Capital Investment Timing and Lifecycle Cost Optimization

Presentation by:

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Presentation agenda

Your/My Expectations

- ❑Understand aspects of AM Capital Investment
- ❑Draw Best Practices Decision Support Tools, DST
- ❑Define, understand Lifecycle Cost
- ❑Explore various means of LCC Analysis
- ❑Understand aspects, concepts and principles of LCC

Capital Investment Timing

"If you don't buy the tool you need, you will eventually pay for it, but not have your tool." *–*

Henry Ford

Capital Investment Timing

- It's never easy to know when the ideal moment is to make large capital investments in equipment.
- Hard Questions arise including
  - Is the risk going to pay off?
  - Is it the right time to commit funds?
  - How quickly will there be a return on the investment?

Capital Investment Timing

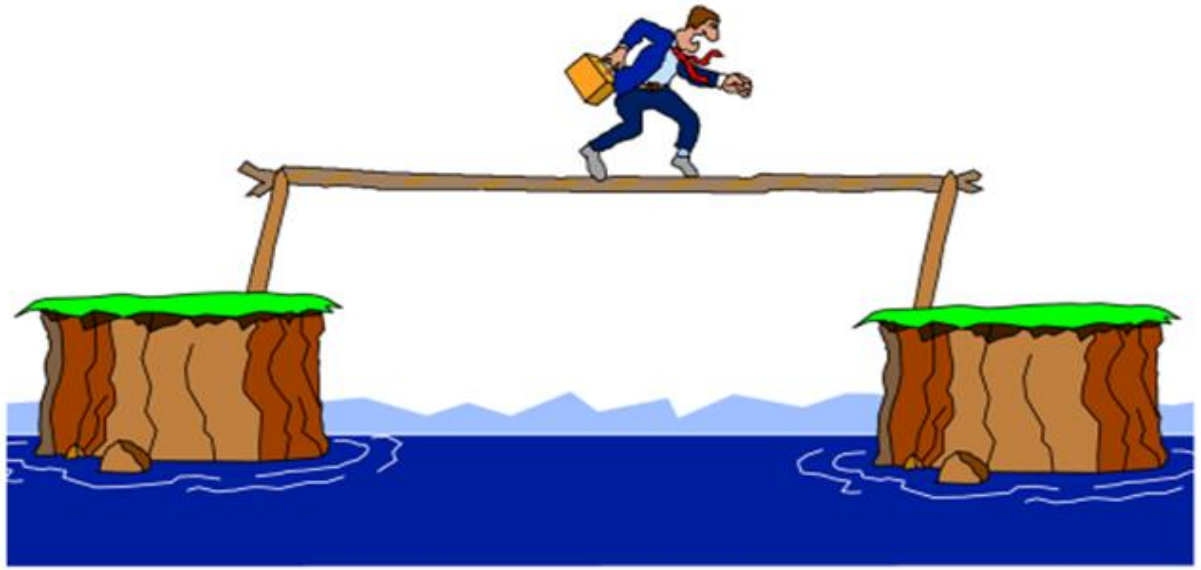
HOW CAN YOU TRULY OPTIMIZE?

- ... the time to replace an aging asset?
- ... management of obsolescence and upgrades?
- ... strategies to extend the life of existing assets?
- ...life cycle costs, risks and performance of alternative design or procurement options?

HOW CAN YOU TRULY OPTIMIZE?

- With the present economic uncertainties, these questions loom large in many investors mind
- However, there is risk not only in investing, but also in failing to invest – especially if your competition forges ahead to devote more capital to production improvements while your company stands idle on the issue.
- No company of any size can afford to pay for a tool in the form of opportunity cost, particularly when opportunity gains can be extraordinarily large.

Capital investment decisions have potential pitfalls

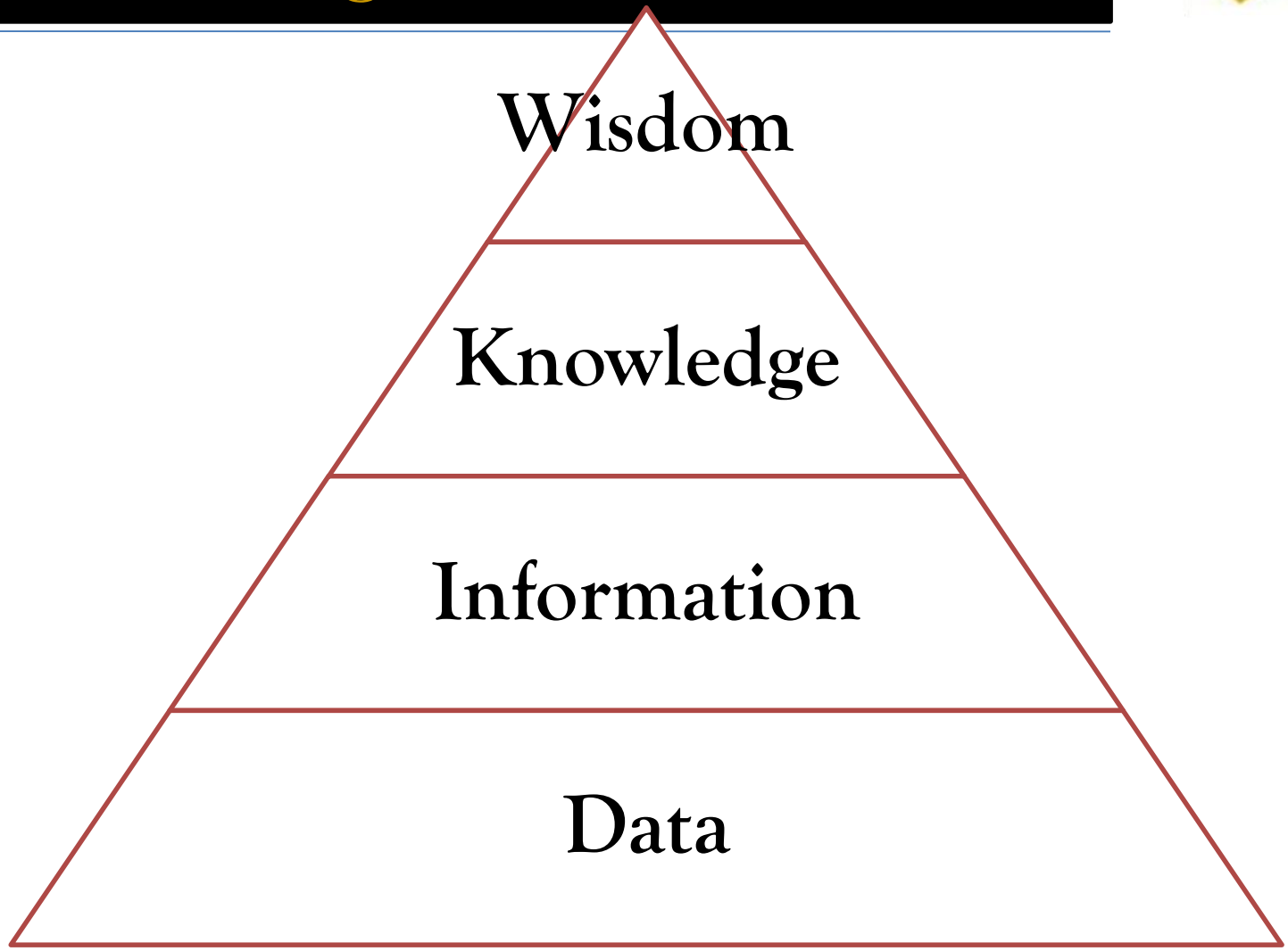


Where do we start?

Data Analytics - Vital Requirement in CIP

- A vital element of effective Asset Management is decision-making that is evidence-based and data-driven.
- In addition, sufficient, accurate data and documentation must be collected in order to:
  - Meet legal and statutory requirements, and
  - Permit effective communication with stakeholders

Data, Information, Knowledge and Wisdom



Data, Information, Knowledge and Wisdom

- **Data -** represents unorganized and unprocessed facts, and is usually static in nature
- **Information –** represents processed and organized data
- **Knowledge -** interpretation of information using human understanding based on study and experience
- **Wisdom -** combines knowledge with experience and judgement, and which allows us to better understand what knowledge, information and data we need in order to be able to make an effective decision

ISO 55001 On Data Requirement

ISO 55001 Demands that organizations

- Understand what their information needs are to meet the requirements of stakeholders (internal and external) regarding information and reporting (financial and non-financial).
  - This, by definition, would include data and information required to meet any statutory or legal reporting and record-keeping obligations, including ensuring that traceability meets any legal and regulatory requirements.
- Understand what data and information is required in order to support the achievement of organizational and asset management objectives.

