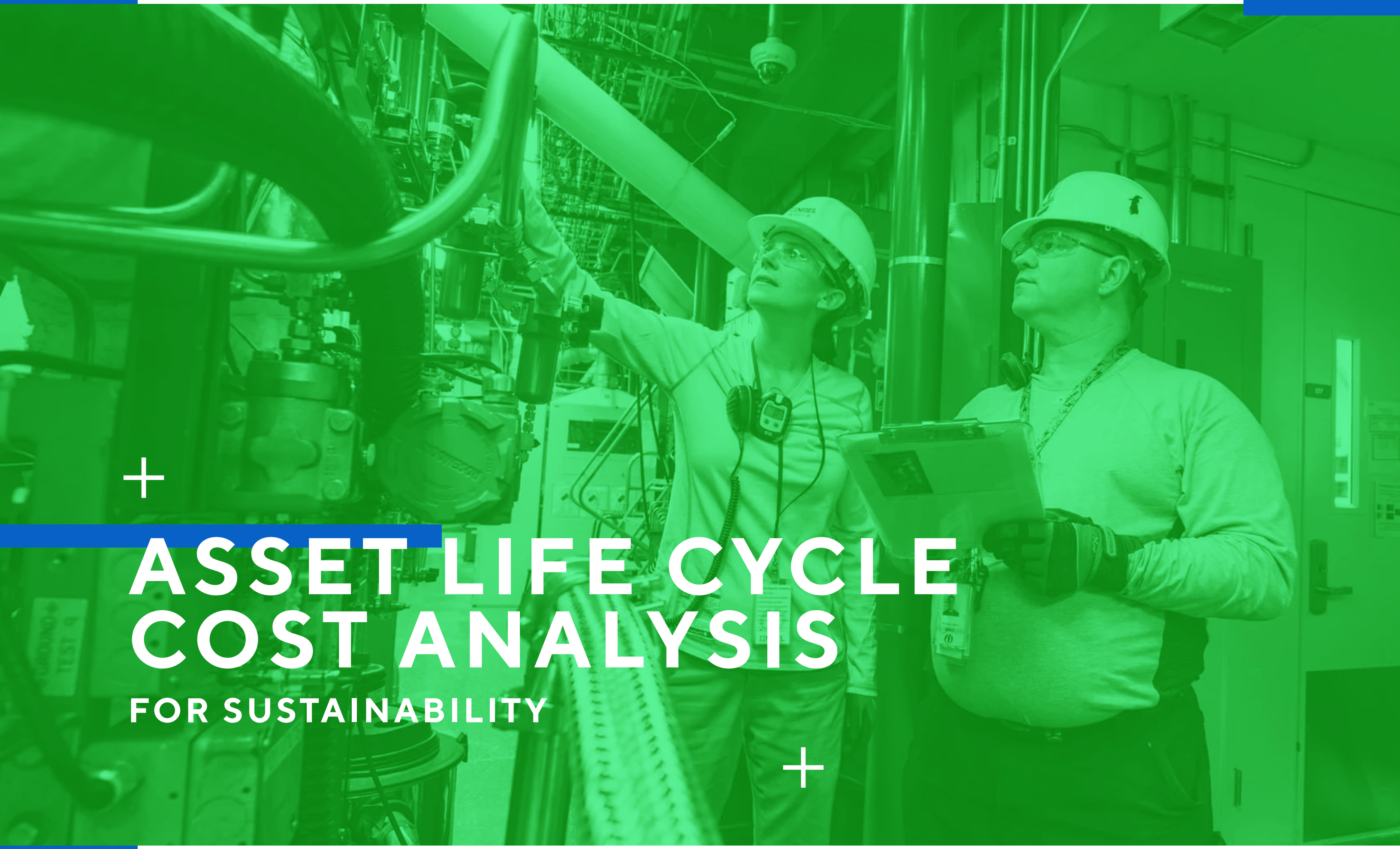

ASSET LIFE CYCLE COST ANALYSIS

FOR SUSTAINABILITY

TABLE OF CONTENTS

ASSET LIFE CYCLE COST ANALYSIS FOR SUSTAINABILITY

The environment in which businesses operate today is continuously changing, and the rate of change is accelerating. Successful businesses are realizing that excellence is built by resilience and the willingness and ability to change. The centrality of success relies on the ability to evaluate economic alternatives and adapt accordingly.

Economic and financial factors taken into consideration in the decision-making process are evolving to include sustainability and natural capital preservation. Building and maintaining an adaptive business is not just a matter of implementing a single strategy for life cycle costs but continuously strategizing and implementing innovative life cycle cost alternatives that consider scalability for up-growth sustainability.

