



## Section IV

# COST-BENEFIT ANALYSIS METHODOLOGY

The purpose of the cost benefit analysis (CBA) is to help decision makers make informed choices on whether to invest in Smarting of health facilities, which are designed not only to increase the resilience of the facility to the impact of hazards, whose effects have been exacerbated due to climate change, but to also implement climate mitigation measures through a reduction of the energy and water consumption thus making the health facility more efficient.

### Definitions by UNISDR (UN Office for Disaster Risk Reduction)

**Hazard:** “A potentially damaging physical event, phenomenon, or human activity that may cause loss of live or injury, property damage, social and economic disruption or environmental degradation”

**Climate Change:** “Encompasses all forms of climatic inconstancy regardless of their statistical nature or physical causes. It may result from such factors as solar activity, long-period changes in the Earth’s orbital elements, natural internal processes or the climatic system, or anthropogenic forcing.”

**Vulnerability:** “The condition determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards”

**Resilience:**

- Reduced failure probabilities
- Reduced consequences from failure
- Reduced time to recovery

The cost benefit analysis process estimates the benefits and costs of an investment for two reasons:

1. To determine if the project is viable; if it is a good investment
2. To compare one project investment with other competing projects, to determine which is more feasible.

It allows decision makers to appraise projects in a consistent and comparable manner.

Conducting a CBA can be an expensive and cumbersome undertaking, depending on the range of input data used to determine a project's costs and benefits. Hence, these are recommended for use in projects where the potential costs of the project(s) are significant enough to justify the allocation of resources to forecast, measure and evaluate anticipated benefits, costs and impacts.

## Input Data Requirements

Certain assumptions and decisions need to be made to determine some of the input data and there are definite questions that will be raised.

It is important to ensure that the assumptions and methodological approach are consistent for the various projects being compared. Some of the questions that may be asked are:

1. What baseline will the benefits of the project(s) be estimated?
2. What is the chronological and spatial extent of project impact(s)?
3. Which specific elements of the project / activities are most relevant to the CBA?

## Discount Rate

The value of money or goods in the present is viewed as higher than the expected value of goods and financial returns in the future. The further a potential benefit or cost is in the future, the less its value. This concept is made tangible by a process called discounting. This is where a discount rate is applied to anticipated costs and benefits of a project over the duration or 'life span' of the project to convert the value of a return in the future into today's value. Hence, for instance, the returns of a multi-year project are usually referred to as discounted returns.

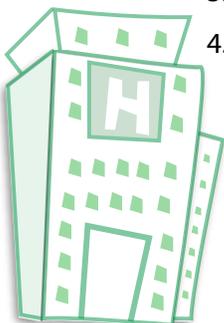
The lower the discount rate sometimes referred to as interest rate, the higher the return value of the project's future costs and benefits. Conversely, the higher the discount/ interest rates the lower the future return value will be.

The selection of the appropriate discount rate is important to ensure that future project returns are not being over- or under-estimated in today's value.

## Types of Cost Benefit Analysis

There are different types or methods of analysis to determine the economic efficiency of a project. The types that will be covered in this section are:

1. Benefit Cost Ratio (BCR)
2. Incremental Cost Benefit Ratio
3. Net Present Value (NPV)
4. The Payback Period



## Benefit Cost Ratio (BCR)

This is the ratio of project benefits versus project costs. It involves summing the total discounted benefits for a project over its entire duration/life span and dividing it over the total discounted costs of the project.

$$\text{BCR} = \frac{[\sum B_i / (1+d)^i]}{[\sum C_i / (1+d)^i]} \text{ summed over } i = 0 \text{ to } n \text{ years}$$

Where:

$B_i$  = the project's benefit in year  $i$ , where  $i = 0$  to  $n$  years

$C_i$  = the project's costs in year  $i$ , where  $i = 0$  to  $n$  years

$n$  = the total number of years for the project duration/ life span

$d$  = the discount rate

The simple steps in this methodology are:

1. Determine the discounted benefits for each year of the project
2. Determine the discounted costs for each year of the project
3. Sum the total discounted benefits for the entire project duration
4. Sum the total discounted costs for the entire project duration
5. Divide the total discounted benefits over the total discounted costs

## Understanding the results of BCR

BCR < 1.0	BCR = 1.0	BCR > 1.0
In economic terms, the costs exceed the benefits. Solely on this criterion, the project should not proceed.	Costs equal the benefits, which means the project should be allowed to proceed, but with little viability.	The benefits exceed the costs, and the project should be allowed to proceed.

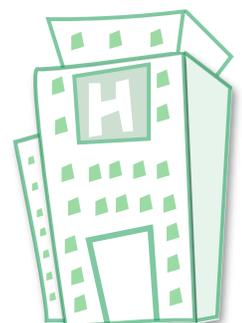
This method does not give a result of the projected total gains or losses of one project compared with another project. This can be done using the incremental BCR methodology.

## Incremental Benefit Cost Ratio

This method helps to determine the margin by which a project is more beneficial or costly than another project. It is used to compare alternative options to help determine which is more feasible over the other(s).

The steps in this methodology are:

1. List the projects from the least costly to the most expensive in ascending order.



- Take the least costly project and compare it to the second cheapest option by subtracting the total discounted benefits for each project and dividing this by the difference in the total discounted costs for each project.

$$\text{Incremental BCR} = (\sum B_1 - \sum B_2) / (\sum C_1 - \sum C_2)$$

Where:

$\sum B_1$  = total benefits for project '1'

$\sum C_1$  = total costs for project '1'

- If the incremental BCR obtained is higher than the target incremental BCR, then discard the lower-cost option (project 1 in this case) and use the higher-cost option (project 2) to compare with the next project on the ascending cost list.
- If the incremental BCR obtained is lower than the target incremental BCR, then discard the higher-cost option (project 2 in this case) and use the lower-cost option (project 1) to compare with the next project on the ascending cost list.
- Repeat these steps (2-4) until all of the project options have been analysed.
- The project which has the highest cost and an incremental BCR equal to or greater than the target incremental BCR.

