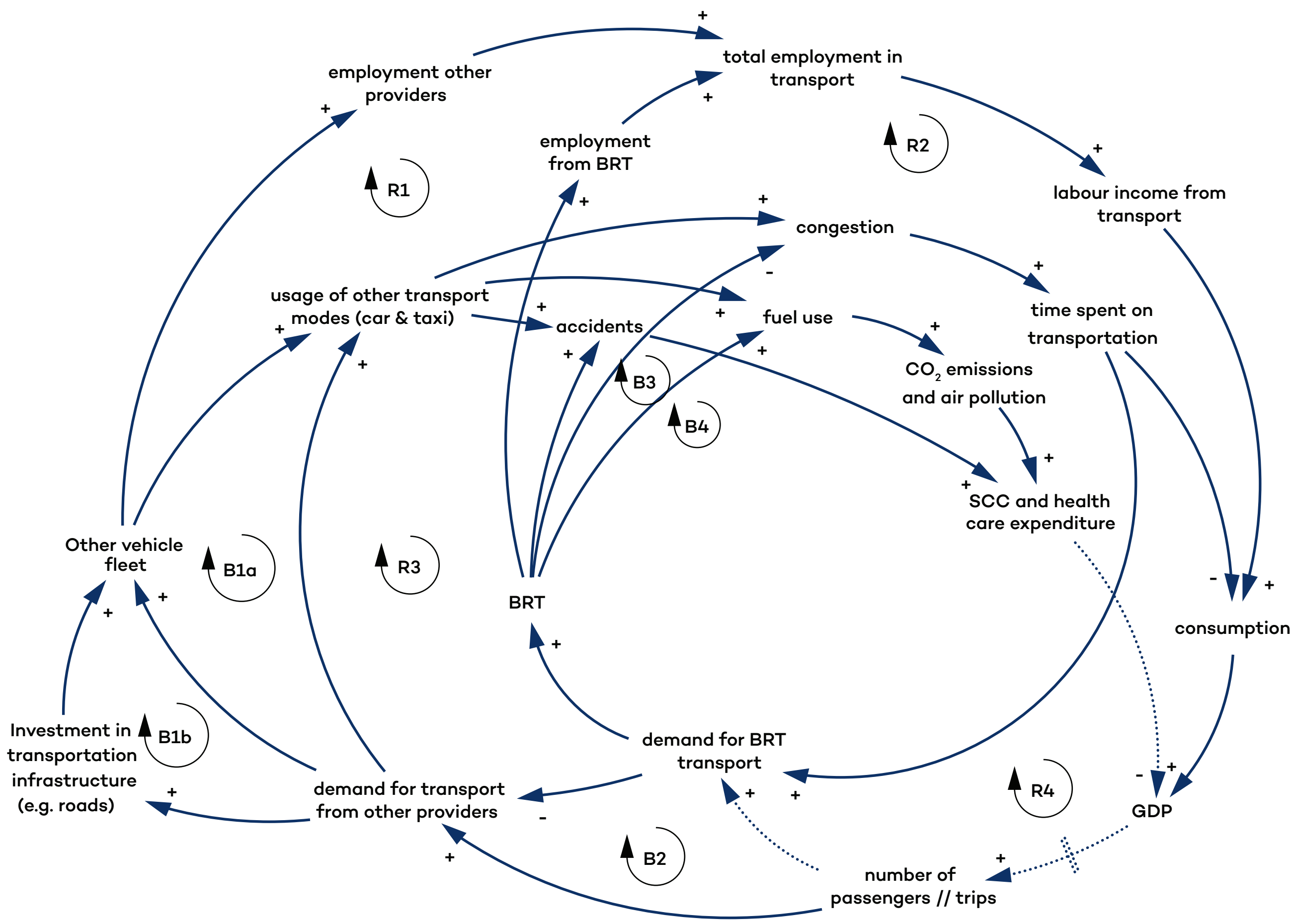

Figure 4. Causal Loop Diagram for the SAVi BRT assessment

MODEL OVERVIEW PROJECT FINANCE

The main purposes of a project finance model are: 1) to identify the optimal capital structure; 2) To assess the financial viability of the project; and 3) to calculate the expected return on investment under different operational and risk scenarios.

1. Project sponsors use financial models to determine what the optimal debt-equity split that should used in the financing of the project. This largely depends on the project's revenue and cost profile: the timing and size of incoming cash flows during operations and the associated costs in each period. Most infrastructure projects follow a so-called "J-curve": having high upfront costs and relatively small, but steady revenue streams. The "J" represents the fact that it takes a certain number of years before the project breaks even and generates a return on investment.