MANAGING ASSETS FOR LIFE CYCLE

Asset management enables a business to examine the need for a specific asset and optimize its performance for the duration of its life cycle in support of the organization's strategic objectives. It enables the selection and application of analytical approaches for managing an asset – from conception through disposal, or recycling – within the broader asset management eco-system while balancing the costs, opportunities, and risks.

Let's look at some key working definitions in the context of asset management. Top of mind is life cycle cost, which supports the realization of a unique customer value by balancing costs, opportunities, and risks against the desired performance of assets, to achieve overall business goals.

An asset is an item or entity that has potential or actual value to a business. Value can be tangible or intangible, financial or non-financial, and can be impacted by risks and other liabilities. It can be positive or negative at different stages of the asset's life. Physical assets usually refer to equipment, inventory, and properties owned by the business. Then there are intangible assets, which are non-physical assets such as leases, brands, digital assets, use of rights, licenses, and intellectual property rights. For simplification, we will focus on the life cycle cost analysis of physical assets.

The asset life cycle goes through several critical milestones – from planning to design, construction-installation-testing, operation and maintenance, and retirement of the asset (disposal or recycling). Many assets reach the end of their effective life before they become non-functional (e.g. regulations change, the asset becomes non-economic, the expected level of service increases, or capacity requirements exceed design capability). Technological developments and changes in user requirements are other common factors influencing the effective life of an asset. Life cycle cost analysis can be applied to the whole life cycle of a product or asset, a project, or even parts or combinations, at different phases.

However, certain limitations to conducting a life cycle cost analysis should be noted.

- It does not factor in intangible aspects, such as customer satisfaction or brand loyalty.
- It is based on assumptions about the future, such as how long the product or system will be used and how much it will cost to maintain over time.

If we were to follow the life cycle of an asset, the main costs incurred can be grouped into components associated with specific asset life cycle milestones: 1) acquisition costs, which include the establishment of the asset need (planning and design) and existence (construction-installation-testing); 2) ownership costs such as those related to its use (operations-maintenance); and 3) end of life costs that involve disposal and/or recycling (see Figure 1 below).

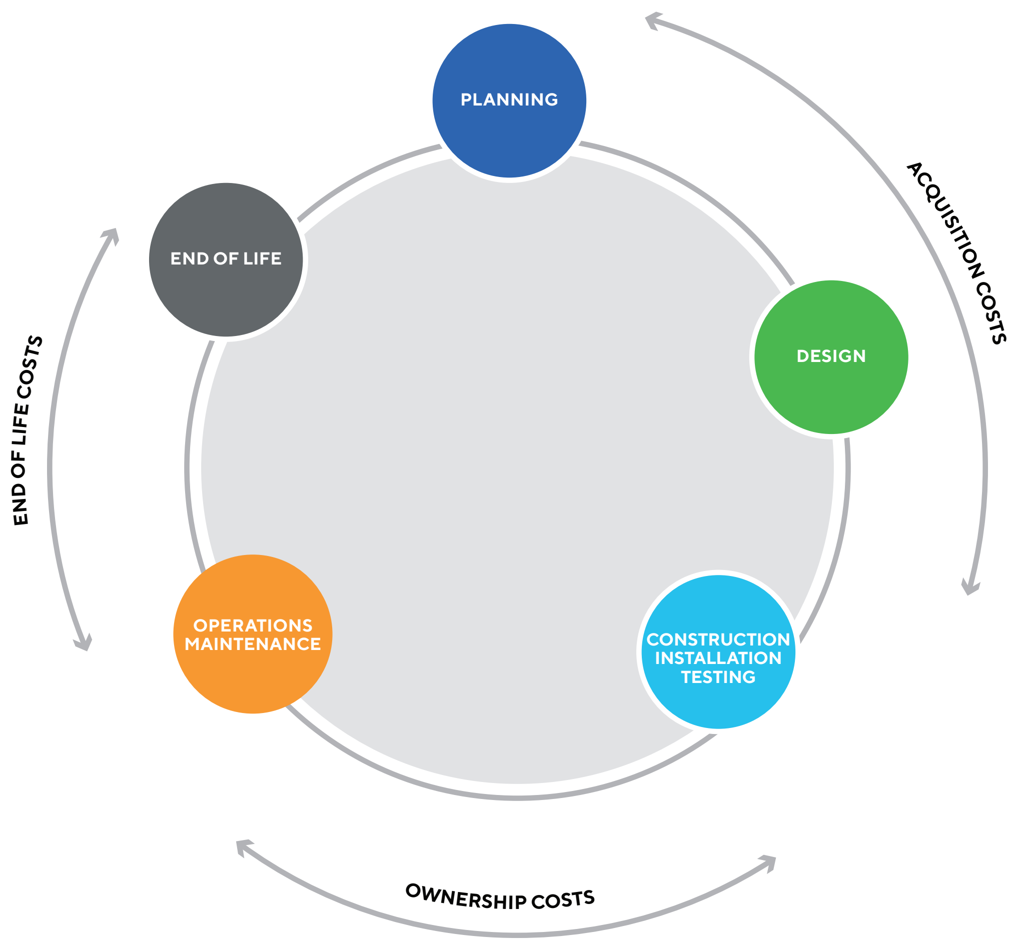

Figure 1: Asset Life Cycle Milestones

TOTAL COST OF OWNERSHIP

If we express life cycle costs in simplistic terms, then:

Total Cost of Ownership = Acquisition Costs + Ownership Costs + End of Life Costs

The acquisition costs, or the initial procurement costs, are generally visible and can be readily evaluated.

