Fukuoka City: Pioneering Life Cycle Costing for Efficient Water Management

CASE SNAPSHOT

SECTOR

Water

COUNTRY

Japan

TIMELINE

1979–Present

COST

Initial investment of ¥32.5 billion ($148.3 million) for the Water Distribution Control Center and leakage reduction program.

RESULT

- Internal Rate of Return (IRR) of **15%**, demonstrating sound investment decisions.
- Leakage rate reduced from **14% in 1979 to 2% by mid-2000s**, significantly lowering operational costs and water production needs.
- Delayed capital expenditures by controlling demand through water reclamation facilities and usage-based tariffs.

CASE STUDY SUMMARY: FUKUOKA CITY'S EFFICIENT WATER MANAGEMENT

THE OBJECTIVE

Fukuoka City aimed to develop a sustainable and efficient water management system by minimizing water leakage, optimizing resource use, and ensuring long-term cost efficiency through strategic life-cycle costing.

THE CHALLENGE

Fukuoka City lacked sufficient natural water resources due to the absence of a Class A river system[1]. The problem became critical during the severe drought of 1978, which restricted water supply for 287 consecutive days and limited access to just 10 hours per day.

Drivers for change:

- Drought exposed vulnerabilities in water infrastructure.
- Rapid urbanization increased water demand beyond available supply capacity.

Outcome needed:

In 1979, a year after the drought, the city set out a vision to become a water-conscious city and launched multiple initiatives to create an efficient water management system. However, to efficiently manage existing water resources, sustain growth, and maintain high liveability standards, the following challenges had to be overcome:

- High physical water loss (leakage) from the system, which was around 14% in 1979.
- Insufficient infrastructure capacity to meet the needs of urbanization.
- Lack of up-to-date data on the performance of the water management system.
- The growing gap between demand and supply of water.
- Lack of supportive policy frameworks to support life cycle costing best practices (e.g., procurement and contract structuring, O&M procedures, long-term financing mechanisms, etc.)

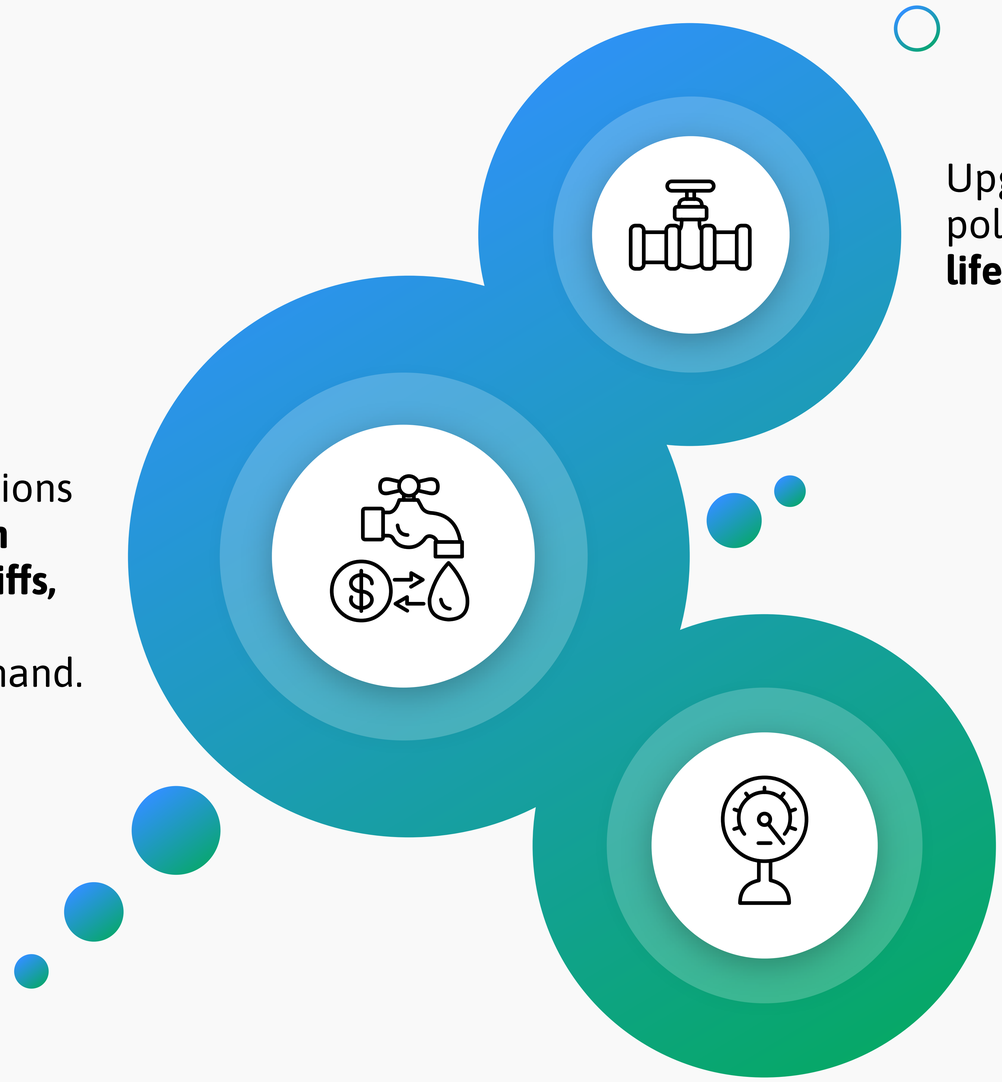
[1]"Class A Rivers" are rivers that are part of river systems considered to be particularly important for the maintenance of the land or national econom y. These rivers are designated by the Japanese Ministry of Land, Infrastructure, Transport, and Tourism.