ISO 55001 On Data Requirement

ISO 55001 Demands that organizations

- Consider the impact of quality, availability and management of information on decision making.
- Determine
  - What data is to be collected
  - The level of quality of data collected
  - How and when to collect the data
  - How and when to analyze and evaluate the data collected.
- Have processes in place for the effective management of information.
- Have an effective document management system in place.

Data as an Asset

- ISO 55000 definition of an asset as being "something of potential value to an organization"

Specifying Data and Information Needs

- ISO 55001 clearly states that data and information should be collected in order to ensure that:
  - Stakeholders' needs for information and reporting are met, and
  - The organization can meet its asset management and organizational objectives.

Most of the data collected will go towards making more effective asset management decisions

Asset Decision Making

- **Note that decisions can be made at many different organizational levels, including:**
  - Strategic Decisions – potentially those with the greatest potential business impact, but also those for which objective data is most likely to be difficult to obtain and analyze
  - Management Decisions – such as those relating to the replacement or upgrading of assets to better meet business needs
  - Operational Decisions – involved with short term control of maintenance and operational activities

ISO 55001 Stems-Out

- The quality required of the data collected
- How and when to collect the data
- How and when to analyze and evaluate the data collected

- **Quality of Data can be assessed in terms of:**

Quality of Data Attributes

- **Completeness** (is all of the data to be collected, or only some of it)
- **Accuracy** (does the data accurately represent reality – particularly a concern when human data input is required)
- **Timeliness** (is the data available as and when required)
- **Accessibility** (is the data readily available to those using it)
- **Consistency** (are the same definitions and standards applied across the organization)

Data Requirement – A pragmatic Approach

- In taking a pragmatic approach, the answer lies, as is usual in all things related to Asset Management, by considering, for each decision and/or information or reporting requirement:
  - The Benefits of better decision making/reporting
  - The Risks associated with poor (non-data-driven) decision making or reporting, and
  - The Costs associated with specifying, collecting, managing and analyzing the data required for more effective decision-making and reporting.

To this end, I suggest that you start by:

- Identifying your most critical assets – in alignment with ISO 55001 and avoid addition erroneous work.
- Identifying the requirements of all key stakeholders (including regulators and other external stakeholders) regarding the mandatory provision of reports or information
- Identifying the types of decisions that you will make which will have the greatest potential impact on the achievement of your asset management (and organizational) objectives

These decisions could include:

- **Capital Investment Decisions**
- Decisions regarding the allocation of Operating Expenditure
- Technical Decisions relating to day-to-day Operations
- Decisions regarding the timing of major events or activities such as shutdowns or overhauls
- Decisions regarding the allocation of Working Capital (such as for spare parts holdings)
- Decisions relating to whether to insource or outsource particular activities
- Etc.

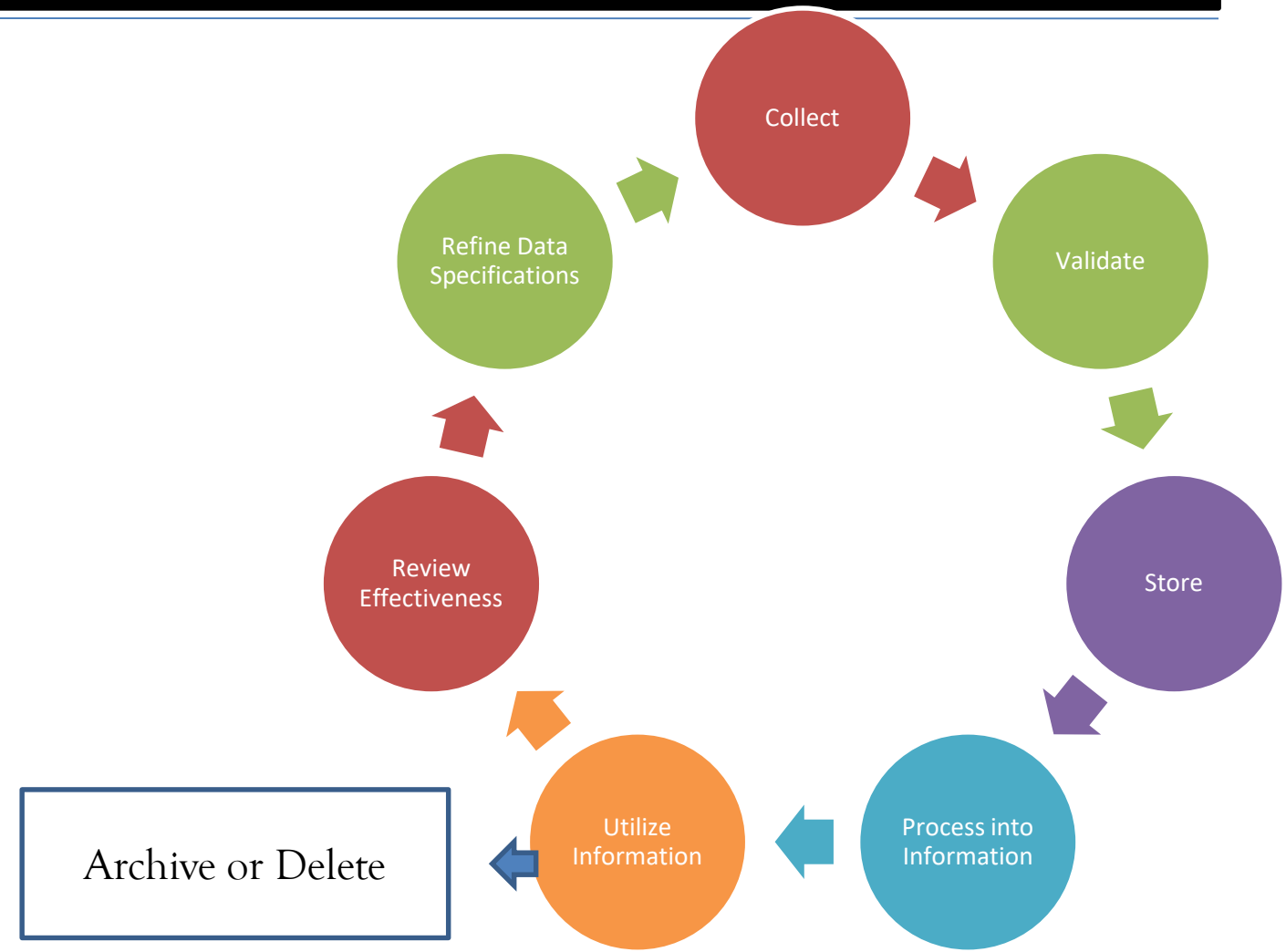
Collect Data About

- Data about the assets themselves (what they are, what they cost to acquire, where they are located etc.)
- Data about the current condition of the assets
- Data about the current level of performance of the assets (in terms of technical performance and cost performance – operating and maintenance)
- Data relating to the activities that have been performed on the assets – operational activities, maintenance activities and modifications/upgrades/replacements
- Data about the financial or other impacts if the assets underperform or fail to perform at all
- Data relating to safety, environmental or other incidents associated with the assets
- Data relating to forecasts of future asset performance, costs and risks
- Other data that allows adequate evaluation of alternative courses of action