Typical items are:
- Design and administration
- Equipment purchasing (fabrication and manufacturing)
- Logistics support
- Installation
- Commissioning
- Spare parts
- Production loss during installation
- Initial baseline and performance curves
- Quality assurance and quality control activities
- Testing and verifications for release to Operations

The ownership costs, which often exceed the acquisition costs, are not readily visible and are more difficult to predict. Typical items are:
- Maintenance (preventive, predictive, scheduled, unscheduled)
- Operational (energy, utilities, environmental compliance)
- Logistic support
- Spare parts
- Energy or fuel consumption
- Production loss during maintenance or failure
- Equipment rental
- Inspection
- Quality Control and Quality Assurance

End of life costs are generally minimal in comparison with the other components of the total cost of ownership, and they often include:
- Salvage and disposal
- Logistics support
- Permits and legal

Within the life cycle analysis eco-system, decisions often need to be made to support growing requirements for increased production outputs, risk mitigation, increased quality, and sustainable environmental and societal stewardship. This requires alternatives generation and selection during periodic repairs, replacements, upgrades, and redesigns. Total cost of ownership of an asset is often far greater than the initial capital outlay cost and can vary significantly between different alternative solutions. Understanding the costs over the whole life of an asset provides a quantitative basis for the best decision-making.

LIFE-CYCLE ASSET MANAGEMENT PLAN ALIGNMENT WITH ISO55000

The term 'Asset Management Plan' is defined in ISO55000 as "documented information that specifies the activities, resources, and timescales required for an individual asset or grouping of assets to achieve the organization's asset management objectives."

The Asset Management Plan as defined in ISO55000 is the same as the Life Cycle Management Plan understood to be a grouping of planned and unplanned activities that identify all the operating and maintenance needs of the asset, including periodic repairs, condition monitoring, and overhaul.

MAKING DECISIONS FOR LIFE CYCLE COSTING AND LIFE-CYCLE ASSET MANAGEMENT PLANS

Most life-cycle cost analyses are conducted according to the traditional problem-solving process and framework, outlined below.

- Define objectives.
- Identify alternatives.
- Define assumptions based on projected benefits and costs.
- Evaluate alternatives.
- Decide among alternatives.

Traditionally, during the Planning, Design, and Construction-Installation-Testing phases, the project manager is under great pressure to control scope growth, manage allocated funds, and accelerate the execution period. Although these early phases in the life cycle of the asset are an opportunity to make lifelong decisions, because of the project execution pressure, the asset is often released to Operations carrying forward less than adequate decisions. This is a major cause for elevated costs to operate, maintain, and retire the asset (see illustration of costs progression provided in Figure 2 below).

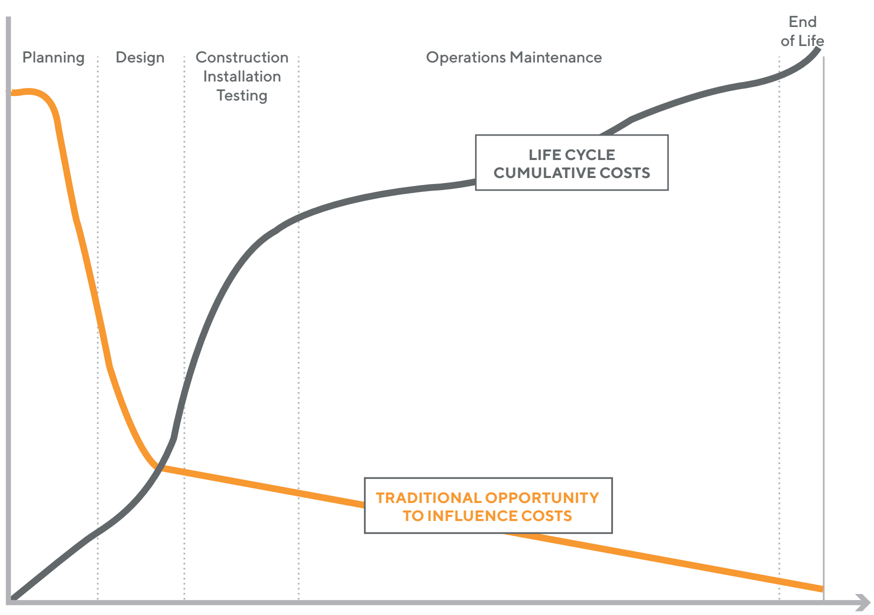

Figure 2: Life Cycle Cumulative Costs and Traditional Capabilities to Influence It

FINANCIAL METRICS USED FOR LIFE CYCLE ANALYSIS

The process of life cycle cost analysis can be broken down into the following five steps:

1. IDENTIFY THE ASSET
   The first step is to identify the asset that will be evaluated. This could be a physical asset or a grouping of assets, such as a sub-system, system, or business unit.