THE SOLUTION

BREAKDOWN OF THE LCC APPROACH

The following section describes the **technical, operational and financial solutions**, guided by life cycle costing principles, that were implemented by Fukuoka City to achieve economic efficiency and sustainability of the city's water management system.

Snapshot of the final solutions:



Upgrading distribution pipes with polyethylene sleeves to extend **lifespan** from **40 to 80 years**.

Complementary interventions such as water **reclamation facilities, usage-based tariffs, and public awareness campaigns** to control demand.

Establishing a centralized **Water Distribution Control Center** for real-time monitoring and control of water flows and pressures, allowing for more targeted leakage reduction measures.

Technical

A robust life cycle costing approach begins with the **Identification and Evaluation of Design Alternatives** to best compare and assess the feasibility of various options. Ultimately, this process should result in the selection of a technical solution that will perform most cost effectively throughout the entirety of the asset's life cycle.

Reduction of Pipe Replacement Costs with Polyethylene Sleeves

Items	Standard Pipes	Pipes with Polyethylene Sleeves
Investment Cost (Relative, Percent)	100%	102%
Pipe Lifespan (Years)	40 Years	80 Years
Net Present Value Of Replacement Costs (5% Discount)	117%	104%

In Fukuoka, polyethylene sleeves were chosen over standard pipes as they doubled pipe lifespan from 40 to 80 years at an additional upfront cost of only 1–2 percent. This reduced pipe replacement costs by approximately half each year.

Approximately 3,000 km, or 75 percent, of distribution pipes are now protected by polyethylene sleeves in Fukuoka City. As a result, the net present value of pipe replacement costs has been reduced by approximately 13 percent.

This technical modification was only possible due to revisions made within Fukuoka's procurement policy.

(See the Enablers section below for more information on upstream reforms that are required for downstream technical solutions to be enacted).

Operational

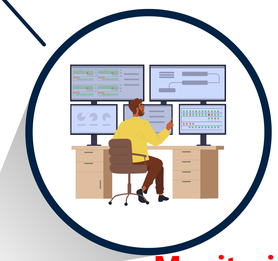
While considering design alternatives, to best assess life cycle costs, the ***operation, maintenance and rehabilitation plans*** for each option must also be considered.

In the case of Fukuoka, in addition to selecting polyethylene pipes to keep maintenance costs low, the city realized a Water Distribution Control Center would be necessary to effectively control water flow and pressure.

