

DESIGN BUILD REIMAGINED

10-12 May 2022
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AIQS
ADVANCING BUILT ENVIRONMENT COST PROFESSIONALS

LIFE CYCLE COST ANALYSIS
why? what? when? how?

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12 May 2022

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DESIGN BUILD REIMAGINED

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In-Touch Advisory connects stakeholders with life cycle solutions for the Built Environment.

Stephen has been an AIQS member since 1983, achieving FAIQS in 1997. Additionally, in 2013 he received an AIQS Lifetime Achievement Award. In 2011 he received his FMA Australia Life Membership, and in 2018 he became Australia's first IFMA Fellow.

Since 2012, he has been the Property Council's rep to Standards Australia's MB-022 committee and an Australian delegate on the ISO 41000 series of Facility Management standards, and the global liaison to the ISO 55000 series for Asset Management standards.

Prior to **In-Touch Advisory**, Stephen had a distinguished career with RLB spanning four decades, including leading Advisory and Research initiatives.



Stephen is also a former AIQS-NSW Councillor; Past Chairman of FMA Australia, IFMA Foundation, and IFMA Research Committee; and former Deputy Chairman of the Australian Government's FM Action Agenda.



Author, AIQS' Information Paper: Life Cycle Cost Analysis (2022)


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About Today's Presentation



- Standards ... when the world agrees!
- AIQS Information Paper: LCC Analysis (2022)
- Why?** Cost Prediction, and Service Life
- What?** Relationship between WLC and LCC
- When?** Cost Management Life Cycle
- How?** Applications and processes
- Benefits, sustainability and stewardship



This document has been prepared for the AIQS presentation at DesignBuild in Melbourne on 12 May 2022. It should be noted that this document represents a summary of the issues addressed and does not constitute advice. The author makes no representation as to its accuracy or completeness and the information should not be relied upon as such. Although care has been exercised in its preparation, the author accepts no legal responsibility for any loss or damage suffered as a result of any inadvertent inaccuracy. This document reflects the author's personal views only. This document should not be relied upon without seeking independent, professional advice and obtaining the full version of the publications and sources referred to herein.



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Using standards to create and maintain ...

AIQS ~ ICMS ~ ISO ~ Property Council ~ RICS ~ Standards Australia ~ various other sources

'Standards'

a common language

consistent reporting


greater transparency

increased confidence through reduced risk


ability to performance benchmark

data capture, costing, analysis and forecasts

... a means of embracing and improving LCC analysis.




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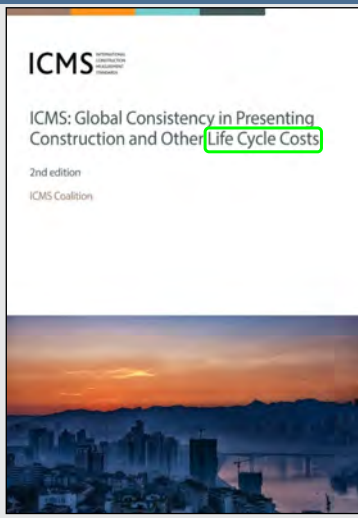
International Construction Measurement Standard (ICMS)

- ❑ **ICMS Coalition** formed in 2015, now with 47 cost professional bodies worldwide, including **AIQS**.
- ❑ **ICMS** scope covers buildings and civil engineering assets.
- ❑ **ICMS#1** released July 2017, *capital cost focus*.
- ❑ **ICMS#2** released September 2019, *plus LCC*.
- ❑ Focus on constructed assets so that **cross-boundary costs** can be consistently benchmarked and cost differences identified.
- ❑ Standards for measuring, reporting and **benchmarking** of construction project cost and **life cycle costs** (2019).



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Free: <https://icms-coalition.org/>



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International Construction Management Standard (ICMS)

- ❑ Public consultation (July – September 2021), published 30 November 2021:
 - Name change
 - Carbon emissions
 - Five new project types
- ❑ **ICMS#3** will provide... *“a common reporting framework for capital costs, life cycle costs and carbon emissions”* ...recognises interrelationships to improve decision making... *“about the design, construction, operation and maintenance of the built environment that optimises environmental sustainability”*.




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Source: ICMS Coalition media release, 30 November 2021




AIQS Information Paper: LCC Analysis (2022)



Executive Summary



Life Cycle Cost (LCC) analysis aims to achieve the best value rather than lowest cost solutions for our **Built Environment**. LCC analysis provides a valuable **comparative and management tool** that can influence the design, specification, construction, operations, and **sustainability performance**.