2. DETERMINE THE LIFE CYCLE DURATION
   Life cycle duration represents the period over which the asset will be used.

3. IDENTIFY ALL COSTS FOR THE DURATION OF THE LIFE CYCLE
   The third step is to identify all costs associated with the asset over its life cycle. This includes not only the initial purchase price but also any additional investments, such as upgrades or modifications, as well as any recurring costs, such as maintenance, repair, and operational expenses. Life cycle costs include:

   - **One-time cost or investment costs** – incurred when a company makes an actual investment, such as buying a new machine. These costs can be high, but they usually result in some immediate benefits. For example, the new machinery may increase production capacity or allow for a higher level of quality control. In some cases, investment may also lead to increased employee morale and motivation.
   - **Re-occurring costs** – continue to occur after the initial purchase, including the cost of operations and maintenance. Operating costs are associated with running day-to-day operations. This includes things like utilities, rent, and supplies. For most businesses, maintenance and operating costs are the largest expense they will incur. As such, it is important to track these costs and find ways to reduce them. Maintenance costs also include the functional upkeep of a healthy asset, such as asset health condition monitoring.
   - **Disposal costs** – associated with the disposal of the product once its useful life ends. This might include decommissioning and cleanup costs, which are incurred at the end of the asset life cycle. Decommissioning and cleanup are required to preserve the integrity of the site and avoid environmental damage. The process of decommissioning involves removing all structures and materials that are no longer needed, as well as decontaminating the area to make it safe for future use.
   - **Residual value** – the value of the product, if any, after it reaches the end of its useful life.

   For example, a product with a low initial purchase price but higher maintenance and operating costs may have a higher life cycle cost than a product with a higher initial purchase price but lower maintenance and operating costs. Likewise, a product with a long lifespan may have a lower life cycle cost than a product with a shorter lifespan. Taking the time to calculate the life cycle cost of a product empowers the business to make the best economic decisions.

4. CALCULATE FINANCIAL METRICS TO ASSIST IN ALTERNATIVES COMPARISON
   The most used financial metrics are based on the calculation of the **Net Present Value (NPV)** of all costs identified in Step 3 above. This involves discounting future costs to an asset's present value using an appropriate discount rate, as well as considerations for interest rates. Additional financial metrics used are **Internal Rate of Return (IRR)**, **Payback Period (PBP)**, and **Return on Investment (ROI)**.

5. COMPARE ALTERNATIVES
The fifth and final step is to compare the life cycle cost of the asset with alternative options. This can help the business choose the option that provides the best value over its entire life cycle.

The **Time Value of Money (TVM)** is a fundamental financial concept that states a sum of money is worth more now than the same sum will be at a future date due to its earnings potential in the interim. It is a core principle of finance, which recognizes that a sum of money in hand has greater value than the same sum to be paid in the future. TVM is also referred to as the **present discounted** value. The principle of the time value of money means that money can grow only through investing, so a delayed investment is a lost opportunity. By investing money today, it has the potential to grow over time. For example, money deposited into a savings account earns interest. Over time, the interest is added to the principal, earning more interest. This is known as the power of compounding interest. On the other hand, if money is not invested, its value erodes over time due to factors such as inflation and loss of potential earnings.

The time value of money has a negative relationship with inflation. Inflation refers to an increase in the price of goods and services. As prices rise, the value of a single dollar goes down, which means you cannot purchase as much as you were able to in the past.

The time value of money concept uses the following formula to calculate **Future Value (FV)**:

FV = PV x (1 + i)n or PV = FV / (1+i)n

where:
FV = Future value
PV = Present value
i = Interest rate per period
n = Number of periods

To understand the time value of money and solve related problems, it is often helpful to draw a timeline and reflect the cash flows at different times. This serves as an effective visual aid to better understand all the variables.

You can calculate the **Present Value (PV)** using a spreadsheet:

=PV(rate,n,pmt)

where,
rate = Interest rate (also known as discount rate) for the period
n = Number of payment periods for the given cash flow
pmt = Payment, or cash flow, to be discounted

The PV formula assumes that the payments are equal over the total number of periods.