2. Project finance models can also calculate whether the cash flows generated by the project will be sufficient to service the debt and generate an attractive risk-adjusted return for both equity and debt investors. This assessment includes the calculation of key profitability and credit indicators, such as the internal rate of return (IRR), net present value (NPV), debt service coverage ratio (DSCR) and loan life coverage ratio (LLCR). The definition of these indicators can be found in the glossary.
3. Project finance models are also well placed to stress test projects and assess how the expected return changes under certain operational and risk scenarios. This is calculated by a so-called "scenario table," which modifies key project assumptions and shows how key financial indicators react to these changes. Scenarios could be simple operational events, such as an increase in the price of feedstock, disruption in operation, or more complex climate events, such as heat waves, sea level rise or carbon tax.

The project finance model used in SAVi is built in Microsoft Excel and follows Corality SMART best practices to improve readability and auditability of the model by a third party. The outputs of the system dynamics model in SAVi are used as inputs in the project finance model and vice versa. The system dynamics model quantifies and monetizes the relevant environmental, social and economic externalities associated with the project. It also helps to identify the scenarios used in the scenario table. Depending on the purpose of the assessment and the target audience, some of the externalities are included as costs or benefits in the scenario table. Outputs of the system dynamics model can also change some of the key assumptions of the project finance model.

The main outputs of the project finance model are the financial indicators mentioned earlier. During the customization of the model, the list of indicators can be changed or extended as needed. Project-specific data, such as cost of financing, can also be extracted from the project finance model and fed back into the system dynamics model.

Part V: Conclusions

The SAVi assessment of the BRT project provides BOS with an overview of the multiplier benefits of the project. It also sheds light on how externalities such as pollution and GHG emissions are avoided when implementing the BRT project, and how they impact the financial viability of the project. Finally, the analysis took into account risks related to the demand for the BRT, and demonstrates the impact of overestimating (or underestimating) demand on the financial performance of the project.

Beyond the negative externalities, and the demand-risk scenarios, SAVi also assessed the potential shifts in the job market of the transportation sector. Indeed, the analysis shows that there will be a job loss in the other modes of transportation that will not be fully absorbed by the jobs directly created through the project. However, SAVi also demonstrates that mobility to and from Dakar will improve significantly, giving more citizens access to the formal job market. It is expected that the overall impact on employment is positive.

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Addendum to the SAVi Bus Rapid Transit analysis

Cost and Revenue Sensitivity Analysis BRT

This document is an addendum to the SAVi Bus Rapid Transit analysis. BOS requested that IISD complement the SAVi BRT analysis with a cost and revenue sensitivity analysis.

Table 1 provides an overview of the assumptions of the sensitivity analysis. Tables 2 to 6 present the integrated cost-benefits analyses (CBAs) of each of these assumptions for baseline, low- and high-demand scenarios.

Table 1. Overview assumptions for the sensitivity analysis

Assumptions	Unit	Value
Baseline scenario	CFA / Trip	150.0
5% increase in fare	CFA / Trip	157.5
10% increase in fare	CFA / Trip	165.0
5% decrease in fare	CFA / Trip	142.5
10% decrease in fare	CFA / Trip	135.0
+ 30.90% increased capital expenditure (CAPEX)	CFA/Trip	150.0 and 30.9% increase in CAPEX

Table 2 demonstrates that baseline fares result in a net loss under the low- and high-demand scenarios. Only the BRT scenario results in a net profit. When integrating the externalities, all scenarios bring positive benefits.

Table 2. Baseline Integrated CBA

		BRT	BRT - Low demand	BRT - High demand
Investment				
Investment in BRT infrastructure	mn CFA	103,624	103,624	103,624
Investment in rolling stock	mn CFA	54,218	45,879	62,931
O&M cost rolling stock	mn CFA	332,361	282,629	463,825
Additional project-related costs				
Cost of financing	mn CFA	58,975	58,975	58,975
Compensation payments	mn CFA	3,152	3,152	3,152
Reinstallation payments	mn CFA	1,213	1,213	1,213
Subtotal (1) - Sum of costs	**mn CFA**	**553,543**	**495,471**	**693,720**
Revenues	**mn CFA**	**565,537**	**448,833**	**682,243**
Subtotal (2) - Net profits	**mn CFA**	**11,994**	**-46,639**	**-11,477**
Externalities				
Discretionary spending	mn CFA	95,737	70,160	121,313
Value of time saved	mn CFA	541,065	424,614	657,517
Avoided cost of transport	mn CFA	1,455,114	1,146,107	1,764,121
Avoided cost of pollution	mn CFA	38,769	30,012	47,504
Avoided cost of emissions	mn CFA	17,751	13,020	22,430
Avoided costs of accidents	mn CFA	31,226	24,682	37,771
Subtotal (3) - Sum of added benefits	**mn CFA**	**2,179,663**	**1,708,595**	**2,650,656**
Total net benefits	**mn CFA**	**2,191,658**	**1,661,957**	**2,639,179**