1. Introduction
2. Life Cycle Cost (LCC)
3. Process of LCC Analysis
4. Glossary of Terms
5. References & Resources




LIFE CYCLE COST ANALYSIS
AIQS INFORMATION PAPER
1ST EDITION
AIQS

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AIQS Information Paper: LCC Analysis (2022)




Objective: Provision of current, credible, concise and practical guidance for LCC.



Exclusions: Specifically this 1st edition LCC paper has not dealt with:

- Embodied energy and carbon emissions related to the Built Environment in terms of processing, manufacturing, transport and project delivery. Specifically, the measurement and presentation of carbon emissions, please refer to *ICMS#3 November 2021* for more details.
- Life Cycle Assessments (LCA) tools relating to total **environmental impact of a material or product** through every step of its life. *ISO 14040: 2019 Environmental Management life cycle assessment, principles and framework* provides more details on LCA methodologies and protocols.
- Life cycle aspects of **sustainability rating tools** such as GreenStar, NABERS, LEED, etc.
- Nor have we provided **case studies, templates, worked examples, etc.**

This is not to suggest that such issues and aspects are not relevant or important to AIQS members, allied professionals, our clients or the community.

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WHY? Cost Prediction

Cost Prediction: “encompasses *estimating, cost planning, benchmarking* across the **project life cycle** for *clients, consultants and contractors* on both **buildings and infrastructure**”

Source: RICS’ Global Professional Statement on Cost Prediction (GPSCP 1st edition, 2020)

QUANTITY
(of the works and time)

×

RATE
(costs per unit of the works)

+


RISKS / Contingencies
(for known unknowns)

=



COST PREDICTION
‘out-turn cost’
(in accordance with the agreed ‘scope and quality of the works’)

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This formula depicts the simplicity of the contemporary approach to Capital Works estimating. The RICS’ GPSCP (2020) focuses on the cost prediction process; recognition of cost data sources, attributes and integrity; and the out-turn cost / final account targets. Noting ISO 31000:2018 defines risk as the “effect of uncertainty on objectives”.


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WHY? Cost Prediction

Life Cycle Cost (LCC): “Cost of an asset or its parts *throughout* its life cycle, while fulfilling the performance requirements” Source: ISO 15685-5: 2017

LIFE CYCLE COST (LCC)
(in accordance with AIQS defined ‘Service Life’)

=

Initial Acquisition / Capital Costs, etc.

–

Tax Depreciation Entitlements, etc.

+

Replacement / Upgrade & Disposal Costs

+


Operation and Maintenance Costs

–



Residual / Recycling / Recovery Value

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LCC = (AC - TD) + (OC + RC) – RV Plus: adjusting for the time value of money, Net Present Value (NPV) preferred by ICMS.


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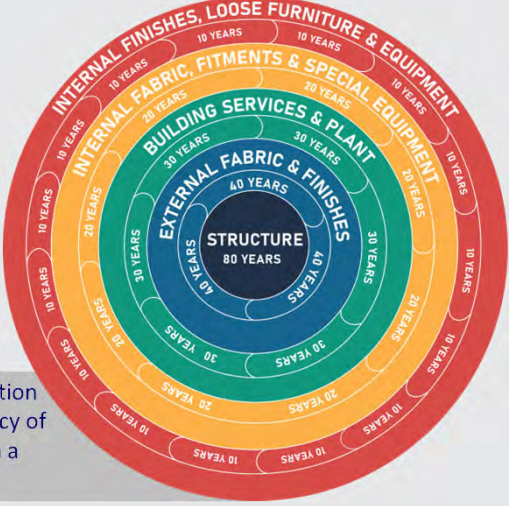



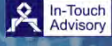
WHY? Service Life



Service Life: “Period of time after practical completion that a constructed asset or facility, or its elements and component parts, meet(s) or exceed(s) the performance requirements”.

Sources: ISO 15686-11: 2014, ISO 21930: 2017, and now AIQS modified (2022).
Preferred term: ATO, AS/NZS 4536, ISO 15686-5: 2017 and ICMS (2019 and 2021).

✓ This life cycle ‘onion’ is only a graphical representation of the concept of differential **Service Life** expectancy of the building elements and component parts within a constructed asset or facility.




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WHY? Service Life

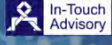
At its core, **LCC analysis** is life expectancy based.