Net Present Value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a certain period. In the real world, NPV is often used to evaluate investment opportunities and decide on capital allocation. Businesses are constantly looking for positive NPV opportunities since it indicates that the anticipated earnings of such investment are greater than the estimated costs. That is, an alternative investment with a positive NPV will be profitable, and an alternative investment with a negative NPV will result in a net loss.

However, when comparing alternatives, we look for the most favorable NPV (this often means selection of the least negative NPV). If comparing two negative NPVs from two alternatives, we prefer the least negative, which will return a positive NPV delta between the alternatives.

Suppose we want to compare two alternatives, alternative 1 with an initial acquisition cost of $100,000 and resale value of $20,000 after 7 years of service versus alternative 2 with an initial acquisition cost of $125,000 and resale value of $35,000 after 10 years of service.

Discount rates may vary when calculating life cycle costs depending on the context and purpose of the analysis. Usually, the discount rate may be based on alternative investments with comparable risk profiles or industry-specific rates. The discount rate used in life cycle costing is a percentage value that represents the cost of capital to the owner or producer of an asset. It is the rate on a loan or bond adjusted to account for inflation and taxes. The discount rate is used to convert future costs to their present value, allowing for a fair comparison of costs over time.

For simplification, the discount rate utilized in this example is 10%. As summarized below, alternative 1 will return an Equivalent Annual Cost (EAC) of $25,432 and NPV of $123,816, while alternative 2 will show a more favorable return NPV of $169,879 at EAC of $27,647.

	Alternative 1			Alternative 2		
	Costs-Resale	**EAC**	**NPV**	**Costs-Resale**	**EAC**	**NPV**
Acquisition Cost	$100,000	$20,541		$125,000	$20,343	
Resale Value	($20,000)	($2,108)		($35,000)	($2,196)	
Average Maintenance / Year	$1,500	$1,500		$2,000	$2,000	
Average Operations Cost / Year	$5,500	$5,500		$7,500	$7,500	
Total EAC, NPV		**$25,432**	**$123,816**		**$27,647**	**$169,879**

Internal Rate of Return (IRR) is a calculation used to estimate the profitability of potential investments. It is the discount rate that makes the NPV of all cash flows from a particular investment alternative equal to zero. IRR is expressed as a percentage and is used to rank various alternatives based on their expected rates of return.

IRR can be negative. A negative IRR indicates that the potential investment alternative's cash outflows exceed its cash inflows, resulting in a loss or a non-profitable investment alternative. If the actual discount rate of a project (cost of capital) is higher than its IRR, the actual NPV would turn out to be negative; if the actual discount rate of a project is lower than its IRR, the actual NPV would be positive. Therefore, a project with an IRR greater than its cost of capital should be profitable. This metric is also often used when there is a lack of clarity or a lack of consensus within the business as to what discount rate should be used in an NPV calculation.

NPV and IRR are two financial metrics frequently combined to evaluate the profitability of investments or capital projects. They are primarily used in capital budgeting, which is the process by which businesses determine whether a new investment or expansion opportunity is worthwhile.

Suppose we have an initial investment of $450,000 to acquire an asset with a 10-year life cycle and we have four alternatives to compare. For a discounted rate of 10%, alternative 2 is the most favorable, as it has the highest NPV and IRR.

	NPV	IRR
Alternative 1	($10,000)	7%
Alternative 2	$40,150	14%
Alternative 3	$25,350	10.9%
Alternative 4	$37,150	13.1%

A **Payback Period (PBP)** tells the business the length of time required to recover the cost of an investment. It ignores the time value of money and the cash flows that occur after the payback period. The best way to calculate the payback period is to calculate the cumulative cash flows. Another way to think of the payback period is in terms of a break-even point, or the point in time at which positive cash flows and negative cash flows incurred to date net to zero. By calculating the cumulative cash flows, it is easy to see when the cash flows flip from being negative to being positive.

Year	Savings Condition Monitoring	Cost to Implement	Cash Flow
0		$5,750,000	($5,750,000)
1	$2,130,120		($3,619,880)
2	$2,545,138		($1,074,742)
3	$3,120,000		$2,045,258
4	$3,120,000		$5,165,258
5	$3,120,000		$8,285,258
	$14,035,258	**$5,750,000**	
		Payback	**2.34 years**

Often, businesses need to decide between mutually exclusive projects. Assuming the maximum acceptable payback is 5 years, and the discount rate is 10%, alternative 1 is eliminated because the payback period is greater than 5 years and alternative 2 is eliminated as well as NPV is negative, and IRR is less than 10%. Among the remaining alternatives 3 and 4, based on the information available for the decision, alternative 3 has a greater NPV and IRR than alternative 4, making it the preferable choice.