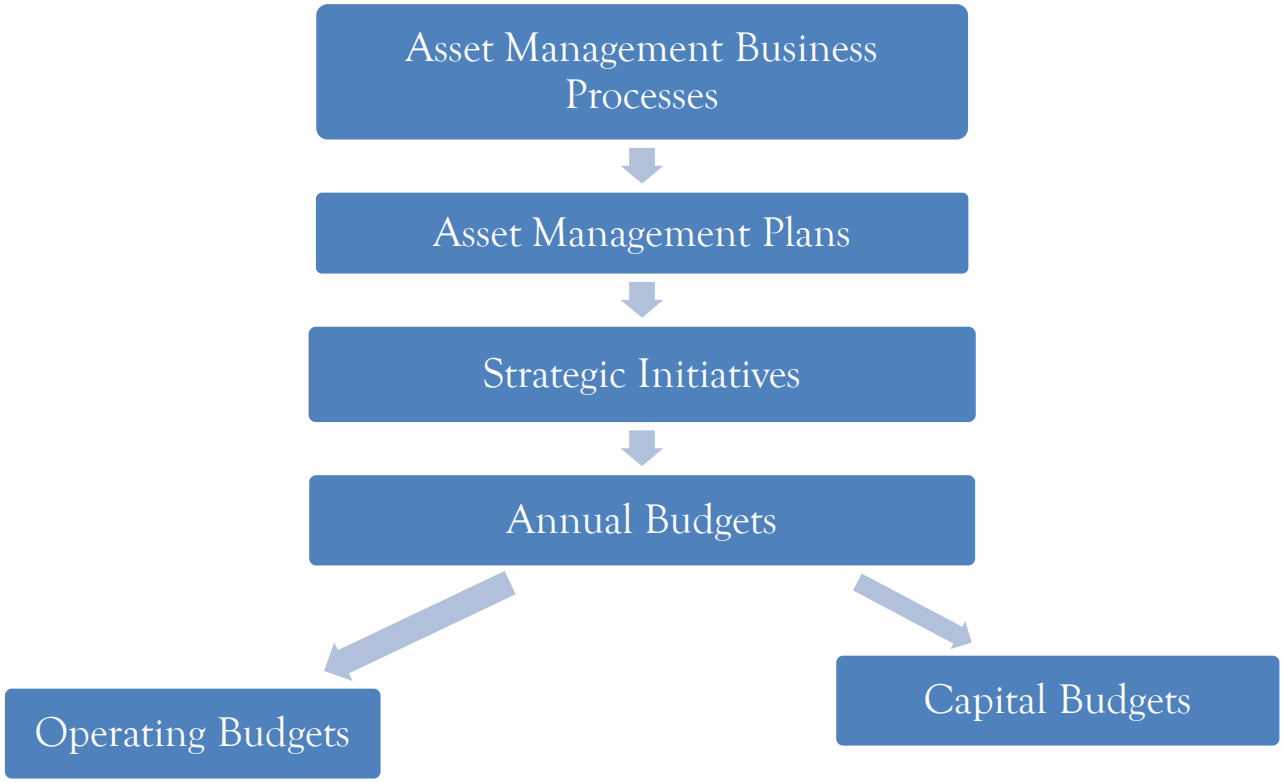
Organization that've embraced Data will expect to see ...

- Clearly, the data that is required for more critical decisions and/or reports must be collected, evaluated and analyzed with a high degree of quality and rigor. In an organization with effective asset management decision making in place, we would expect to see that the organization has:
  - Consciously considered this issue,
  - Identified the data required to support decision-making for critical decisions on critical assets,
  - Identified the data required by stakeholders for reporting on critical assets, and
  - Specified the quality standards for those data elements in terms of the attributes mentioned earlier in this article (Completeness, Accuracy, Timeliness, Accessibility and Consistency)

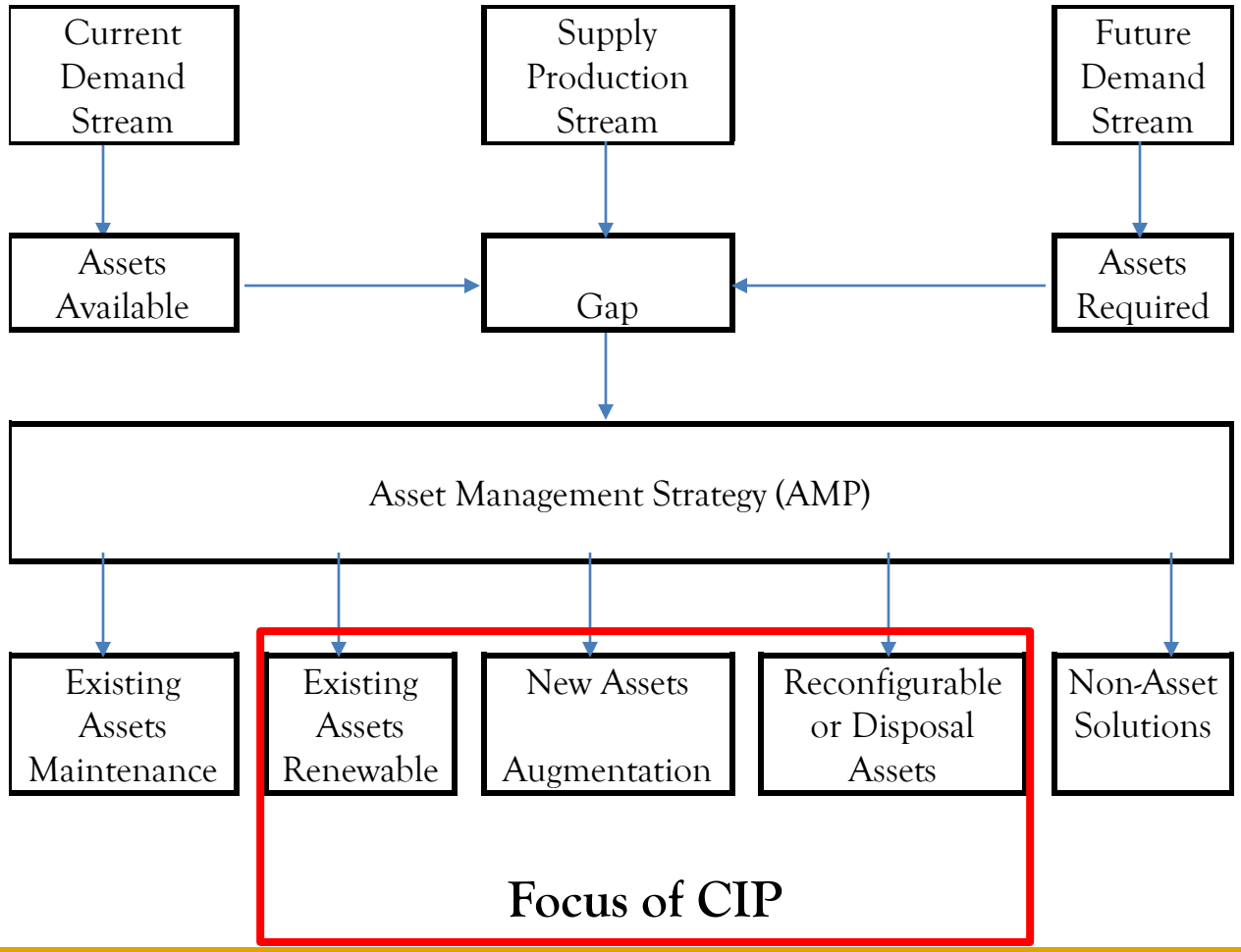
Managing and Processing Asset Management Data



