

AN INNOVATIVE SOCIAL PROJECT TURNING GREY TO GREEN

COST VS BENEFIT OF THE GREEN DECK DEVELOPMENT

Dr Mark S.C. HSU, Associate Professor Department of Civil and Environmental Engineering The Hong Kong Polytechnic University











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□ Identifying the tangible and intangible costs and benefits of the Green Deck development.

- Determining if the benefits of the Green Deck development outweigh its costs.
- □ Conducting a sensitivity analysis as a risk assessment for infrastructure investments.



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Processes of Cost Benefit Analysis



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Green Deck A Catalyst for Vibunt Community

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Cost & Benefit Identification

Tangible:

- Costs/benefits that directly influence the individual decision makers (Halsnæs et al., 2007).
- Assumed the government is the main investor.

Intangible:

Costs/benefits or 'externalities' that would influence the utility of other individuals, but which are not taken into consideration by the individuals causing them (Halsnæs et al., 2007).

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Cost & Benefit Identification



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Cost & Benefit Identification



Example on Calculating the Benefit:

- **Temperature reduction:** 11.82 million/year
- Energy saved
- Average electricity rate: 1.83 HKD/kWh (CLP, 2023)
- Temperature reduction by trees in Hong Kong: on average 2.4 Celsius degree (Kong et al. 2017)
- Saved electricity by reducing one Celsius degree: 2501277 kWh (Fung et al. 2006)

Saved electricity cost by temperature reduction:

2501277 * 2.4 * 1.83 = 10.99 million HKD/ year

Emission avoided

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- Emission factors of electricity generation: 0.55 kgCO₂e/kWh (CLP, 2022)
- Social cost of CO2: 43 USD/tonne (Interagency working group on social cost of carbon, 2013)
- PPP exchanged rate: 1 USD = 5.875 HKD (world bank, 2021)

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Total save on annual emission cost:

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2501277 * 2.4 * 0.55 * 0.043 * 5.875 = 0.83 million/year



Cost Valuation

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Parameters for Benefits Evaluation	Values	References and Notes	
Duration of Construction (year)	11	(Arup, 2022)	
Space Use (Total Site Area) (hectare)	3.0004	(Arup, 2022)	
Total Construction Cost (million HKD)	6890	(Arup, 2022)	
Annual Operation & Maintenance (O&M) cost per hectare	3.6	(LSCD, 2015)	
Median Hourly Wage rate in 2021 (HKD)	75.7	(Census and Statistics Department, 2022	
Average persons in each vehicle	2	(Transport Department, 2022)	
Traffic flow of the cross-harbour tunnel in 2021	107,450	(Transport Department, 2022)	
Social Cost of Carbon (USD/ton)	43	(Interagency working group on social cost of carbon, 2013)	
PPP exchange rate of HKD/USD	5.875	(World bank, 2021)	
Carbon emission intensity (kg CO ₂ /m ²)	386.5	(Hong et al. 2015)	
CLP Group's Greenhouse Gas Intensity (kg CO2/kWh)	0.55	(CLP, 2022)	
Electricity per day (kWh)	5800	(CLP, 2021)	

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Benefit Valuation

Parameters for Benefits Evaluation	Values	References and Notes	
Art gallery entrance fee (HKD)	10	(HKMOA, 2022)	
Number of visitors (million per year)	9.73	(Song et al. 2017 and Vu et al. 2015)	
Property (Hedonic) value increased rate by the Green Deck project (percentage)	27.03	(Hui et al. 2022)	
Consumer Price Index	1.34	(C&SD, 2022	
Number of full-time staff and students at PolyU	26873	(PolyU, 2022	
Average annual rainfall in Hong Kong (mm)	2307.1	(Hong Kong Observatory, 2022)	
Willingness to pay to reduce road noise per decibel/year/person (HKD)	115.60	(Leong, 2019)	
Temperature reduction by trees (Celsius degree)	2.4	(Kong et al., 2017	
Non-residential electricity rate (HKD/kWh)	1.83	(CLP, 2023)	
CLP Group's Greenhouse Gas Intensity (kg CO2/kWh)	0.55	(CLP, 2022)	
Median hourly wage in Hong Kong in 2021 (HKD)	75.7	(Census and Statistics Department, 2022a)	
Medical cost saving per person (HKD/person/year)	1829	(Census and Statistics Department, 2022b)	
Population living near Green Deck	132022	(Census and Statistics Department, 2022c)	
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Cost & Benefit Valuation