The Center, which includes real-time data monitoring functionality, allowed for cost-saving O&M measures such as:

The Center currently operates 24 hours a day, staffed by three operators, and actuates about 2,000 valves a day.

Water Distribution Control Center



Fukuoka City
Waterworks Bureau

Monitoring Data

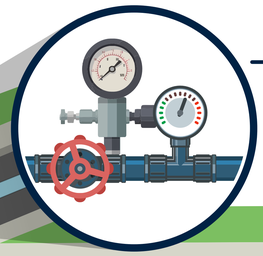
Control Signal

Distribution Pipes

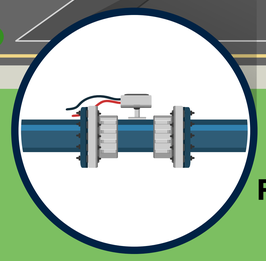
Remote Monitoring and Control Device (Telemeter)

Early detection and response to breakdowns through remote monitoring and control (i.e., pressure is maintained at approximately 0.4 MPa as pipes become susceptible to damage when the pressure goes beyond this threshold; prior to the establishment of the Center, pressures often reached over 0.5 MPa)

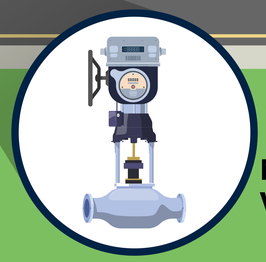
Pressure Meter



Leakage reduction from 13% to 2% by controlling water pressure, which in turn led to reduced costs of water production and delivery for the city



Flow Meter



Motorized Valves

Labor savings by remotely controlling valves

Complimentary Operational Interventions

Fukuoka City also supplemented existing water sources through water reclamation activities. As of 2020, the city was operating two reclamation facilities totaling a capacity of nearly 12,000 cubic meters per day. The reclaimed water is used for toilets and sprinklers in more than 450 locations over nearly 1,500 hectares. Through the addition of this water recycling solution, Fukuoka City was able to significantly meet water demand via reclaimed water.

Financial

When applying principles of life cycle costing, decision makers must understand that, often, a solution that minimizes upfront capital costs may not be optimal when considering economic efficiency throughout the entirety of an infrastructure asset or system's lifetime. At time, additional up-front investments can ultimately result in a reduction of operating expenditures and delayed future capital expenditures.

Life-cycle costing analysis (LCCA) is an approach used by Fukuoka City to prioritize investments based on whole-life costs.

LCCA is used to compare the total costs of competing project alternatives that would yield the same level of service and benefits.

Summary of Costs (USD)

		Initial Investment (USD)	Recurrent Costs	
			Cumulative (USD)	Annual (USD)
Water Distribution Control Center		$71.65 million	$69.22 million	$1.87 million
Leakage Reduction Program	Leakage Inspections	n.a.	$8.41 million	$0.22 million
	Cathodic Protection	n.a.	$0.40 million	$0.009 million
	Service Pipe Replacement	n.a.	$8.02 million	$0.31 million
	Lead Service Pipe Replacement	n.a.	$4.87 million	$0.27 million

Figures were converted from Japanese Yen (¥) to US Dollars (USD) using the 2020 average exchange rate (1 JPY = 0.009354 USD) for consistency and comparability.

Investing in Infrastructure for Sustainability

- In the case of Fukuoka, a LCCA approach was used to justify investments both in the polyethylene pipes and the Water Distribution Control Center.
- The Water Distribution Control Center required a large initial investment and hence was financed by municipal bonds.
- However, for the water supply system to be self-sustaining while in operation, water tariffs were used to cover operational expenditures and depreciation of invested assets (see table above).

Implementing Tariffs for Water Conservation

- In addition to funding an investment, tariffs can be used to incentivize water saving behaviours.
- In Fukuoka, a combination of fixed tariff and usage-based tariffs is being adopted.
- Once household usage exceeds a certain threshold, tariffs (per cubic meter of water) increase, thereby incentivizing citizens to maintain their water usage under a specific threshold.