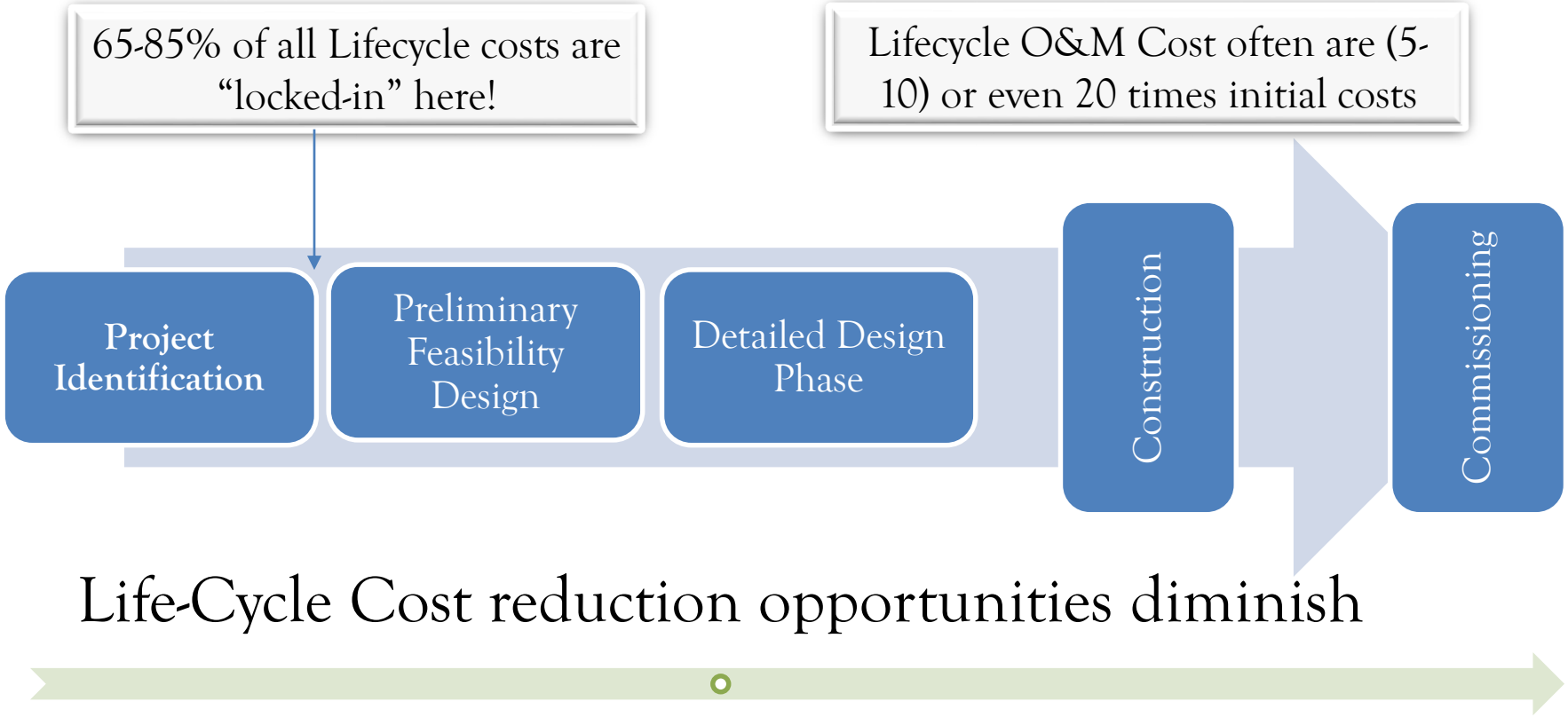
Best Practice CIP Asset Management Framework



Balancing Future Demands with Current Capabilities



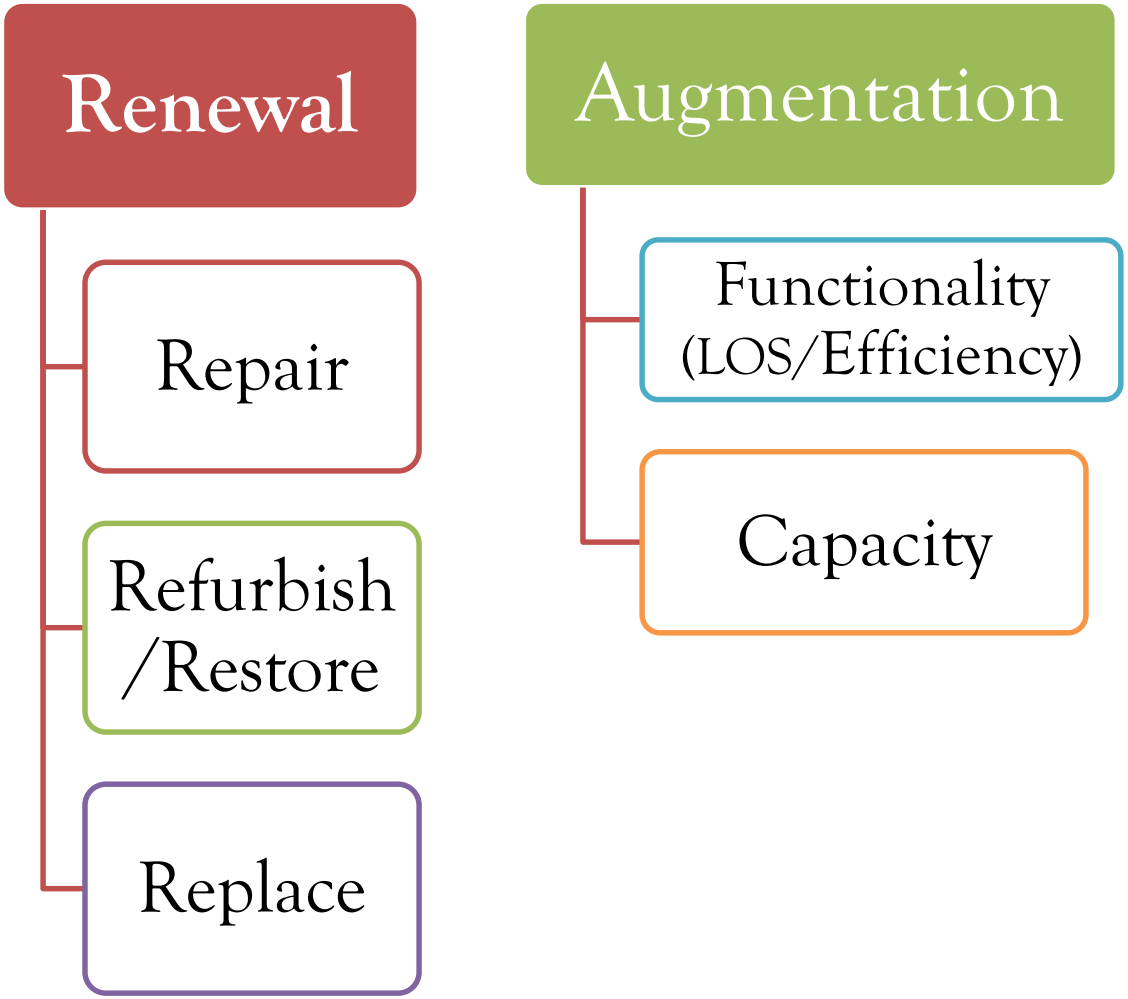
The CIP Process Locks in Life Cycle Costs



Deriving the CIP Investment Program Best Practice Model

The strategic CIP —Business Plan ▪ What are we going to do and why? ▪ What will it cost? ▪ How will it be funded? ▪ Life-cycle impact on LOS, rates, and financial condition	1	Identification Validation Prioritization Financing
On time and on budget ▪ Managing costs ▪ Managing schedules and deliverables ▪ Managing contracts and changes	2	Execution Control
Integration into the portfolio of assets ▪ Registry ▪ Start-up, shake-down, burn-in, commissioning ▪ Manuals, spares, and service ▪ Initiating the maintenance regimen	3	Handover

Capital investment is made up of two major types of projects



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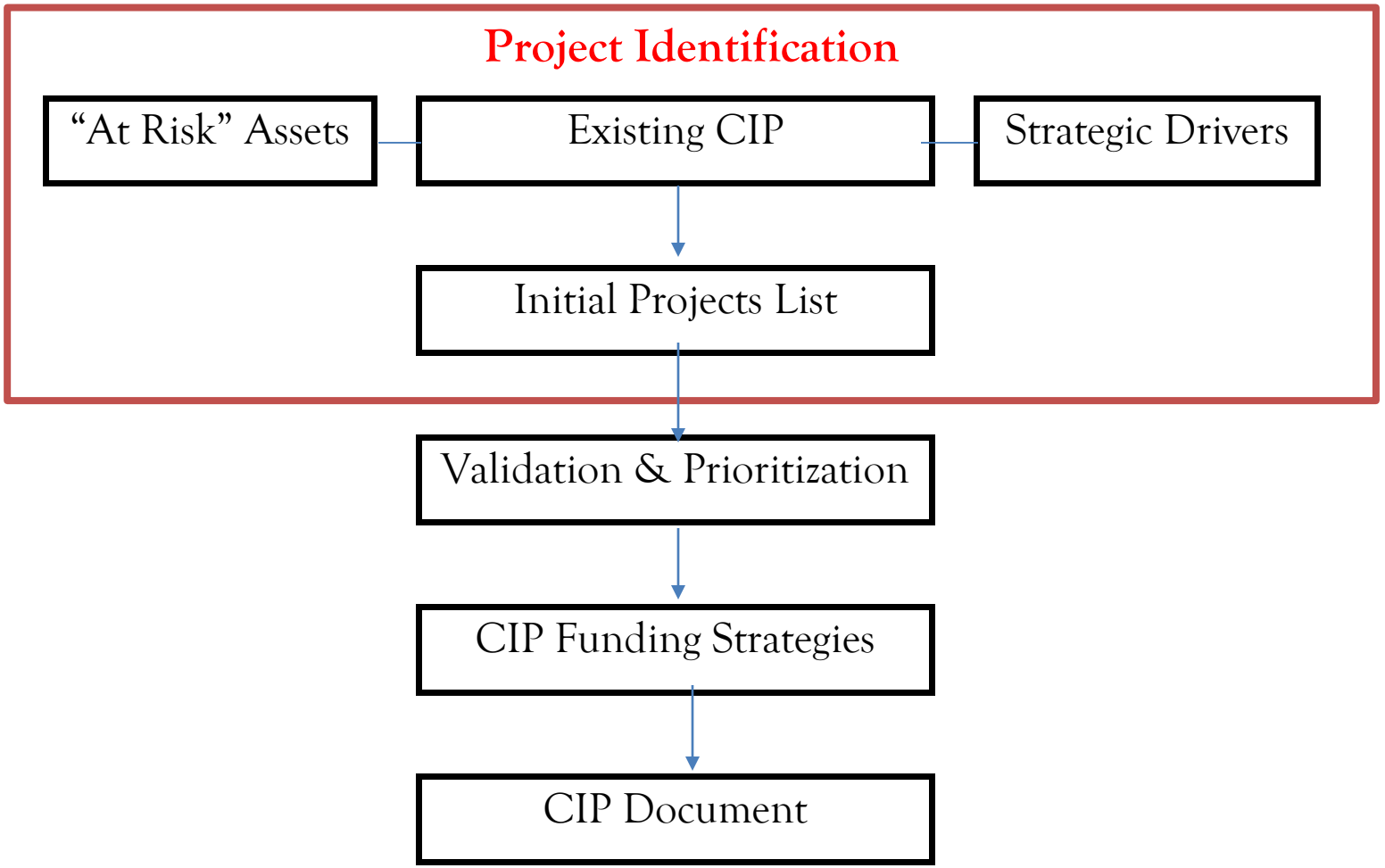
Project Identification