Service Life and the prospect of premature **obsolescence**:

- Physical:** condition-based.
- Economic:** too expensive to maintain.
- Functional:** ceases to function as intended.
- Technological:** no longer superior to alternatives.
- Statutory or legal:** compliance-based.
- Social:** cultural, behavioural and fashion changes.
- Environmental:** related to trans-generational equity, eg. pursuing a circular economy or achieving carbon neutrality.

✓ Individually or in combination **Obsolescence** is difficult to predict, but generally equates to **loss of competitiveness**.




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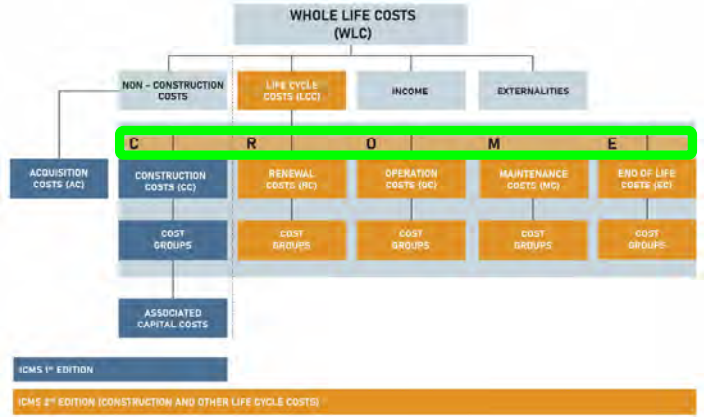




WHAT? C.R.O.M.E. explained

ICMS#1 (2017) versus ICMS#2 (2019) footprint
 ICMS#2 (2019) defined **C.R.O.M.E.** as the new framework:

- Construction
- Renewal
- Operational
- Maintenance
- End of Life



Source: ICMS#3, 2021





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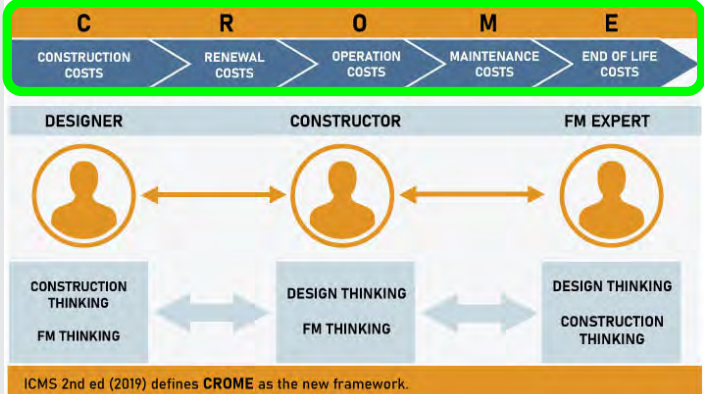



WHAT? C.R.O.M.E. explained


ICMS#2 (2019) **C.R.O.M.E.** approach as a relationship framework of the significant contributors to the facility life cycle (*Designer, Constructor and Facility Management (FM) Expert*).

Source: Courtesy of Anil Sawhney, Construction Journal (November-December 2019) article

Cost as a communication tool.




ICMS 2nd ed (2019) defines CROME as the new framework.




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WHAT? Relationship between WLC and LCC

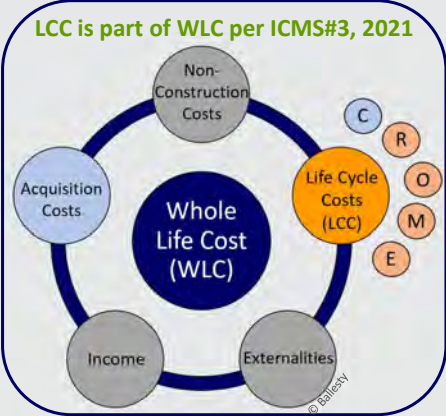


ISO 15686-5: 2008 *Buildings and constructed assets – Service life planning - Part 5: Life-cycle costing* (current edition 2017) sets out definitions for these two (2) terms:


- ❑ **Whole Life Cost (WLC):** All significant and relevant initial and future costs and benefits of an asset, throughout its life cycle, while fulfilling the performance requirements. (ISO 15685-5: 2017)
- ❑ **Life Cycle Cost (LCC):** Cost of an asset or its parts throughout its life cycle, while fulfilling the performance requirements. (ISO 15685-5: 2017)

✓ International Construction Measurement Standards: Global Consistency in Presenting Construction and Other Life Cycle Costs, 2nd edition (ICMS#2, 2019), and then ICMS#3, 2021.