	NPV	IRR	PBP [yrs]
Alternative 1	$55,400	23.1%	7
Alternative 2	($7,700)	8.2%	2
Alternative 3	$30,000	17.8%	2.5
Alternative 4	$28,000	16.1%	1.8

Return on Investment (ROI) is another financial metric used to evaluate the efficiency or profitability of an alternative investment, or to compare the efficiency of several different investment alternatives. ROI is calculated by taking the difference between the current or expected value and the original value, divided by the original value, and then multiplied by 100.

ROI is typically expressed as a percentage because it is intuitively easier to understand than a ratio. ROI calculations include the net return in the numerator because returns from an investment can be either positive or negative. When ROI calculations yield a positive result, it means that net returns are favorable because total returns exceed total costs. When ROI calculations yield a negative figure, it means that the net return is not desirable because total costs exceed total returns. ROI does not take into consideration the investment period duration, so it might miss an economic opportunity somewhere else.

THE COMPLEXITY OF LIFE CYCLE COST ANALYSIS IN THE REAL WORLD

Calculating life cycle costs is not always as simple as presented in the previous examples; however, the advantage in the decision-making process is that there are various financial metrics that can be used in combination with technical assumptions and calculations. The most important factors to consider in the life cycle analysis are the overall costs and the economic life span of the asset. Once all these factors have been considered, businesses can make decisions based on which alternative will provide the best value in the long term.

Case study

A manufacturing plant had to make the decision of continuing to operate 'as is' with a system of two pumps in a parallel configuration, implement a health condition monitoring program, perform a hydraulic re-rate with material upgrade, or upgrade the pumps to an improved design. Total Cost of Ownership, calculated for a period of 25 years, shows a favorable NPV for continuing to operate in the current configuration with the implementation of a condition monitoring program that will provide real- time indication of the equipment health changes followed by planned and scheduled applicable maintenance interventions. The implementation of a health condition monitoring program was also aligned with the business's safety strategic targets of eliminating personnel hazards in the field. The decision for the preferred alternative might change if the assumptions used for this decision are changing, such as including considerations for improvements of the longevity of the asset or its performance.

	Inputs for Simulation		Simulation Outputs, Inputs in Total Cost of Ownership Calculations		Failure Impact Used in Total Cost of Ownership Calculations		
			# of Failures for 25 Years Simulation				
	MTBF [yrs]	Repair Time [days]	Both Fail	One Fails, One Operates	Production Loss / Event	Repair Cost / Event	Implementatio Cost
Repair Existing Pumps	1.66	2	1.18	16	$150,000	$25,000	$0
Implement Health Condition Monitoring	3		0	0		$25,000	$15,000
Hydraulic Re-rate with Material Upgrade	4		0.288	7		$25,000	$480,000
Upgrade Pump Design	6		0.14	5		$15,000	$1,500,000

LIFE CYCLE COSTS ANALYSIS FOR SUSTAINABILITY

The United Nations Brundtland Commission defined sustainability in 1987 as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."

In 2002, Nobel Laureate Paul Crutzen used the term 'Anthropocene' to capture the idea that human activities have become a major geological force shaping the planet. He believes that the impact of human activities, such as industrialization, deforestation, and the release of greenhouse gases, has fundamentally altered the Earth's systems balance, including the climate and biodiversity. He presents these changes to be so significant that they warrant the recognition of a new epoch in geological time following the past 10,000 years of Holocene into the era of Anthropocene.

The Earth is home to society, which includes the economy as a conglomerate of businesses, plants, systems, sub-systems, and assets (see Figure 3 below). Life cycle costing analysis and decisions made at the asset level have an incremental contribution to the balance within the economy by considering factors that protect natural resources from depletion and degradation, while deriving the materials and energy required for sustaining and serving the human civilization aspirations.

Figure 3: Earth as Home to Society and Economy

The 'Tragedy of the Commons' is an archetypal scenario that describes a commonly held good or resource and a group of people who use that resource, individually and collectively. If each individual or group of people use the common resource without coordination with others and hoping for unlimited access to it, the logical result of these actions will be depletion for all.

In 1971, John Holdren, Barry Commoner, and Paul Ehrlich formulated a thought-provoking analytical formula that is meant to express the sustainability impact factors through the IPAT Equation, which expresses the relationship between the key factors of population, affluence, and technology.

The IPAT equation is:

I = P x A x T

where,
I = Impact
P = Population
A = Affluence
T = Technology

The modified IPAT formula shown below reflects goods and services per person:

Impact = Population x Goods & Services/Person x Impact/Goods & Services

If the formula is further adapted to the world of industrial operations, the impact is directly correlated with the number of assets, the quantity of services required during the life cycle, and the technology involved to sustain the asset life.