## Net Present Value

This method considers the difference between the total discounted benefits minus the total discounted costs, which gives the Net Present Value of a project. Projects with positive net benefits are considered to be viable and a project with a higher NPV as compared with another project with a lower NPV is measured to be less lucrative. In other words, the higher the NPV, the greater the calculated benefits of the project.

$$\text{BCR} = [\sum B_i / (1+d)] - [\sum C_i / (1+d)] \text{ summed over } 1 = 0 \text{ to } n \text{ years}$$

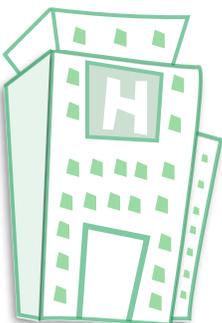
Where:

$B_i$  = the project's benefit in year  $i$ , where  $i = 0$  to  $n$  years

$C_i$  = the project's costs in year  $i$ , where  $i = 0$  to  $n$  years

$n$  = the total number of years for the project duration/ life span

$d$  = the discount rate



## Payback Period

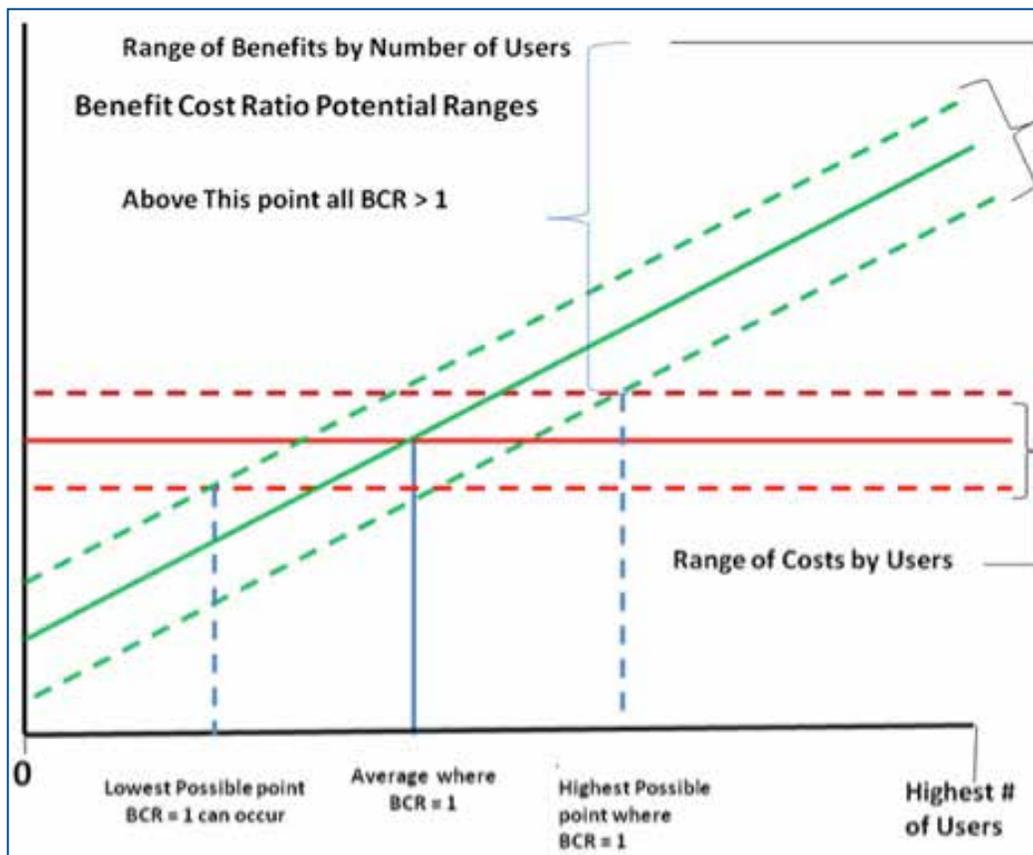
This is the time period required for the total discounted costs of a project to be surpassed by the total discounted benefits. This can be easily done, say in excel, by calculating the cumulative discounted benefits and cumulative discounted costs of a project for each consecutive year of a project. The year that the cumulative benefits exceed the cumulative costs is the payback period year of the project. In other words, the year following the project payback period will see net profits or benefits to the project.

## Sensitivity Analysis

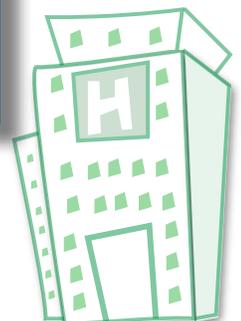
The calculated benefits and costs of a project may vary depending on differing assumptions about the input data and methodology applied in the cost benefit analysis. The range of potential outcomes for differing inputs can be gauged using a sensitivity analysis.

A sensitivity analysis is also useful to determine the potential where the net benefits of the project will not be positive, as highlighted in the Figure below.

For example some projects calculated benefits and costs may be affected by how the project is scheduled, determining an appropriate project life span, the geographic scale of the impacts of the project and knowing what discount rate to select.

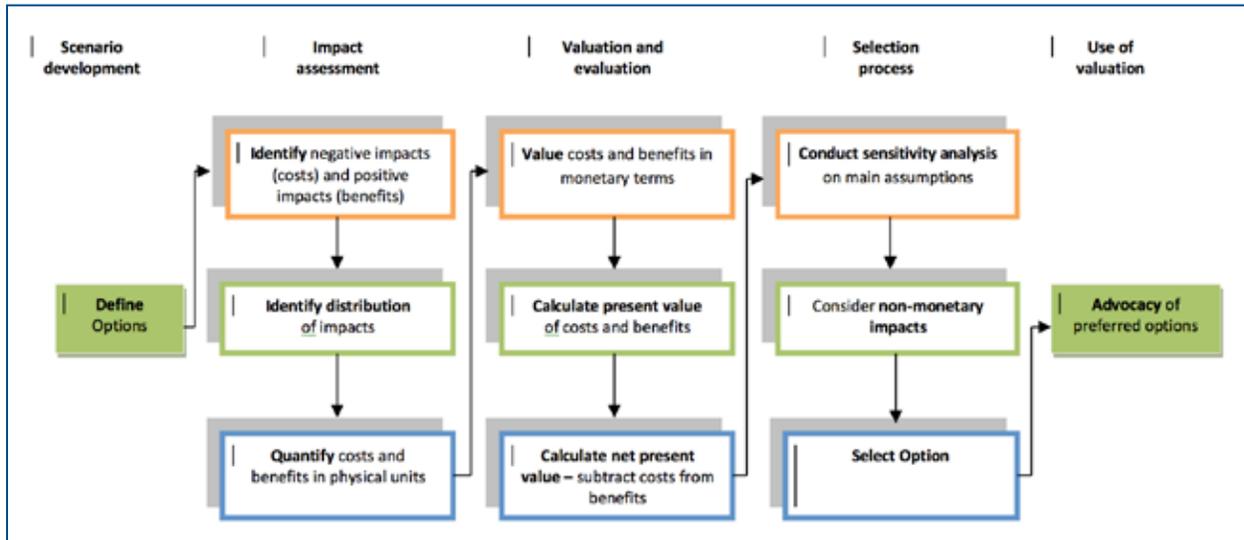


Sensitivity analysis of projects for range of potential costs and benefits



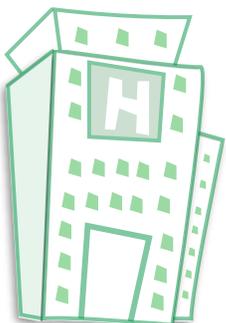
## Methodology Used in the CBA of the Demonstration Projects

The main steps performed by economist, Dr Mark Bynoe, in the CBA for the demonstration projects are presented in the next Figure, showing how these steps fit with the overall framework of analysis advocated in the toolkit. These steps are described in detail below:

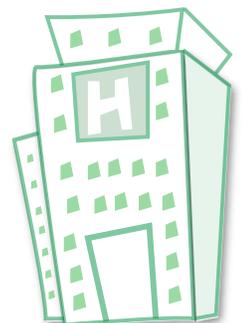


Methodological Steps Followed in the Cost Benefit Analysis for the SMART Health Care Facility

1. Define options. The first step in the CBA was to identify the alternative options to be considered. The options under consideration were specific to the particular problem and context, but under other circumstances may have included investments, projects, policies, and development plans. It was important to have a clear and detailed description of what each option was as detailed in the following section.
2. Identify costs and benefits. We then identified all negative impacts (costs) and positive impacts (benefits) related to each option under consideration. If known, it is useful to describe the geographical and temporal boundaries of the analysis, i.e. the area and number of years over which costs and benefits are expected to accrue. In our analysis, the entire Island was seen as being the beneficiary and the project was projected to have a life of 20 years.
3. Identify the distribution of impacts. Costs and benefits of alternative options will not be distributed evenly over the various individuals and groups that are impacted by the project. The distribution of costs and benefits (and the potential need for compensation) therefore becomes an important determinant of whether the project was acceptable and desirable.
4. Quantify costs and benefits in physical units. Each cost and benefit was then quantified in relevant physical units for each year in which those benefits and costs occur. We utilized the excel spreadsheet for our analysis.
5. Value costs and benefits in monetary units. Each cost and benefit was then quantified in monetary units for each year in which it occurs.



6. Calculate present values. Calculating present value (PV) involved discounting values that occur in future years. Present value costs and benefits were then summed across years to obtain the total present value costs and benefits.
7. Calculate the net present value (NPV). The net present value (NPV) of each option.
8. Calculate the benefit cost ratio (BCR) and internal rate of return (IRR). The results of a CBA can also be represented by two other indicators of a project's worth (in addition to NPV). These are the benefit cost ratio (BCR) and the internal rate of return (IRR). The IRR is the discount rate at which a project's NPV becomes zero. If the IRR exceeds the discount rate, the project generates returns in excess of other investments in the economy, and can be considered worthwhile.
9. Conduct sensitivity analysis. Information on the monetary values of costs and benefits of alternative options will often not be known with absolute certainty. Uncertainty over the values or assumptions included in the analysis leads to the results also being uncertain. One such area is the discount factor applied. We therefore varied this, among other things, to test the sensitivity of our analysis.
10. Select option. Based on the information generated on the NPV of each option, the sensitivity of the results, the distribution of impacts, and additional non-monetary information, a decision maker can select the most preferred option.
11. Use the results. The results of the CBA can then be used in various ways to influence a decision over a policy or project.



## Summary of the Economic Analysis of Smarting of Georgetown Hospital, St Vincent

The cost benefit analysis (CBA) for the Georgetown Hospital in St Vincent, conducted by economist, Dr Mark Bynoe, was done for the scope of works of the retrofitting project. This included improving the condition to better withstand the impact of natural hazards including the effects of climate change.

Two options were considered in the cost benefit analysis: Do Nothing and Retrofitting for Smarting the facility. The costs and benefits associated with each option are shown in Tables 1 and 2. The comparisons indicate that the Do Nothing option would not provide any benefits to the medical facility.

**Table 1 - Comparison of Costs and Benefits for the 'Do Nothing' option**

Options	Costs/Issues	Benefits
Do nothing	<ul style="list-style-type: none"> <li>Continued dilapidation of the hospital; hinders its efficient operations.</li> <li>Leaking roof.</li> <li>Fading, peeling and moss/mold growth on exterior walls.</li> <li>Water damaged and worn floor finishes.</li> <li>Inefficient ventilation, hot water systems, cooling systems and water catchment.</li> <li>Inadequate water storage capacity and lack of water treatment.</li> <li>Lack of fire/smoke alarms, emergency lighting, exit signage maps, fire extinguishers and handicap accessibility.</li> <li>Insufficient provision of shelter from the elements.</li> <li>Vulnerability to wind uplift and hurricane events.</li> <li>Water damage to wooden beams and supporting posts.</li> <li>Insufficient lighting of the ambulance area.</li> <li>No public restroom facility for visitors.</li> <li>Outdated power supply system and non-operational emergency power supply.</li> <li>Current building codes do not adequately address resilience to climate change and climate variability to meet the 'Hospitals Safe from disasters'.</li> </ul>	<b>ZERO BENEFITS</b>

**Table 2 - Costs and Benefits associated with the retrofitting option**

Options	Costs/Issues	Benefits
Retrofitting (Smart Hospital)	<ul style="list-style-type: none"> <li>Capital cost of designing and retrofitting the hospital.</li> <li>Incremental maintenance cost.</li> </ul>	<ul style="list-style-type: none"> <li>Revised hospital design that can withstand greater natural hazards intensities.</li> <li>Minimized vulnerability to wind uplift of the roof and improved structural integrity of the hospital.</li> <li>Improved healthcare, reduced mortality and other social spill-off benefits.</li> <li>Eradicate leaking roof.</li> <li>Improved roof bearing capacity such that it could accept the solar panels for the proposed Photo Voltaic (PV) system.</li> <li>Improved hospital ventilation, security, safety, hygiene, accessibility, conservation, lighting, sanitation, aesthetics and morale.</li> <li>Reduced energy demand generally and from the national grid, and improved efficiency in the use and production of electricity.</li> <li>Enhanced hospital compliance to safety and risk reduction and staff awareness and development.</li> <li>The provision of a baseline from the project from which replication and policy recommendations can be drawn for incorporation into the building codes of St. Vincent and the Grenadines and the wider Caribbean.</li> </ul>

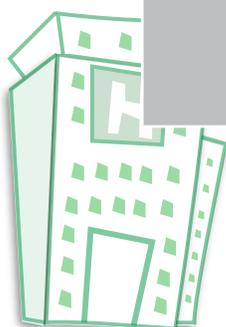


Table 3 below highlights the actual cost breakdown for the retrofitting works, which were donor funded and treated as a sunk cost for the CBA study.

The total cost of various elements of the works at the Georgetown Hospital is illustrated below in \$US. The majority of the funds were used to upgrade the electrical system and provide an alternative source of energy in the PV system.