The primary failure model gives insight into strategic "drivers at work"

Failure Mode	Definition	Tactical Aspects	Management Strategy
Capacity	Volume of demand exceeds design capacity	Growth, system expansion	(Re)design
LOS, Level of Service	Functional Requirements exceed design capacity	Codes & Permits: OSHA, Life Safety, Service Etc.	(Re)design
Mortality	Consumption of asset reduces performance below acceptable e level	Physical deterioration due to age, usage (including operator error), acts or nature	O&M Optimization Renewal
Efficiency	Operations costs exceed that of feasible alternatives	Pay-back Period	Replace

Capital investment is made up of two major types of projects

"At Risk Assets"

- High business risk exposure scores
- Very low remaining useful lives
- Poor condition scores or scores approaching designated minimum acceptable levels
- Poor performance scores
- Poor reliability scores
- No redundancy
- Imminent major failure mode of capacity or level of service
- Problem assets (high work order frequency/ maintenance time)

"Each project should have a CIP project identification sheet that identifies …

- ❑ Problem statement
- ❑ Proposed scope
- ❑ Location
- ❑ Background & context
- ❑ Rationalization
- ❑ Fiscal requirements
- ❑ Design issues
- ❑ Permits required
- ❑ Comments

Validation: driving down the cost of CIP

Can we…

- ❑ Eliminate projects?
- ❑ Defer projects?
  - Change maintenance?
  - Change operations?
- ❑ Shift to more appropriate Optimized Renewal Decision Making (ORDM) solution (repair, refurbish, replace)?
- ❑ Find a non-asset solution?

CIP validation

How do we know that we have…

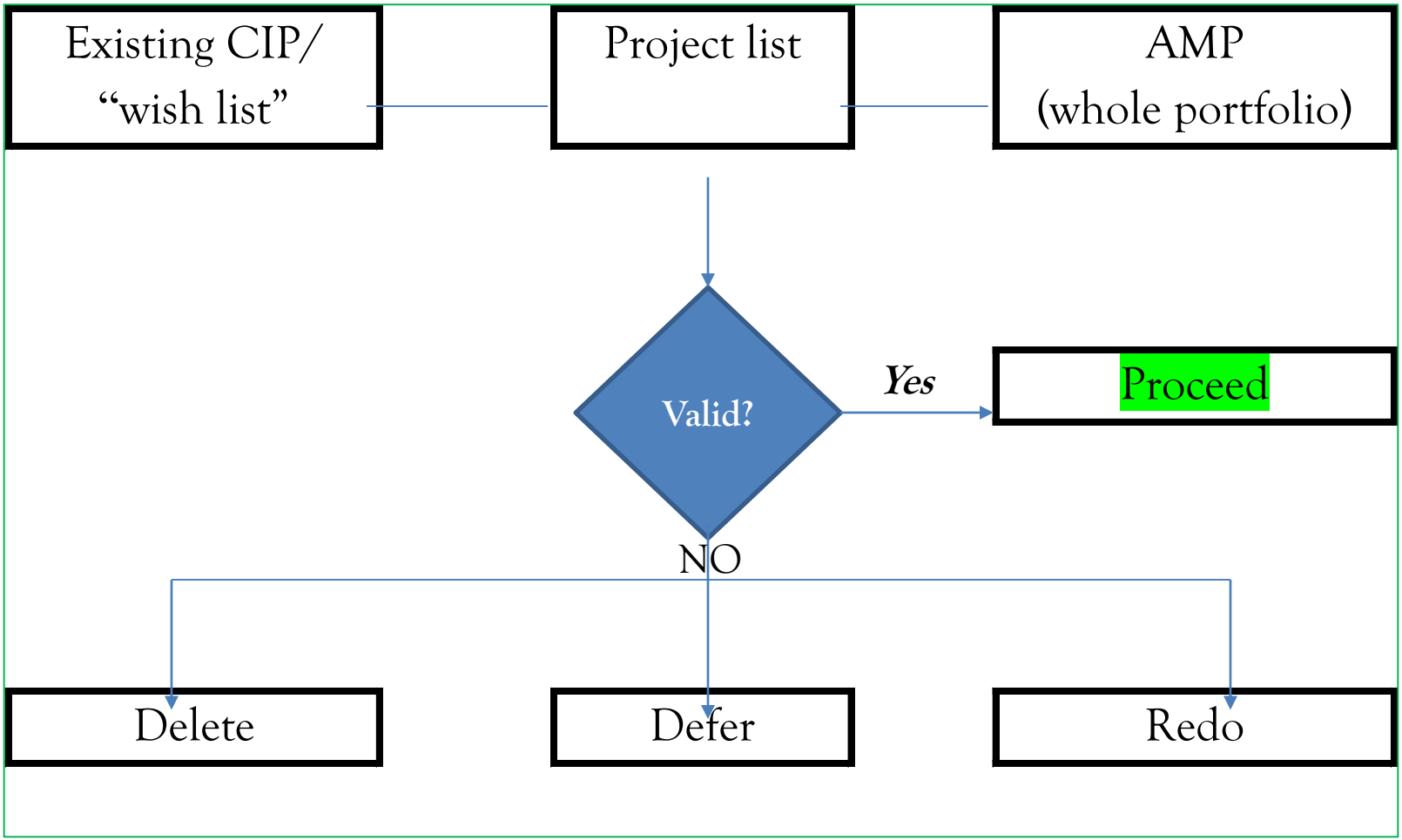
- ❑ The right projects?
- ❑ At the right time?
- ❑ At the right cost?
- ❑ For the right reasons?