Impact = Assets Population x Goods & Services/Asset x Impact/Goods & Services

This adapted formula needs to be understood as a direct correlation of factors and not an equality. Affluence for industrial operations is the level of provisions we desire for the assets to operate and that is expressed as goods and services per asset. Affluence can be influenced by technology, and technology is a critical element for success (including policies, processes, acts of innovation, tax incentives, and any mechanism and process that will drive the efficiency and availability of goods and services).

In simplistic terms, to decrease the impact, the future will hold designing multi-functional assets, reducing the number of services to only the required ones based on the health condition of the asset, and implementation of a technology that will support lower emissions and better use of materials with emphasis on looping back to reuse the resources and eliminate waste in a circular economy supporting an industrial ecology.

In an industrial ecologic environment, the assets no longer have a life cycle with a beginning (planning, design, construction, installation, and testing), a middle (operations and maintenance), and an end of life. When materials, parts, and assets stop being used, they go back into a useful cycle through a circular economy. A circular economy, therefore, is a systematic approach to extend the useful life of technical materials and contribute to the regeneration of biological systems. Circular economy decisions are being made for sustainability efforts at every major asset life milestone, as illustrated in Figure 4 below.

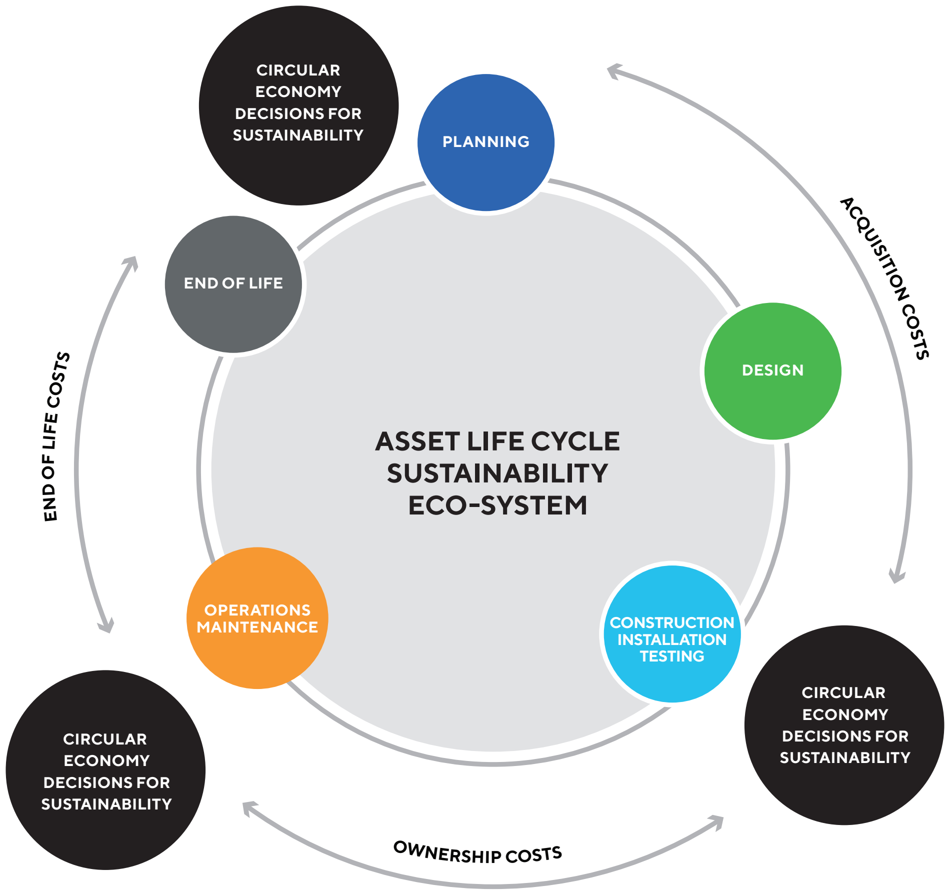

Figure 4: Asset Life Cycle Sustainability Eco-System Considerations

Earth Overshoot Day marks the date when humanity's demand for ecological resources and services each year exceeds what Earth can regenerate in that year. In 2023, Earth Overshoot Day was August 2. The Earth Overshoot Day for 2024 is estimated to be much sooner than 2023, on July 25.

To reduce the life cycle costs and be an active contributor to the circular economy and sustainability, businesses need to consider the following in their life cycle cost decision process:

- Build alternatives for evaluation using simplistic and modular design that is restorative and regenerative.
- Make use of sensor-based technology that allows knowledge of the equipment health and condition deterioration, so that you can plan and schedule maintenance activities accordingly; rather than waiting for costly and disruptive failures to occur or replace components before the end of life.
- Implement analytics and machine learning (ML) capabilities that can leverage data to make real-time and proactive decisions regarding usage and service needs.