Items				Annual Values (million HKD)
Cost	Construction Stage	Tangible	Design and Consultation Cost	25.05
			Construction Cost (11-year)	626.36
		late a site la	Cost of Temporary Traffic Congestion	755.78
		Intarigible	Construction Carbon Emission	0.27
	On another stand	Tangible	O&M Cost	10.80
	Operation stage	Intangible	Operation Carbon Emission	0.29
Benefit	Operation stage	Tangible	Revenues (art gallery & sports complex)	9.29
			Visitor expenditures	598.47
			Property value (hedonic)	411.39
			Air pollution reduction	5.53
			Carbon sequestration	0.02
			Surface runoff reduction	0.14
		Intangible	Noise pollution reduction	9.32
			Temperature reduction	11.82
			Health and well-being	79.68
			Travel time reduction	0.28



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Cost and Benefit Analysis

B-- benefitC-- costt-- time periodT-- time horizon, 50 yearsr-- discount rate, 4% r_{IRR} -- Internal Rate of Return

Net Present Value (NPV)

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Benefit-Cost Ratio (B/C Ratio)

$$BCR = \frac{\sum_{t=1}^{T} B_t / (1+r)^t}{\sum_{t=1}^{T} C_t / (1+r)^t}$$

1

$$NPV = \sum_{t=1}^{T} \frac{(B_t - C_t)}{(1 + r_{IRR})^t} = 0$$







Cost and Benefit Analysis



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Cost and Benefit Analysis



B = - benefit $C = -\cos t$ t = - time period T = - time horizon, 50 years r = - discount rate, 4% $r_{IRR} = -\text{ Internal Rate of Return}$ $NPV = \sum_{t=1}^{T} \frac{(B_t - C_t)}{(1 + r_{IRR})^t} = 0$

The IRR is the rate of return of the investment project that makes the NPV equals zero.

IRR = 5.5%

<u>Decision Rule</u> If IRR > Discount rate, accept the project

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Comparison with urban infrastructures in Asia



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Cost Benefit Analysis Result of the Green Deck Project

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IRR: 5.5%

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Discounted rate (%)

10

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--- IRR

— NPV

No	Project	Location	B/C ratio	Ref.
1	Stormwater treatment	China	1.91	Liu er al. (2016)
2	Public housing prefabrication	China	1.81	Shen et al. (2019)
3	Solar photovoltaic system for commercial buildings	India	1.11	Goel and Sharma (2022)
4	Waste recycling	Vietnam	1.01	Tong et al. (2021)

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Risk Assessment

Sensitivity Analysis

The selected parameters concerning visitors and property value:

- Parameter 1: Number of visitors
- Parameter 2: Expense of each visitor
- Parameter 3: Property value

Parameters are adjusted from -20% to +20%.



Sensitivity Analysis



-The number of estimated visitors to Green Deck (million/year)

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Average food and beverage expense for visiting Green Deck (HKD/person)
 Property (Hedonic) value increased by the Green Deck project (million/year)

Advised marketing strategies to attract visitors

- Roll out souvenirs of Green Deck (e.g., cups, purses, and clothes)
- Organize cultural activities or exhibitions collaborating with surrounding parties (e.g., PolyU and Hong Kong Coliseum)







Conclusions

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□ This study estimated the costs and benefits of the Green Deck development.

The result shows that the Green Deck project is economically feasible (pay back year: 2058).

Net Present Value (NPV): NPV = HK\$3.32 billion > 0,

Benefit-Cost Ratio (B/C Ratio): B/C ratio = 1.35 > 1,

Internal Rate of Return (IRR): IRR (5.5%) > Discount Rate (4%).

□ Compared with some urban infrastructure development projects in Asia, the B/C ratio of the Green Deck project is viable.

□ Marketing strategies (e.g., collaborations with surrounding art and cultural institutions) are advised to target attract more visitors to increase the net present value.





THANK YOU

END OF PRESENTATION