CIP Validation

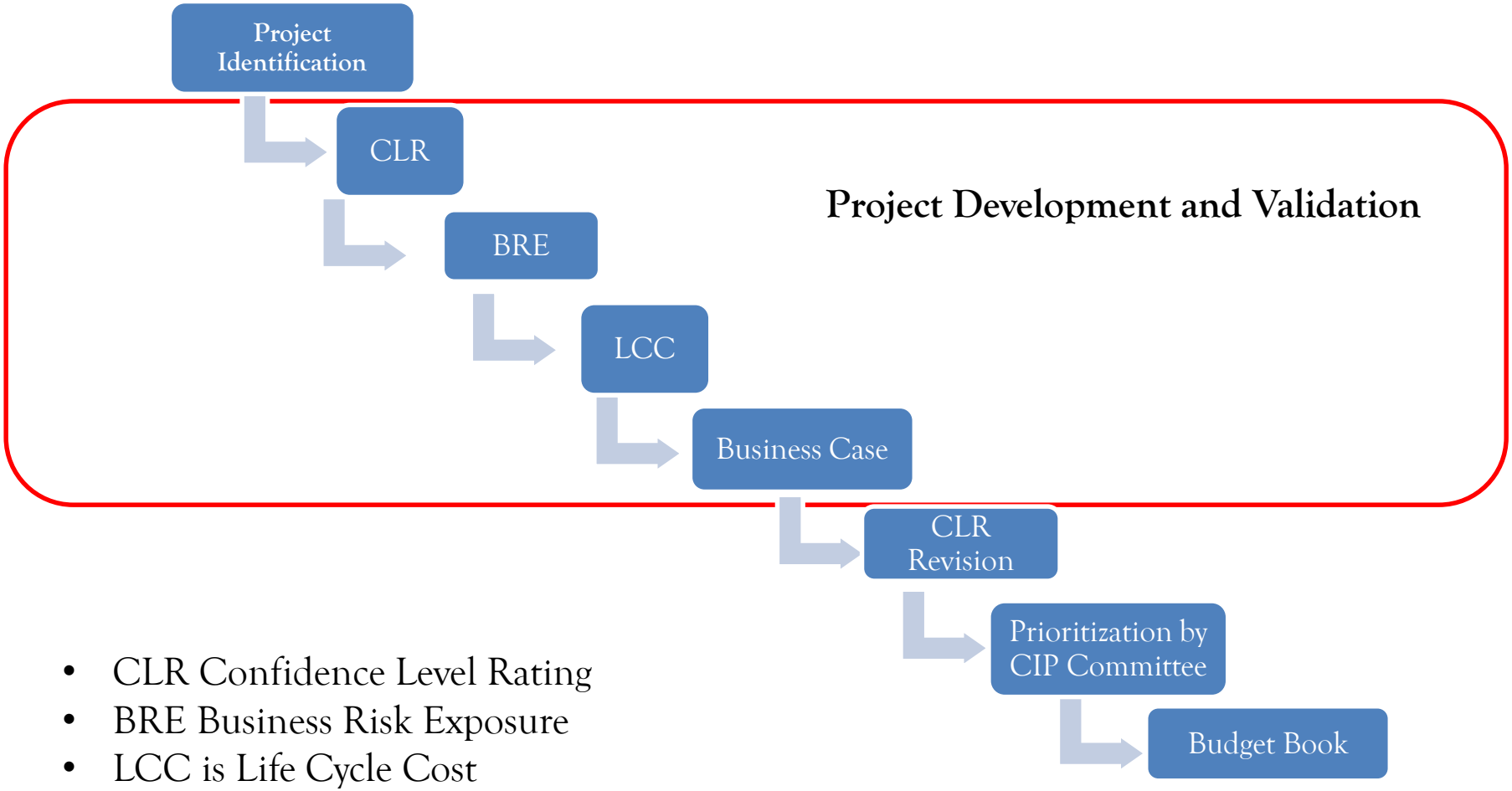
How do we —validate?

- We produce a ***rigorous business case*** for all projects that justifies the timing and project solution including
  - Life cycle cost (capital and O&M)
  - Triple bottom line‖ risks (financial, social, and environmental)
- We ***sufficiently analyze*** in a step-by-step approach to ensure that we have reached ***an acceptable level of confidence*** (confidence level rating—CLR)
- We set the sophistication of analytical process to match the ***risks, value of the capital, and life cycle costs to be invested***

Validation as a —decision filter



Process steps



- CLR Confidence Level Rating
- BRE Business Risk Exposure
- LCC is Life Cycle Cost
- CIP Capital Improvement Program

Measuring confidence in proposed projects and solutions

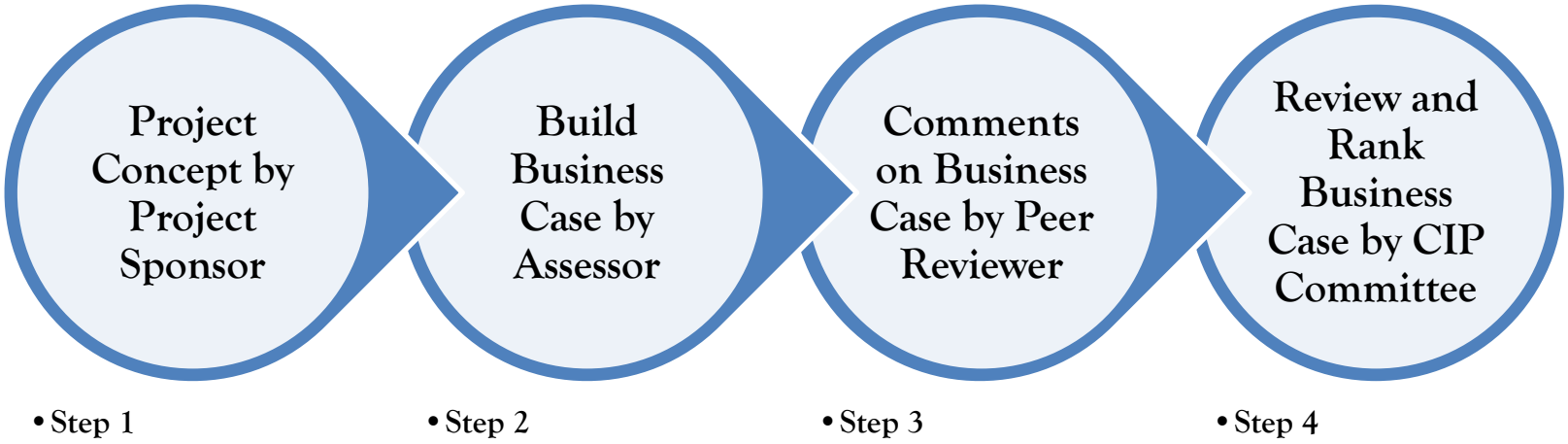
- How confident are we that we are recommending the right ***solution*** at the right ***time*** at the right ***cost***?

$$\text{Confidence Level Rating} = \frac{\text{Quality of Analysis} + \text{Quality of Data Used}}{2}$$