- Extend the utility of all materials by choosing durable and long-lasting products that are made of high-quality materials and construction, even if the acquisition cost is greater, which will save the business money in the long run by needing fewer repairs and replacements.
- Purchase products that are, or can be, reusable and recycled, including mechanical and electronic spare parts. This not only reduces waste, but it is also a source of savings and eliminates the need to buy new products.
- Consider renting and borrowing items that have a limited use.
- Select assets and technologies with consideration for energy and water conservation, which can reduce operational and maintenance costs per margin.
- Replace parts and equipment with more durable and efficient designs.
- Choose equipment that has a minimum carbon footprint, is more energy efficient, uses less utilities and materials, and is easy to repair and recycle.
- Improve asset efficiency and performance to reduce energy consumption and non-desirable interruptions.
- Consider using shared spare parts services rather than holding them in an owned inventory.
- Design products that are easily repaired or upgraded for prolonged use.
- Train facility managers and maintenance and operations personnel on processes and practices that minimize equipment and system failures, reduce waste and emissions, increase recycling and reusing of materials, and require powering off the equipment when not in use.
- Establish connectivity across assets to facilitate access to data and remote capabilities to interact with assets.
- Empower operations and maintenance staff with devices that allow them to access analytical data and make timely decisions for interventions.
- Use renewable and alternative energy sources, such as solar, wind, and biomass, to power equipment and charge batteries, reducing the use of fossil fuels and greenhouse gas emissions.

The concept of life cycle cost analysis and decisions taking sustainability into consideration requires, for most business sectors, a paradigm shift that when fully implemented will allow the coupling of economic well-being to societal good, while positioning the Earth and future generations in that re-orientation of ‘bending the curves’ with good work and meaningful intentions.

The future relies on sustainable maintenance and reliability where the main objective is to reduce impact on the environment and reduce waste. When maintenance, reliability, and efficiency go together and the evaluation of life cycle alternatives embraces sustainability, the results are reflective of an enhanced environmental, social, and economical business performance.

REFERENCES

ISO55000 – Asset Management-Overview, Principles and Terminology

ISO55001 – Asset Management-Management Systems-Requirements

ISO55002 – Asset Management-Management Systems-Guidelines for the Application of ISO 55001

Edward E. Lawler III, Christopher G. Worley, Built to Change-How to Achieve Sustained Organizational Effectiveness, San Franscisco, Jossey-Bass Publishers

Tita Ouvreloeil, Reliability Engineering in Action to Support Asset Management, SMRP Conference, 2017

Nicholas Anthony and John Hastings, Physical Asset Management, Springer, pg. 169-185

Investopedia, online available www.investopedia.com, accessed on Nov 11, 2023

Harvard Business School, Financial Accounting, CORe Certification Program, accessed in Jul 2023 – Sep 2023

Harvard Business School, Economics for Managers, CORe Certification Program, accessed in Jul 2023 – Sep 2023

Cornell University, Project Management Certification Program, accessed in Sep 23 – Oct 23

Robin Greenwood, David Scharfstein, Calculating Free Cash Flows, Harvard Business School

Massachusetts Institute of Technology, Sustainability: Strategies and Opportunities for Industry, Chief Sustainability Officer Certification Program, accessed in Oct 2023 – Dec 2023

United Nations, online available, un.org, accessed on Oct 15, 2023

Malcolm Gladwell, The Tipping Point-How Little Things Can Make a Big Difference, New York, Little Brown, 2000

David A. Nadler, Champions of Change, San Franscisco, Jossey-Bass Publishers

LEGAL NOTICE

While all attempts have been made to verify information provided in this publication, neither the author nor the publisher assumes any responsibility for errors, omissions, or contradictory interpretation of the subject matter herein.

The purchaser or reader of this publication assumes responsibility for the use of these materials and information. Adherence to all applicable laws and regulations, including federal, state and local, governing business practices and any other aspects of doing business in the U.S. or any other jurisdiction is the sole responsibility of the purchaser or reader. Allied Reliability assumes no responsibility or liability whatsoever on behalf of any purchaser or reader of these materials.

ABOUT ALLIED RELIABILITY

Allied Reliability's production and asset management experts are committed to optimizing equipment, processes, and people. Our experts work with you for best outcomes.

Understanding how critical asset failures impact the environment, production, financials, and safety enables us to deliver the right monitoring, analytics, decision making and maintenance plans.

We bring unique asset management content along with best practices, advanced tools, and proven methodologies to help customers move forward in their Digital Transformation journey to deliver enhanced performance.

Contact us for more information about our offerings in:

Reliability Services

- Criticality Analysis
- PM Evaluation
- Asset Health Matrix
- PdM Technologies Evaluation
- Work Management Evaluation
- Contract PdM
- Remote Diagnostics
- SmartCBM® Real-time Data Visibility & Analysis
- Coaching and Mentoring

For details, visit www.alliedreliability.com.

Allied® RELIABILITY

www.alliedreliability.com