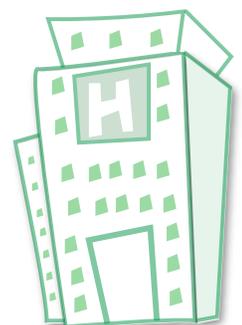
**Table 3 – Capital investment costs of retrofitting works at the health facility**

#	Georgetown Hospital: Item Description	Cost (US\$)
1	Preliminaries	8,866.67
2	Roof Renovations	38,996.11
3	Windows	20,747.04
4	Doors	28,531.63
5	Plumbing and Sanitary Fixtures	24,877.78
6	Electrical Works (Light and Power)	52,951.85
7	Electrical Works (Emergency Power Supply)	20,583.33
8	Electrical Works (Alternative Power Supply)	34,374.07
9	Mechanical works	16,373.70
10	Interior Furnishings	7,461.85
11	Wall Finishes	8,893.33
12	Floor Finishes	11,583.70
13	Ceiling Finishes	8,918.15
14	Code Compliance	11,614.07
16	External Works	3,024.44
17	New Main Entrance Covering	3,007.78
<b>Total Value Added Tax (VAT) 15%</b>		45,120.83
<b>Grand Total Cost (including contingencies)</b>		<b>345,926.35</b>

Costs associated with the planned preventative maintenance programme for the health facility, for the life span of the project – 20 years, was also included as the future incremental maintenance costs of the project. Some of the expenses that were considered in the analysis are as follows:

- Building inspections
- Roof checks and maintenance
- Sanitation and safety checks
- Painting of the facility
- Administrative monitoring
- Insurance for the facility
- Labour costs associated with operating the facility
- Contingency for unforeseen or unplanned expenses

The findings of the cost benefit analysis were such that, if the 'Do Nothing' option was continued, then the health facility would be at increased risk to the impact of natural hazards; with the continued deterioration of the facility, estimated at 5% annually for tangible



and non-tangible assets. In the short-term there is medium risk that as the facility continues to deteriorate it will become more vulnerable to climate change and climate variability. The risk increases to high if no improvements are made in the medium to long-term.

**Table 4 - Risk of the 'Do Nothing' option**

Risk to Hospital Tangible and Non-Tangible Assets			
Risk of deteriorate and increase vulnerable to climate variability and climate change	Do Nothing		
	Short-term	Medium-term	Long-term
Low			
Medium	x		
High		x	x

## Financial Analysis

The two main benefits included in the cost benefit analysis were:

1. Savings due to efficient utilization of water, estimated at 10% of the current consumption.
2. Saving due to efficient energy usage, estimated at 10% of the current consumption.
3. Savings from the energy supply of the PV system, to the order of about 40%.
4. Savings in the ambulance operating between Georgetown and Kingstown.

It should be noted that reductions in energy use consumption were verified for one month following the completion of the retrofitting project and this was found to be 64% savings, which is significantly higher than the estimated 40% used in the analysis.

The water usage was not verified due to a faulty water meter that has since been changed.

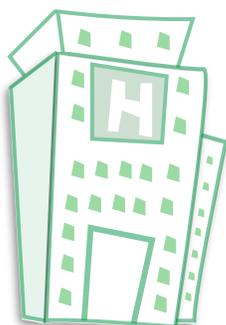
## Discount Rate

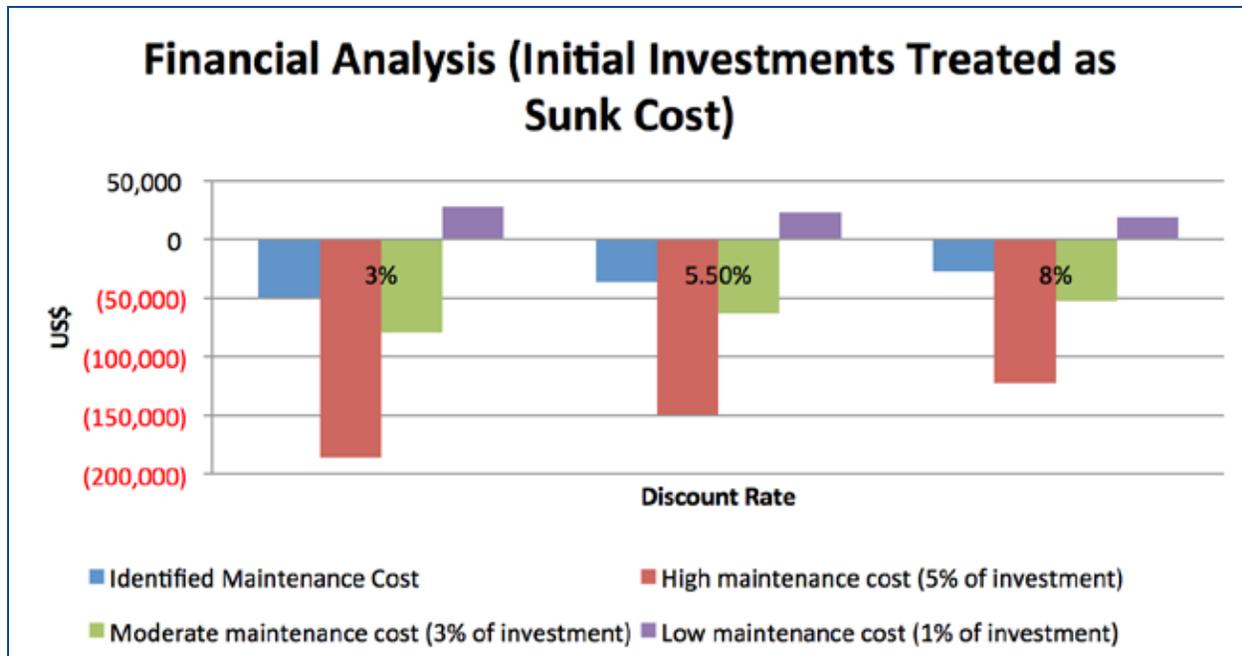
The Caribbean Community Climate Change Centre (CCCCC) estimated benchmarks for the Social Rate of Time Preference (SRTTP)<sup>1</sup> for selected Caribbean Countries. Discount rates of 3%, 5.5% and 8% were used in this analysis. CCCCC estimated that the SRTTP for St. Kitts and Nevis is 3.58%; however, sensitivity analyses suggest it could range from 3% to 8%.

## Net Present Value of the Retrofitting Project based on Annual Maintenance Costs

The Net Present Value (NPV) of the project for 20 years, treating the initial investment as a Sunk Cost, since this was donor funded by DFID, indicated the project as being beneficial in terms of savings for maintenance percentages at 0%, 1% and 3%, but not at 5%.

1. The social discount rate can be defined as a rate at which a person is willing to forgo consumption now in order to derive benefits in the future. It is also the rate at which funds are diverted from one alternative to another, i.e. the cost/benefit to society for investing in this project.