$$= \frac{70+40}{2}$$

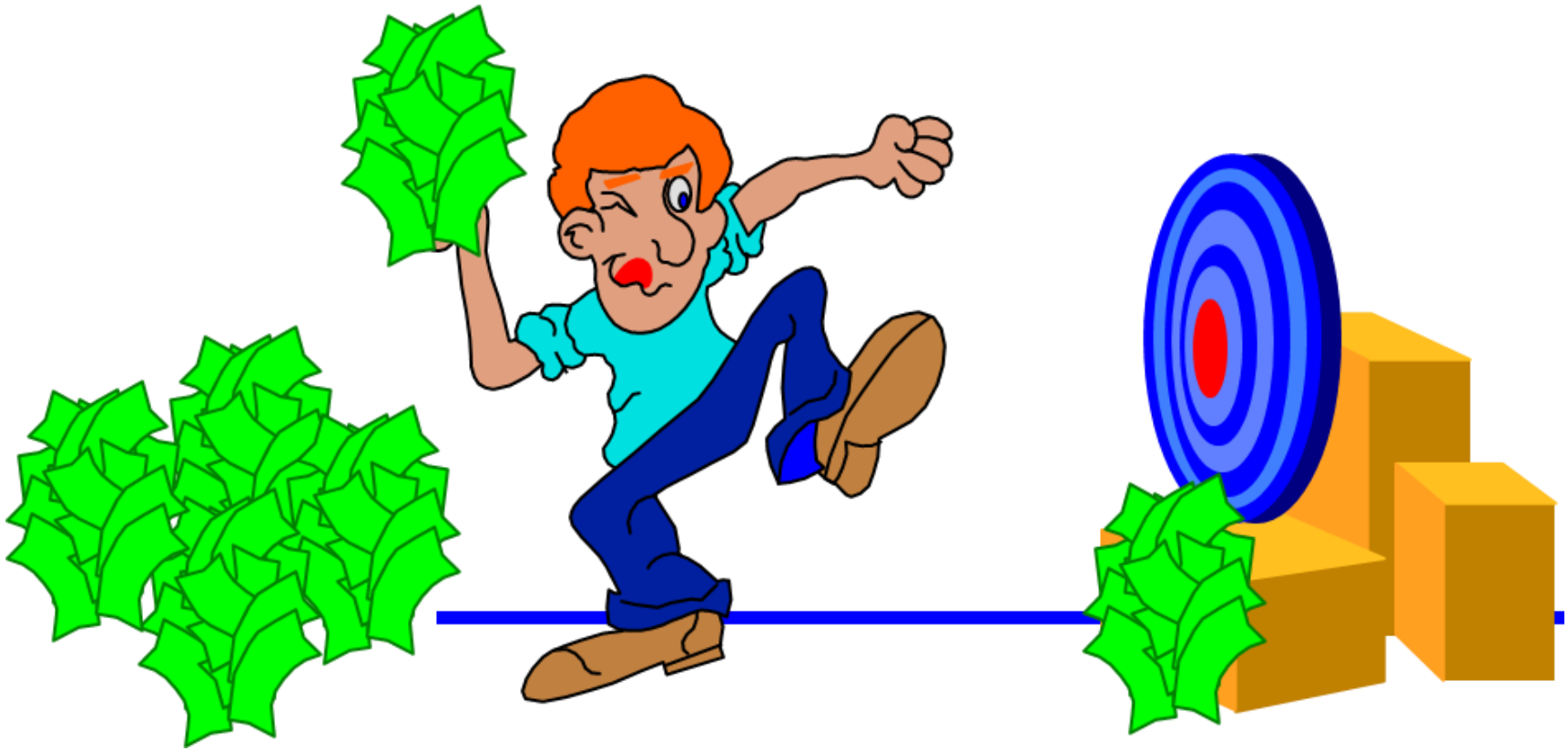
$$= 55\%$$

Confidence level rating process steps



Confidence Level Rating: 13 elements to be considered

Don't Throw good Money after Bad



Life Cycle Costing Optimization

Learning Objective

- Definition, objectives and benefits of Life Cycle Costing (LCC)
- The factors affecting the investment life of a project
- The applicability of LCC to maintenance
- The costs and values included in a Life Cycle Costing Exercise
- Data sources used throughout a Life Cycle Costing Exercise

Definition of LCC

- Sum of all recurring and one-time (non-recurring) costs over the full life span or a specified period of a good, service, structure, or system. In includes:
  - purchase price,
  - installation cost,
  - operating costs,
  - maintenance and upgrade costs, and
  - remaining (residual or salvage) value at the end of ownership or its useful life.

Definition of LCC

- LCC is the process of economic analysis to asses the total cost of ownership of a product, including its cost of installation, operation, maintenance, conversion, and/or decommission.

LCC

- LCC is a economic tool which combines both engineering art and science to make logical business decision.
- This analysis provides important inputs in the decision making process in the product design, development and use.

Objectives of LCC

- Assists Management to smartly manage total cost throughout Asset Management Lifecycle
- To identify areas in which cost reduction efforts are likely to be more effective
- To estimate the cost of impact of various designs and support options

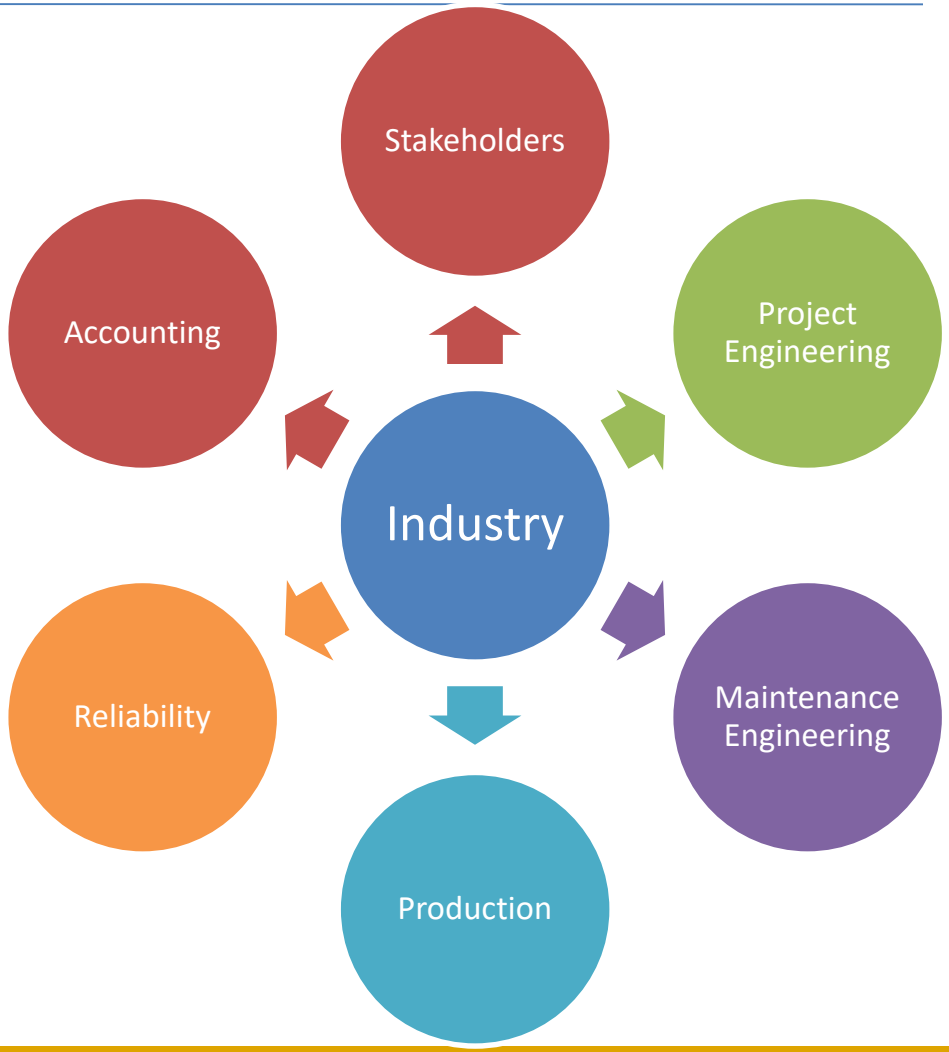
LCC for product supplier

- By using LCC, product suppliers can optimize their design by evaluation of alternatives and by performing trade-off studies.
- By using LCC, product suppliers can evaluate various operating and maintenance cost strategies (to assist product users).

LCC for customer

- By using LCC, customers can evaluate and compare alternative products.
- By using LCC, customers can assess economic viability of projects or products.

Why use LCC?


Stakeholders
Accounting
Project Engineering
Industry
Reliability
Maintenance Engineering
Production

Why use LCC?

Typical conflict in most of the company:

- **Project Engineering** wants to **minimize capital costs** as the only criteria,
- **Maintenance Engineering** wants to **minimize repair hours** as the only criteria,
- **Production** wants **to maximize operation hours** as the only criteria,
- **Reliability Engineering** wants to **nullify failures** as the only criteria,
- **Accounting wants to maximize project net present value** as the only criteria,
- **Shareholders want to increase stockholder wealth** as the only criteria.

Why use LCC?

- LCC can be used as a **management decision tool for synchronizing the divisional conflicts by focusing on facts, money, and time.**

LCC Calculation Approach

- **Deterministic Approach**
  - An Exact Cost is Determined
- **Probabilistic Approach**
  - A range of values is determined with a specific probability distribution

Deterministic Approach

- Fixed discrete Values are assigned to Various Parameters and any type of uncertainties are ignored.
- LCC Calculated is a Fixed Cost

Probabilistic Approach

- Cost Parameters are designed with some appropriate probability distribution
- Random Numbers are generated
- These Random Numbers are used to Calculate the LCC

Calculating the Total LCC

- There are five distinct phases in a product's life-cycle:
  1) Planning and development;
  2) Introduction and growth;
  3) Maturity;
  4) Decline; and
  5) Abandonment or renewal

Calculating the Total LCC

The life-cycle cost includes the following costs:

- Initial Costs (Cic)
- Delivery and Installation Costs (Cinst)
- Energy Cost (Ce)
- Operation Cost (Co)
- Maintenance Cost (Cm)
- Downtime Costs (Cs)
- Decommissioning/Disposal Costs (Cd)

Calculating the Total LCC

The Formula:

LCC = Cic + Cinst + Ce + Co + Cm + Cs + Cd

- Initial Costs (Cic)
- Delivery and Installation Costs (Cinst)
- Energy Cost (Ce)
- Operation Cost (Co)
- Maintenance Cost (Cm)
- Downtime Costs (Cs)
- Decommissioning/Disposal Costs (Cd)