Incentivizing Reclaimed Water for Efficiency

For non-households, the city incentivizes the use of reclaimed water by offering it at a 10–20% lower price than normal water, helping reduce costs and improve the water system's efficiency.

THE ENABLERS

To implement the solutions above, key upstream interventions were required in Fukuoka City:

Policy and Regulation

- **Usage-based tariffs to incentivize water-saving behaviors:** In addition to a fixed tariff based on water meter diameter, Fukuoka City implemented usage-based tariffs to encourage water-saving behaviors. For households, the initial tariff was set at ¥17 per m^3 (US$0.11) for the first 10 m^3 of consumption per month. For monthly consumption between 10 and 20 m^3, the tariff increased significantly to ¥155 per m^3 (US$1.04), with further increases for higher consumption levels. Since the average household uses approximately 12 m^3 of water per month, this tariff structure helped to incentivize reduced consumption. See the table below for details.
- **Local ordinance for reclaimed water:** In 2003, the installation of miscellaneous-used water pipes were mandated in buildings with large floor areas to enable the use of reclaimed water for toilet facilities.
- **Public awareness campaigns:** Since the drought in 1978, Fukuoka City has actively promoted public awareness of water conservation, designating June 1 as Water Saving Day and holding regular campaigns during peak summer months. The city prioritises youth education through textbooks and site visits to water-related facilities, fostering a strong culture of conservation.

Planning

- **Vision:** A clear vision set in 1979 ("water-conscious city") guided strategic investments and demand management initiatives over multiple decades. This city officials were well aware that efficient management of water resources was the primary policy objective, and their daily duties contributed to the overall goal.
- **Development policy:** In the 1970s, while other municipalities adopted pro-development policies and expanded urban boundaries, Fukuoka City created compact urban centres equipped with high-quality basic infrastructure. The city strictly controls development activities, particularly in suburban areas, to ensure water security.

Procurement

- **Procurement specifications:** The city revised its procurement policy, requiring polyethylene sleeves for all new distribution pipes.
- **Evaluation criteria:** In line with the city's vision for efficient water management and quality infrastructure, in 2006 the city introduced the comprehensive evaluation method to select bidders based on quality in addition to price. By 2020 the comprehensive evaluation method was being applied to ¥3 trillion (US$20 billion) of projects each year.

Capacity

- **Digitalization:** The establishment of the Water Distribution Control Center increased the capacity of network operators to monitor and control pressure across a complex network of 2,000 valves 24/7. The implementation of this system required digital skills to be developed among operators.

THE RESULT

The interventions yielded significant impacts related to economic efficiency:

- Life cycle costing analysis enabled Fukuoka City to determine that polyethylene sleeves would extend pipes' lifespan by 40 years, with an additional cost of only 1–2 percent compared with traditional pipeline solutions.
- The same approach motivated an investment in a Water Distribution and Control Center, which was estimated to deliver an Internal Rate of Return of approximately 15%.
- The comprehensive leakage reduction strategy successfully cut leakage rates from 13% to about 2%, generating substantial cost savings in water production and distribution.

QII PRINCIPLES IN ACTION

In addition to **Principle 2 (Economic Efficiency)**, Fukuoka City's approach reflects:

Principle 6: Infrastructure Governance

The comprehensive evaluation method institutionalized since 2006 assessed contractors based on quality criteria including technical proposals, executional capabilities, safety measures, social contributions, local mobilization, reliability, and accountability.

This approach improved technical quality, incentivized private sector capability enhancement, prevented collusion among bidders, and improved overall public works performance.

RELATED REFERENCES

Want to explore this case further? Access the detailed case study here.

Related Materials

- Life-cycle Costing Primer
- World Bank Report: "Well Maintained - Economic Benefits from More Reliable and Resilient Infrastructure"

Similar Case Studies

- Performance-Based Contracting in Ho Chi Minh City (Water Sector)
- Infrastructure Maintenance Practices in Pacific Island Countries