Table 3 shows that a 5 per cent increase in fare is sufficient to yield CFA 22.6 billion in net profit in the high-demand scenario. The low-demand scenario operates at a loss. The baseline BRT scenario results in a CFA 40.3 billion profit. When integrating externalities, all scenarios result in a net benefit.

Table 3. Integrated CBA 5% increase in fare

		BRT	BRT - Low demand	BRT - High demand
Investment				
Investment in BRT infrastructure	mn CFA	103,624	103,624	103,624
Investment in rolling stock	mn CFA	54,218	45,879	62,931
O&M cost rolling stock	mn CFA	332,361	282,629	463,825
Additional project-related costs				
Cost of financing	mn CFA	58,975	58,975	58,975
Compensation payments	mn CFA	3,152	3,152	3,152
Reinstallation payments	mn CFA	1,213	1,213	1,213
Subtotal (1) - Sum of costs	**mn CFA**	**553,543**	**495,471**	**693,720**
Revenues	**mn CFA**	**593,814**	**471,273**	**716,355**
Subtotal (2) - Net profits	**mn CFA**	**40,272**	**-24,198**	**22,635**
Externalities				
Discretionary spending	mn CFA	95,737	70,160	121,313
Value of time saved	mn CFA	541,065	424,614	657,517
Avoided cost of transport	mn CFA	1,455,114	1,146,107	1,764,121
Avoided cost of pollution	mn CFA	38,769	30,012	47,504
Avoided cost of emissions	mn CFA	17,751	13,020	22,430
Avoided costs of accidents	mn CFA	31,226	24,682	37,771
Subtotal (3) - Sum of added benefits	**mn CFA**	**2,179,663**	**1,708,595**	**2,650,656**
Total net benefits	**mn CFA**	**2,219,935**	**1,684,397**	**2,673,291**

Table 4 shows that in the low-demand scenario, not even a 10 per cent increase in baseline fare would suffice to generate positive results.

Table 4. Integrated CBA 10% increase in fare

		BRT	BRT - Low demand	BRT - High demand
Investment				
Investment in BRT infrastructure	mn CFA	103,624	103,624	103,624
Investment in rolling stock	mn CFA	54,218	45,879	62,931
O&M cost rolling stock	mn CFA	332,361	282,629	463,825
Additional project-related costs				
Cost of financing	mn CFA	58,975	58,975	58,975
Compensation payments	mn CFA	3,152	3,152	3,152
Reinstallation payments	mn CFA	1,213	1,213	1,213
Subtotal (1) - Sum of costs	**mn CFA**	**553,543**	**495,471**	**693,720**
Revenues	**mn CFA**	**622,090**	**493,715**	**750,467**
Subtotal (2) - Net profits	**mn CFA**	**68,548**	**-1,756**	**56,747**
Externalities				
Discretionary spending	mn CFA	95,737	70,160	121,313
Value of time saved	mn CFA	541,065	424,614	657,517
Avoided cost of transport	mn CFA	1,455,114	1,146,107	1,764,121
Avoided cost of pollution	mn CFA	38,769	30,012	47,504
Avoided cost of emissions	mn CFA	17,751	13,020	22,430
Avoided costs of accidents	mn CFA	31,226	24,682	37,771
Subtotal (3) - Sum of added benefits	**mn CFA**	**2,179,663**	**1,708,595**	**2,650,656**
Total net benefits	**mn CFA**	**2,248,211**	**1,706,839**	**2,707,403**

In the case of a 5 per cent and 10 per cent decrease in fares, all simulated scenarios indicate a net operational loss. A 5 per cent decrease in the fare (from CFA 150 to CFA 142.5) leads to CFA 16.8 billion in negative operational results in the BRT scenario (see Table 5), while the results for the low-demand and high-demand scenarios become more negative. A 10 per cent decrease in fares further decreases the already negative results for all three scenarios, as summarized in Table 6.