Net Present Value (NPV) based on varying % annual maintenance costs of the initial investment for 20 years

Note, PAHO recommends a planned preventative maintenance cost for health facilities at about 4% per annum of the current value of the building/ facility.<sup>2</sup>

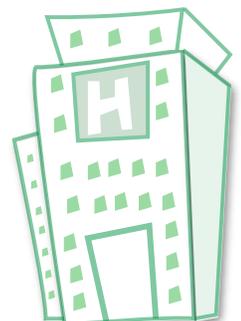
#### Ability to Pay and Willingness to Pay

A willingness and ability to pay survey<sup>3</sup> was used to estimate the utility derived from retrofitting the health facility. Despite majority of the respondents suggesting that they are satisfied with the current health service, when asked about their major concerns about the current health care provided, the following suite of responses followed:

- The Hospital facilities needs urgent upgrading;
- There are inadequate supplies at the hospital;
- The facilities at the hospital are poorly kept and maintained;
- There is a lack of specialist care and the hospital is losing nurses and qualified health professionals;
- There is a lack of privacy with medical records and professionalism is lacking in handling clients;
- The Georgetown hospital should be improved to provide hospital care for persons on the windward side of island;
- Better distribution of medical staff is needed to ensure the availability of doctors at rural hospitals such as Georgetown.
- Key healthcare services are in Kingstown. Travels to Kingstown are too far and exhausting for sick people;

2. Design Manuals for Health Facilities in the Caribbean, PAHO – by Tony Gibbs.

3. See Annex 2 for results of the Willingness and Ability to pay survey.



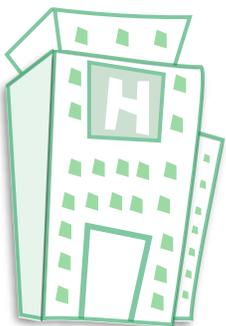
- Cost of healthcare is high;
- Accessibility to a doctor is sometimes a problem;
- Improved supplies, upgraded facilities and improved security needed for the hospital ;
- Accessibility to an ambulance is an issue.

It was found that the average willingness to pay for health services was US\$56 and the average ability to pay was US\$60.<sup>4</sup>

Economic Analysis based on ability to pay (ATP) and willingness to pay (WTP) over the range of discount rates are shown in the following graphs.

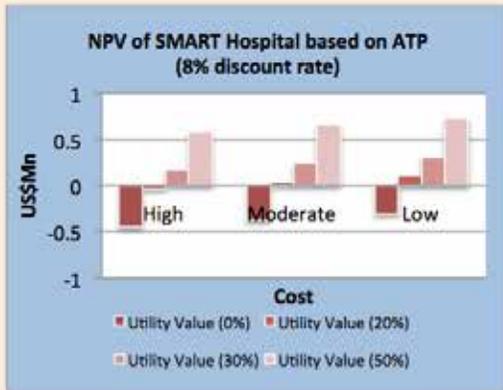
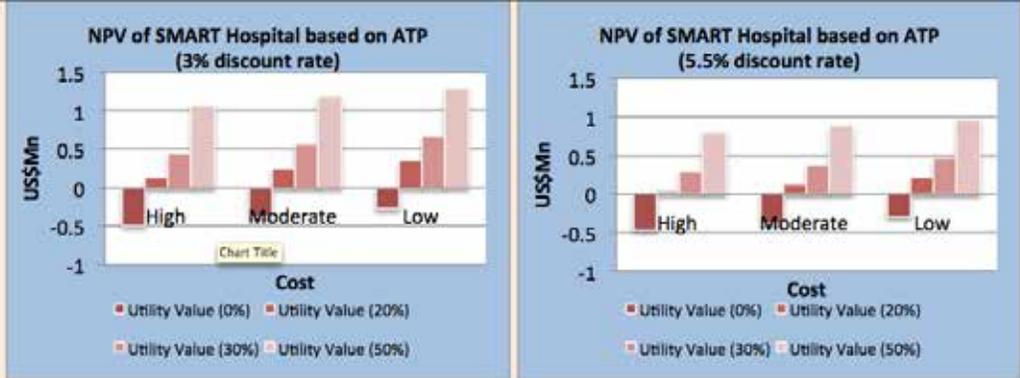
**Table 5 - Range of percentages of ATP and WTP considered in Economic Analysis**

Percentage	WTP (US\$)	ATP (US\$)
0%	0.0	0.0
20%	12	11.2
30%	18	16.8
40%	30	28

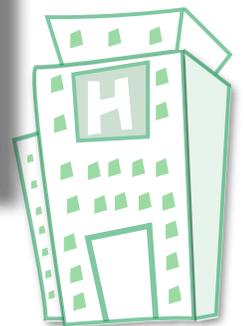
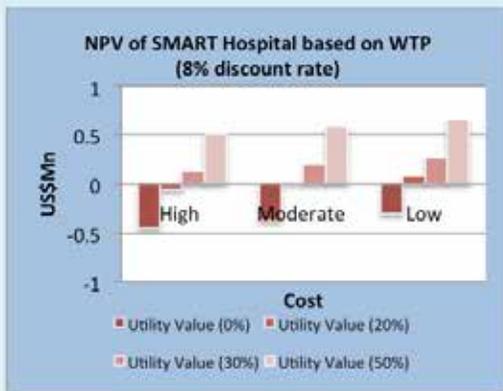
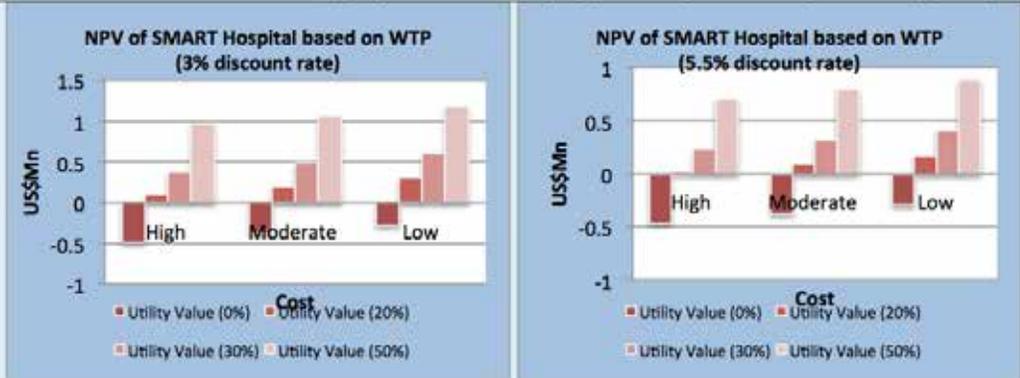


4. The average presented here is the 5% trimmed mean.

**Net Present Value (NPV) for retrofitting project based on varying percentages of Ability to Pay (ATP)**



**Net Present Value for retrofitting project based on varying percentages of Willingness to Pay (WTP)**

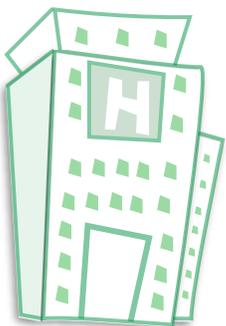


## Conclusions and Recommendations

Retrofitting the Georgetown hospital is more favorable than the 'do nothing' option. 'Do nothing' in the medium to long term puts the hospital's assets, tangible and non-tangible, at a high risk of greater deterioration and increased vulnerability to climate variability and climate change. Contrary, retrofitting the hospital in the short-term is the better option as it will result in a facility that is user and staff friendly with better ventilation, security, hygiene, accessibility, conservation, lighting, sanitation and aesthetics.