Calculating the Total LCC

LCC Simple Formula

LCC = Capital +
Life Time Operating Costs +
Life Maintenance Costs +
Disposal Costs –
Residual Value

Example of LCC Calculation

Question: Suppose there is a Company which wants to buy light bulbs for one of its offices. And they want the bulb to work for 10,000 hours. Now there are two possibilities/choices for their consideration

1. To buy 100 Watt Incandescent Bulb
2. To buy 25 Watt Compact Fluorescent Bulb

Now the task for the economist is to: **Calculate the LCC of both alternatives and decide which one is better for the company.**

Solution

The Costs of the Light Bulb can be divided into two main categories:

1. Initial Costs
2. Operational and Maintenance Costs

Solution

Incandescent Bulb: Initial Costs

Cost of One Bulb:	Kes. 35.00
Life Expectancy of One Bulb:	1,000 hours
No. of Bulbs need to burn for 10,000 hours	10
Total Payment to Light the Bulb For 10,000 Hours	Kes. 350.00

Solution

Incandescent Bulb: O&M Costs

Hours required to use One Kilowatt

Of electricity for a 100 Watt Bulb (1,000/100)=10 Hours

Kwh of Electricity in 10,000 hours (10,000/10)=1,000 Kwh

Total Cost of Electricity used:

(supposing that 1Kwh cost Kes. 16.00) (16 * 1000)

=Kes. 16,000.00

Solution

Compact Fluorescence Bulb: Initial Costs

Cost of One Bulb:	Kes. 1,500.00
Life Expectancy of One Bulb:	10,000 hours
No. Of Bulbs needed to burn	
For 10,000 hours	1
Total Payment to light the bulb	
For 10,000 hours	Kes. 1,500.00

Solution

Compact Fluorescence Bulb: O&M Costs

Hours required to use one kilowatt of

Electricity for a 25 Watt Bulb: (1,000/25) = 40 hrs

Kwh of Electricity in 10,000 hrs (10,000/40) = 250 kwh

Total Cost of electricity used

(Supposing that 1 kwh costs Kes. 16) =(16*250)

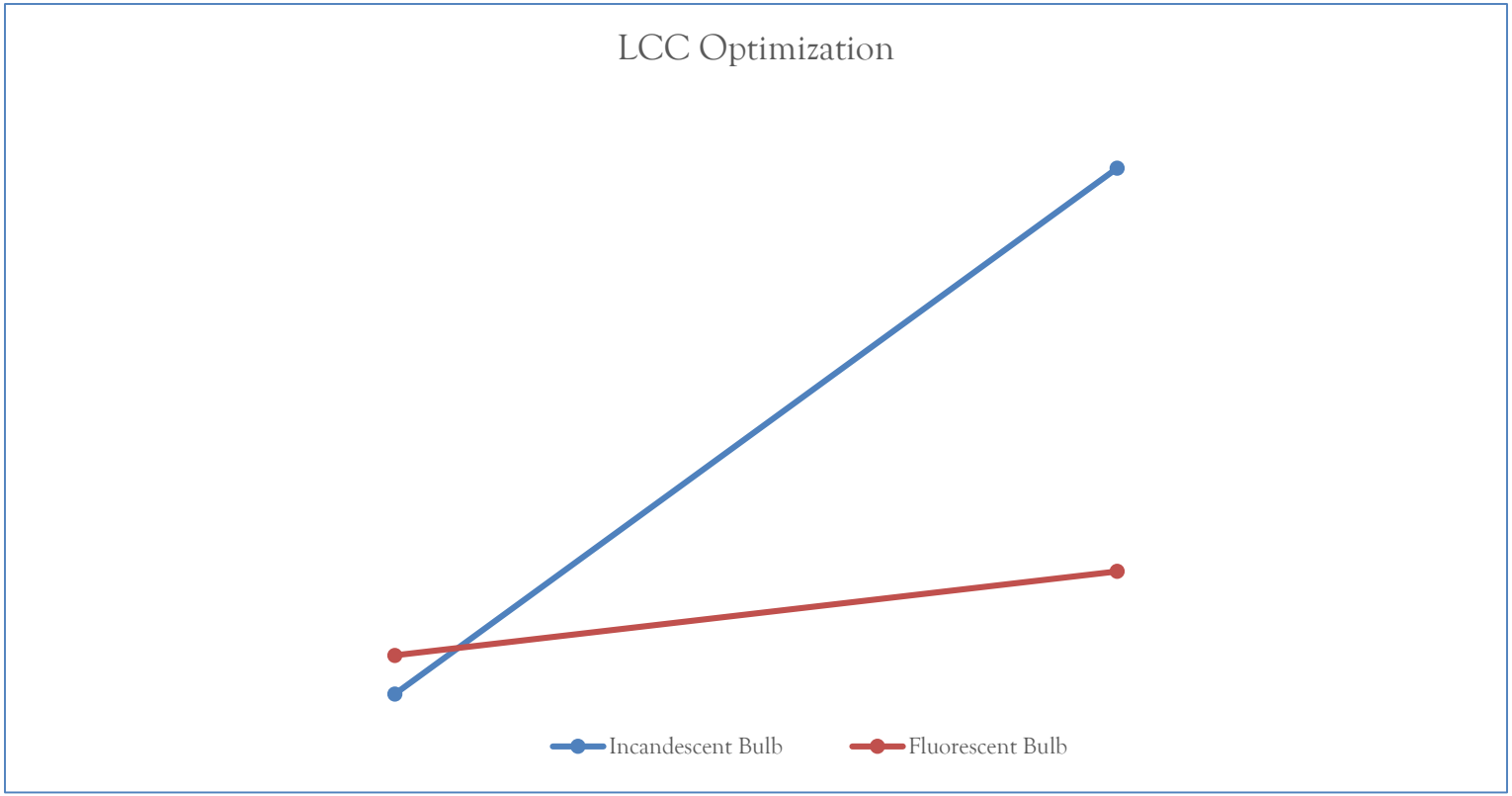
= Kes. 4,000.00

Solution

LCC = Initial Cost + Operation and Maintenance Costs

Alternative	Initial Cost	O&M Cost	LCC
Incandescent Bulb	Kes. 350.00	Kes. 16,000.00	**Kes. 16,350.00**
Fluorescent Bulb	Kes. 1,500.00	Kes. 4,000.00	**Kes. 5,500.00**

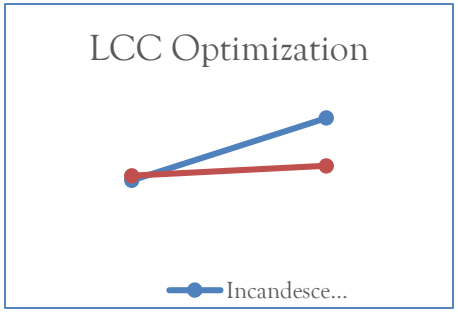
LCC Optimization



LCC Optimization

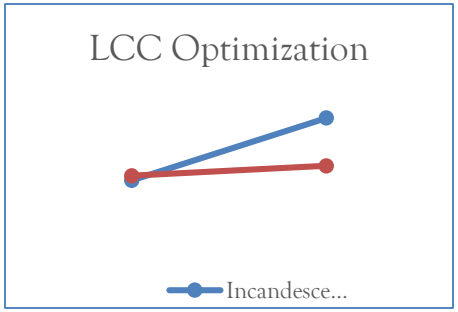
The analysis shows

- Initial Cost of Incandescent bulb machine is much lower
- But, the long-term LCC is much lower for Compact Fluorescent Bulb



Conclusion

- The Compact Fluorescent Bulb is Kes. 10,850.00 less expensive over its life than the incandescent bulb
- Hence a good economist would prefer Compact Fluorescent Bulb for his Company to buy for long-term use because it would prove to be more economic in the long run



Advantages of LCC

- Improved Forecasting
  - LCC Technique allows the full cost associated with procurement to be estimated accurately
- Improved awareness
  - Improved awareness of the factors that drive cost and the resources required by the purchase
- Performance trade-off against cost
  - LCC technique not only focuses on cost but also consider other factors like quality of the goods and level of service to be provided

Disadvantages of LCC

- Time Consuming
  - LCC Costing analysis is too long because of changes of new technology
- Costly
  - The longer the project lifetime, the more operating cost will be incurred
- Technology
  - Technology is always changing day to day

Interactive Session