Table 5. Integrated CBA 5% decrease in fare

		BRT	BRT - Low demand	BRT - High demand
Investment				
Investment in BRT infrastructure	mn CFA	103,624	103,624	103,624
Investment in rolling stock	mn CFA	54,218	45,879	62,931
O&M cost rolling stock	mn CFA	332,361	282,629	463,825
Additional project-related costs				
Cost of financing	mn CFA	58,975	58,975	58,975
Compensation payments	mn CFA	3,152	3,152	3,152
Reinstallation payments	mn CFA	1,213	1,213	1,213
Subtotal (1) - Sum of costs	**mn CFA**	**553,543**	**495,471**	**693,720**
Revenues	**mn CFA**	**537,260**	**426,391**	**648,131**
Subtotal (2) - Net profits	**mn CFA**	**-16,282**	**-69,081**	**-45,589**
Externalities				
Discretionary spending	mn CFA	95,737	70,160	121,313
Value of time saved	mn CFA	541,065	424,614	657,517
Avoided cost of transport	mn CFA	1,455,114	1,146,107	1,764,121
Avoided cost of pollution	mn CFA	38,769	30,012	47,504
Avoided cost of emissions	mn CFA	17,751	13,020	22,430
Avoided costs of accidents	mn CFA	31,226	24,682	37,771
Subtotal (3) - Sum of added benefits	**mn CFA**	**2,179,663**	**1,708,595**	**2,650,656**
Total net benefits	**mn CFA**	**2,163,381**	**1,639,514**	**2,605,066**

Table 6. Integrated CBA 10% decrease in fare

		BRT	BRT - Low demand	BRT - High demand
Investment				
Investment in BRT infrastructure	mn CFA	103,624	103,624	103,624
Investment in rolling stock	mn CFA	54,218	45,879	62,931
O&M cost rolling stock	mn CFA	332,361	282,629	463,825
Additional project-related costs				
Cost of financing	mn CFA	58,975	58,975	58,975
Compensation payments	mn CFA	3,152	3,152	3,152
Reinstallation payments	mn CFA	1,213	1,213	1,213
Subtotal (1) - Sum of costs	**mn CFA**	**553,543**	**495,471**	**693,720**
Revenues	**mn CFA**	**508,983**	**403,949**	**614,017**
Subtotal (2) - Net profits	**mn CFA**	**-44,559**	**-91,523**	**-79,703**
Externalities				
Discretionary spending	mn CFA	95,737	70,160	121,313
Value of time saved	mn CFA	541,065	424,614	657,517
Avoided cost of transport	mn CFA	1,455,114	1,146,107	1,764,121
Avoided cost of pollution	mn CFA	38,769	30,012	47,504
Avoided cost of emissions	mn CFA	17,751	13,020	22,430
Avoided costs of accidents	mn CFA	31,226	24,682	37,771
Subtotal (3) - Sum of added benefits	**mn CFA**	**2,179,663**	**1,708,595**	**2,650,656**
Total net benefits	**mn CFA**	**2,135,104**	**1,617,072**	**2,570,953**

Negative operational results are also observed in the case of a 30.9 per cent increase in CAPEX for investments in BRT infrastructure. The results for the analysis considering increased CAPEX in infrastructure and increased cost of financing are summarized in Table 7. Total CAPEX for BRT infrastructure in the case of increased CAPEX is CFA 135.9 billion, which is CFA 32.3 billion higher than the baseline. Furthermore, the cost of financing is CFA 15.5 billion higher as a result of higher upfront CAPEX payments. In case of this increase in CAPEX, the BRT generates negative operational results across all three scenarios if an average baseline fare of CFA 150 is assumed per trip.