However, the identified revenue streams from retrofitting the hospital in the form of savings from the efficiency utilization of water, savings from rainwater harvested, savings from the efficiency in energy usage and installation of renewable energy will only sustain the project financially over 20 years if the maintenance cost is less than or equal to about 1% of the capital expenditure. It is therefore imperative that the cost of maintenance and operation is minimized and other sources of revenue schemes are identified to financially support the project over its lifespan.

From an economic, social and environmental perspective the project is desirable and it becomes even more desirable if the community (users and staff) derives significant utility from seeing the hospital retrofitted which includes improved ventilation, security, safety, hygiene, accessibility, conservation, lighting, health, sanitation, aesthetics and morale. Furthermore, this project presents a guideline of practices for St. Vincent and Grenadines that other public buildings, schools, hotels and other private building could adhere to.



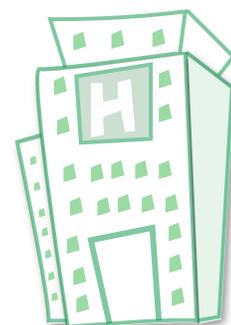
## Summary of the Economic Analysis of Smarting of Pogson Medical Centre, St Kitts

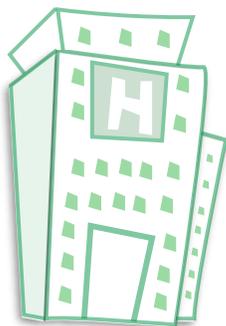
The cost benefit analysis (CBA) for the Pogson Medical Centre, conducted by economist, Dr Mark Bynoe, was done for the original scope of works of the retrofitting project. However, due to financial constraints, the scope of works was later modified and reduced to fit within the allowable budget. Hence, the results presented here represent the theoretical economic analysis had the overall scope been completed.

Two options were considered in the cost benefit analysis: Do Nothing and Retrofitting for Smarting the facility. The costs and benefits associated with each option are shown in Tables 1 and 2. The comparisons indicate that the Do Nothing option would not provide any benefits to the medical facility.

**Table 1 - Comparison of Costs and Benefits for the 'Do Nothing' option**

Options	Costs/Issues	Benefits
Do nothing	<ul style="list-style-type: none"> <li>• The continued disrepair of the medical facility, which hinders its efficient operations.</li> <li>• The roof is prone to leaks under high wind conditions and there is a risk of the roof cracking, main entry roof vulnerable to wind uplift and hurricane events.</li> <li>• Some windows require winder mechanism replacement or repair, the X-ray room window requires proper lining to prevent radiation exposure.</li> <li>• The Emergency exits require improved security features and emergency panic bar mechanisms, the X-ray room door is not adequately lead lined to minimize radiation exposure.</li> <li>• Selected bathroom fixtures require replacement while others have minor damages in need of repairs.</li> <li>• Light fixtures (receptacles, switches, lights) need replacement, ballast units need to be replaced with 60 hz units, breakers trip when multiple appliances and equipment are in use at the same time, battery supply is faulty, diesel storage tank not properly anchored to foundation, electrical meter should be relocated, properly sheltered and mounted outside the generator housing, no existing alternate power supply.</li> <li>• Lack of ventilation, cooling units not working or susceptible to flood damages.</li> <li>• Inadequate water storage capacity and nonexistent water treatment systems.</li> <li>• Shelving units that store medical supplies and files are not properly secured.</li> <li>• Fading, peeling and moss/mold growth on the exterior walls and ceiling tiles.</li> <li>• Inadequate emergency exits signage, emergency fire equipment are faulty and/or damaged, nonexistent emergency lights, illegible fire extinguisher instructions.</li> <li>• Staircases and handicap ramps are exposed to the elements, surface are slippery when wet.</li> <li>• Drains require demarcation to differentiate between storm vs. sewer manholes, pipes need to be flushed, landscaping to prevent water runoff.</li> <li>• Incomplete wastewater treatment system.</li> <li>• A substandard building code.</li> </ul>	<b>ZERO BENEFITS</b>





**Table 2 - Costs and Benefits associated with the retrofitting option**

Options	Costs/Issues	Benefits
<b>Retrofitting (Smart Hospital)</b>	<ul style="list-style-type: none"> <li>Capital cost of designing and retrofitting the medical facility.</li> <li>Incremental maintenance cost.</li> </ul>	<ul style="list-style-type: none"> <li>Revised hospital design that can endure greater hurricane intensities. Minimized vulnerability to wind uplift of the roof and improved structural integrity of the hospital.</li> <li>Improved health facilities and services, mortality and other social spill-off benefits.</li> <li>Resolved roof leaking issues.</li> <li>Improved Hospital ventilation, security, safety, hygiene, accessibility, wastage, lighting, healthier, sanitary, aesthetics, and staff morale.</li> <li>Reduce energy demand and improve efficiency / conservation use and provide reliable production of electricity.</li> <li>Enhanced hospital conformity to safety and risk reduction and staff awareness and development.</li> <li>Improve the drainage of the landscape around the facility and eliminate any potential flooding of the facility.</li> <li>Properly treat and reuse all the sewerage water from the facilities and circulate the treated water through a drip irrigation system into surrounding environs.</li> <li>Minimize the overflow and pumping of sewerage and eliminate the exposure of sewerage water flowing through open drains.</li> <li>The project serves as a baseline from which replication and policy recommendations can be drawn for incorporation into the building codes of St. Kitts and Nevis and in the wider Caribbean.</li> </ul>

Table 2 below highlights the actual cost breakdown for the retrofitting works, which were donor funded and treated as a sunk cost for the CBA study.

The total cost of various elements of the works at the Pogson Hospital is illustrated below in \$US. The majority of the funds were used to upgrade the electrical system and mechanical works with the aims of reducing the current consumption of the facility and also reduce its carbon footprint.

**Table 3 – Capital investment Costs of retrofitting works at the health facility**

Items	Description	Cost (US\$)
1	Preliminaries	26,473.06
2	Roof Renovations	18,531.14
3	Windows	3,088.52
4	Doors	33,799.28
5	Plumbing and Sanitary Fixtures	14,339.58
6	Electrical Works (Light and Power)	40,283.18
7	Electrical Works (Emergency Power Supply)	7,280.09
8	Mechanical works	36,091.61
9	Interior Furnishings	1,103.04
10	Wall Finishes	3,750.35
11	Ceiling Finishes	4,480.37
12	Code Compliance	9,526.29
13	External Works	409.13
<b>Total</b>		<b>188,155.65</b>

Costs associated with the planned preventative maintenance programme for the health facility, for the life span of the project – 20 years, was also included as the future incremental maintenance costs of the project. Some of the expenses that were considered in the analysis are as follows:

- Building inspections
- Roof checks and maintenance
- Sanitation and safety checks
- Painting of the facility
- Administrative monitoring
- Insurance for the facility
- Labour costs associated with operating the facility
- Contingency for unforeseen or unplanned expenses

The findings of the cost benefit analysis were such that, if the ‘Do Nothing’ option was selected, then the health facility would be at increased risk to the impact of natural hazards; with the continued deterioration of the facility, estimated at 5% annually. In the short-term there is medium risk that as the facility continues to deteriorate it will become more vulnerable to climate change and climate variability. The risk increases to high if no improvements are made in the medium to long-term.

**Table 4 - Risk of the ‘Do Nothing’ option**

Risk to Hospital Tangible and Non-Tangible Assets			
Risk of deteriorate and increase vulnerable to climate variability and climate change	Do Nothing		
	Short-term	Medium-term	Long-term
Low			
Medium	x		
High		x	x

## Financial Analysis

The two main benefits included in the cost benefit analysis were:

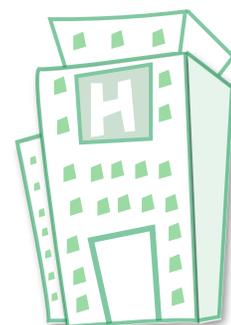
1. Savings due to efficient utilization of water, estimated at 20% of the current consumption.
2. Saving due to efficient energy usage, estimated at 10% of the current consumption.

It should be noted that reductions in energy use and water consumption had not been verified at the time of this report, as the retrofit works were completed on January 20, 2014 the time period until the end of the project did not allow for this data collection.

## Discount Rate

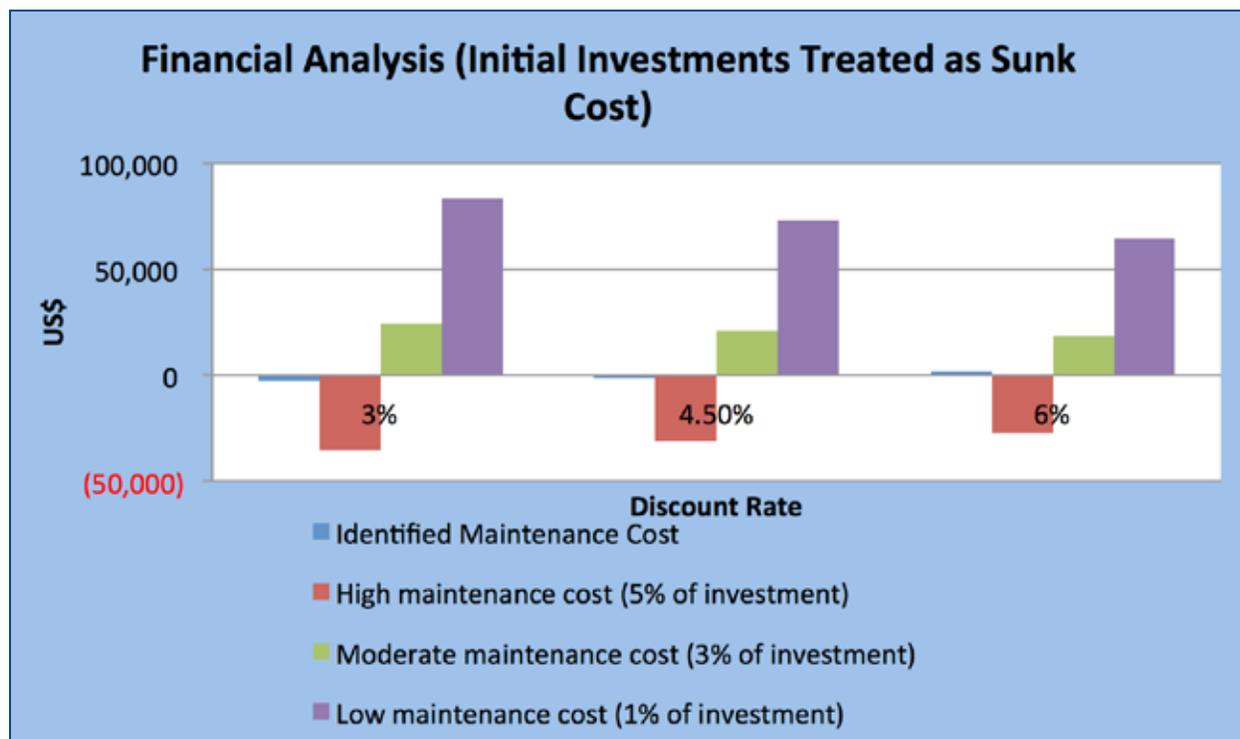
The Caribbean Community Climate Change Centre (CCCCC) estimated benchmarks for the Social Rate of Time Preference (SRTP) for selected Caribbean Countries.<sup>5</sup> Discount rates of 3%, 4.5% and 6% were used in this analysis. CCCCC estimated that the SRTP for St. Kitts and Nevis is 5.61%; however, sensitivity analyses suggest it could range from 3% to 6%.

5. The social discount rate can be defined as a rate at which a person is willing to forego consumption now in order to derive benefits in the future. It is also the rate at which funds are diverted from one alternative to another, i.e. the cost/benefit to society for investing in this project.



## Net Present Value of the Retrofitting Project based on Annual Maintenance Costs

The Net Present Value (NPV) of the project for 20 years, treating the initial investment as a Sunk Cost, since this was donor funded by DFID, indicated the project as being beneficial in terms of savings for maintenance percentages at 0%, 1% and 3%, but not at 5%.



Net Present Value (NPV) based on varying % annual maintenance costs of the initial investment

Note, PAHO recommends a planned preventative maintenance cost for health facilities at about 4% per annum of the current value of the building/ facility.<sup>6</sup>

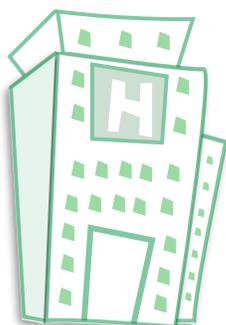
## Ability to Pay and Willingness to Pay

A willingness and ability to pay survey<sup>7</sup> was used to estimate the utility derived from retrofitting the health facility. Despite majority of the respondents suggesting that they are satisfied with the current health service, when asked about their major concerns about the current health care provided, the following suite of responses followed:

- Deteriorating structure, hospital facilities needs upgrading;
- There are inadequate medical supplies at the facility;
  - There is a lack of specialist care and the facility is in need of more trained and qualified health professionals;
  - There is a lack of privacy with medical records;

6. Design Manuals for Health Facilities in the Caribbean, PAHO – by Tony Gibbs.

7. See Annex 2 for results of the Willingness and Ability to pay survey.



- Need for trained staff;
- The Pogson Medical Centre should be improved to provide hospital care long term admissions/treatments;
- Persons from the Sandy Point Area are transported to JNF Hospital in the Capital if they require long periods of monitoring;
- Better distribution of medical staff is needed to ensure the availability of doctors at rural hospitals ;
- Cost of healthcare and medication is high;
- Waiting time to receive service is too long.