Table 7. Integrated CBA +30.9% in CAPEX

		BRT	BRT - Low demand	BRT - High demand
Investment				
Investment in BRT infrastructure	mn CFA	135,954	135,954	135,954
Investment in rolling stock	mn CFA	54,218	45,879	62,931
O&M cost rolling stock	mn CFA	332,361	282,629	463,825
Additional project-related costs				
Cost of financing	mn CFA	74,497	74,497	74,497
Compensation payments	mn CFA	3,152	3,152	3,152
Reinstallation payments	mn CFA	1,213	1,213	1,213
Subtotal (1) - Sum of costs	**mn CFA**	**601,395**	**543,324**	**741,573**
Revenues	**mn CFA**	**565,537**	**448,833**	**682,243**
Subtotal (2) - Net profits	**mn CFA**	**-35,858**	**-94,491**	**-59,330**
Externalities				
Discretionary spending	mn CFA	95,737	70,160	121,313
Value of time saved	mn CFA	541,065	424,614	657,517
Avoided cost of transport	mn CFA	1,455,114	1,146,107	1,764,121
Avoided cost of pollution	mn CFA	38,769	30,012	47,504
Avoided cost of emissions	mn CFA	17,751	13,020	22,430
Avoided costs of accidents	mn CFA	31,226	24,682	37,771
Subtotal (3) - Sum of added benefits	**mn CFA**	**2,179,663**	**1,708,595**	**2,650,656**
Total net benefits	**mn CFA**	**2,143,805**	**1,614,104**	**2,591,326**

Financial Assessment

This financial assessment demonstrates that the social and economic returns make the investment case for mobility projects such as the BRT.

The assessment demonstrates how key financial performance indicators of the BRT project change under the different revenue and CAPEX scenarios described in the previous section. The assessment also covers the three different passenger demand scenarios: default, low and high number of passengers.

Table 8 shows the internal rate of return (IRR) and net present value (NPV) for each scenario. These results do not take into account any of the externalities measured. Therefore, they effectively illustrate the cash flow impact of the different operational scenarios.

Unsurprisingly, increasing the initial costs of the project by 30.9 per cent has a significant financial impact across the different passenger demand scenarios. In case of low passenger demand, the IRR of the BRT project even drops below zero.

The results also show that even a 5 per cent increase in ticket prices can improve the financial viability of the project considerably. For example, under the default passenger demand scenario, the IRR increases from 2.20 per cent to 3.29 per cent, which constitutes a 50 per cent increase. In the case of a 10 per cent increase in ticket prices, the IRR increases by 2.07 per cent, which is a 94 per cent increase from the baseline scenario. This underlines the importance of finding the right price level to balance affordability and financial viability. On the other hand, any decrease in ticket prices results in further deterioration of the financial soundness of the project.

NPV across all the scenarios stays negative. This means that incoming cash flows do not cover the costs when discounted. The only exception is when the price of tickets is increased by 10 per cent and there is a high passenger demand for the services of the BRT. In this case, the project generates an NPV of USD 11 million.

Table 8. Scenario analysis – key financial performance indicators without externalities

	Default passenger demand		Low passenger demand		High passenger demand	
	IRR (%)	NPV (USD mn)	*IRR (%)*	*NPV (USD mn)*	IRR (%)	NPV (USD mn)
Base case	2.20%	(50)	0.76%	(72)	3.41%	(30)
+30.9% CAPEX	0.54%	(99)	Negative	(124)	1.74%	(76)
+5% revenues	3.29%	(32)	1.81%	(55)	4.53%	(9)
+10% revenues	4.27%	(14)	2.75%	(40)	5.54%	11
-5% revenues	0.88%	(71)	Negative	(92)	2.14%	(52)
-10% revenues	Negative	(96)	Negative	(113)	0.25%	(80)

Table 9 demonstrates how the key financial performance indicators change when all the benefits of the externalities measured are factored in. As these benefits are realized at the economy and society level, they do not directly impact the cash flows at the project level. In order to reflect this, the IRR and NPV were changed to sustainable internal rate of return (S-IRR) and sustainable net present value (S-NPV), respectively.

The externalities significantly improve the "business case" for the project. Within those, the avoided cost of transport has the largest impact. Across all the scenarios, the S-IRR and S-NPV increase substantially. The results also show that if the wider environmental, social and economic benefits are taken into account, changes in revenues and CAPEX become less relevant.

Table 9. Scenario analysis – key financial performance indicators with externalities included

	Default passenger demand		Low passenger demand		High passenger demand	
	S-IRR (%)	S-NPV (USD mn)	*S-IRR (%)*	*S-NPV (USD mn)*	S-IRR (%)	S-NPV (USD mn)
Base case	37.70%	1,523	35.31%	1,188	39.73%	1,857
+30.9% CAPEX	31.88%	1,481	29.55%	1,146	33.85%	1,815
+5% revenues	38.00%	1,540	35.61%	1,202	40.03%	1,877
+10% revenues	38.29%	1,557	35.91%	1,216	40.33%	1,898
-5% revenues	37.40%	1,506	35.01%	1,174	39.43%	1,837
-10% revenues	37.10%	1,488	34.71%	1,160	39.13%	1,816

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