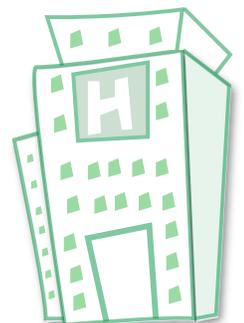
It was found that the average willingness to pay for health services was US\$19.67 and the average ability to pay was US\$20.01.<sup>8</sup>

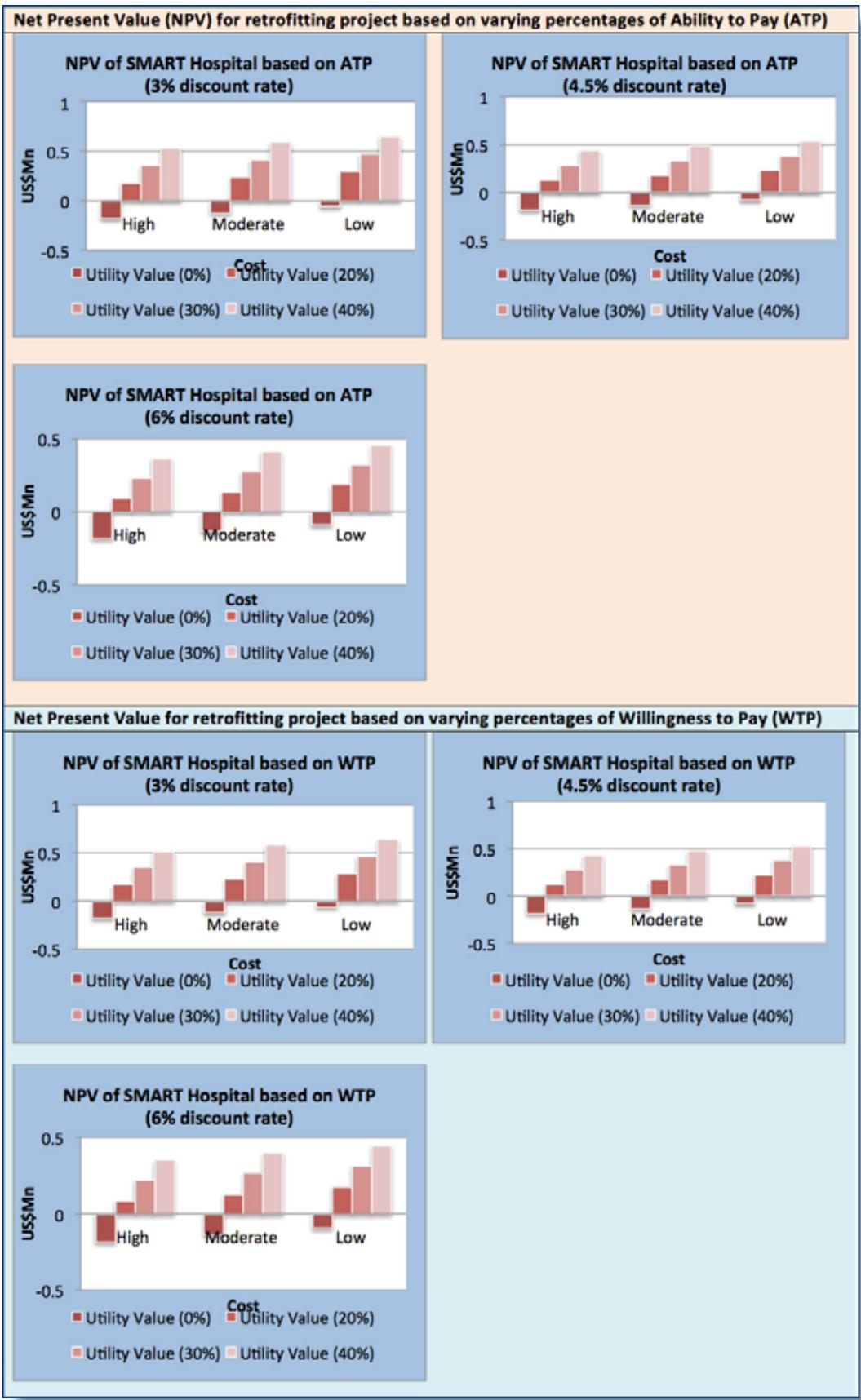
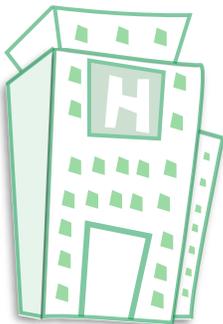
Economic Analysis based on ability to pay (ATP) and willingness to pay (WTP) over the range of discount rates are shown in the following graphs.

**Table 5 - Range of percentages of ATP and WTP considered in Economic Analysis**

Percentage	WTP (US\$)	ATP (US\$)
0%	0.0	0.0
20%	3.9	4.0
30%	5.9	6.0
40%	7.8	8.0

8. The average presented here is the 5% trimmed mean.





## Conclusions and Recommendations

- In the analysis provided above, a variety of discount rates and differing assumptions were used to reach the conclusions drawn below. In such a case, where actual data may not be readily available, the estimations tended to take the conservative route, only entering those benefits that are known, while over-estimating the costs.
- With the currently identified revenue streams in the form of savings from efficient usage of water and energy, the project was found to be financially sustainable since the capital investment was treated as a sunk cost, which was due to funding from UK Department for International Development. Also, the project was found to be feasible when the operation maintenance was a maximum of about 3-4% of initial investment. However, it is imperative that maintenance costs in minimized and other sources of revenue schemes are identified to financially support the project over its lifespan.
- The above findings also point to a fundamental issue that keeps occurring in environmental economics literature. It is evident that for adaptation projects of this nature to succeed, and given the limited fiscal space within which many governments in Small Island Developing States (SIDS) operate, funding for these types of initiatives either have to be of a grant or on a concessional basis.
- From an economic, social and environmental perspective the project is desirable and it becomes even more desirable if the community (users and staff) derives significant utility from seeing the hospital retrofitted which includes improved ventilation, security, safety, hygiene, accessibility, wastage, lighting, health, sanitation, aesthetics and morale. This project presents a baseline project for St. Kitts and Nevis that other public buildings, schools and private building could adhere to.
- Of significant, are the benefits derived from savings on energy consumed and enhanced energy efficiency. St Kitts and Nevis has one of the highest energy costs in the region and this energy architecture makes most projects unsustainable. However, through building in energy efficiency criterion and utilizing a renewable energy source would allow the facility to be feasible. This is a significant lesson learnt for other such projects that may be undertaken.

**The full Cost Benefit Analysis reports are available at the Smart Hospitals website**

**<http://bit.ly/1gcELQk>**