LCC is part of WLC per ICMS#3, 2021




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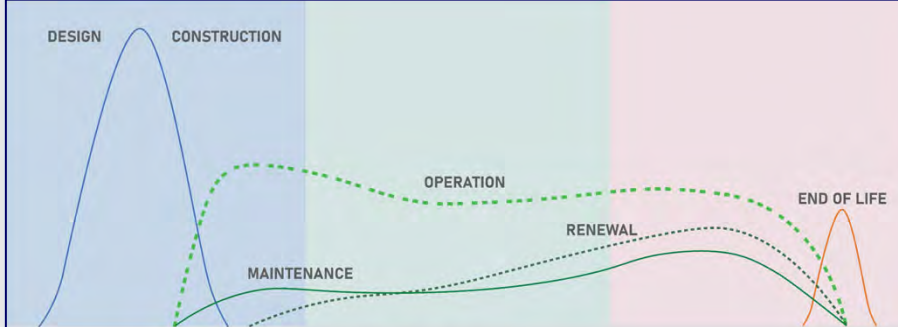
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WHEN? Cost Management Life Cycle



- ❑ **QS's are essential** to the **Cost Management** process, and uniquely positioned to influence improved **LCC outcomes** in contributing to a more sustainable, productive, and liveable **Built Environment**.




LIFE CYCLE




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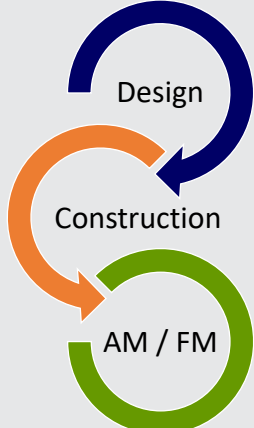


WHEN? Cost Management Life Cycle




FACILITY LIFE PHASES *	PROJECT STAGES PER ACMM & ICMS COMBINED	BASIS & DOCUMENTS REQUIRED	COST MANAGEMENT ACTIVITIES	LCC INTERFACE & DELIVERABLES
DESIGN	1. Concept	Study brief, business case, business information	Start Stage Coordination Plan	Business Case or Feasibility Study reports based on facility policy and functional objectives
	2. Outline Proposal or	Scope of works (Site, layout, location, plan, building shape etc.)	Outline Proposal Cost Estimate/Summary Estimate	Life Cycle Report related to project planning, business and life cycle planning
	3. Select Design	Conceptual design plans, site plan, architectural drawings, structural drawings, etc.	Basic Design/Outline Cost Estimate/ Cost Plan	Life Cycle Planning with comparative analysis and value selection
	4. Development	Final working drawings and specifications	tender (Site, Plan, Details, etc.)	Life Cycle Plan per design to tender
Project planning (including all risks, benefits, business, technical and environmental of total and single LCC requirements)				
CONSTRUCTION	5. Tender to	Final Bill of Materials of Works	tender (Contract, administration and pricing)	Life Cycle Plan per tender administration and pricing
	6. Construction	Final specification and construction management plan	Final Construction Management Plan	Project Monitoring and Construction Management
Performance Evaluation of facilities (including monitoring and reporting target LCC requirements)				
ASSET / FACILITIES MANAGEMENT	7. Asset	Costs of operating a facility (Operational Asset cost) or major components since they reach the end of their life, and other related information, including the impact of climate and other factors on the asset's life cycle	CAPEX Budget to support the service delivery plan	Business Case or Feasibility Study reports based on facility policy, functional objectives and value selection
	8. Operation	Costs of running and managing a facility, including maintenance, support services, etc. (including energy and other resources)	OP&M Budget to support the service delivery plan	Business Case or Feasibility Study reports based on facility policy, functional objectives and value selection
	9. End of Life	Costs of decommission, repurpose and potential maintenance or a facility (Operational Asset) or its parts and all associated management, including the impact of climate and other factors on the asset's life cycle, including the impact of climate and other factors on the asset's life cycle, including the impact of climate and other factors on the asset's life cycle	Management Plan to support the service delivery plan	Management Plan to support the service delivery plan

- ★ Facility Life Cycle Phases shown here are nominal, the groupings are not exclusive or confined. By definition design, construction and asset/facilities management should co-exist, overlap & integrate.
- ★ AIQS' Australian Cost Management Manual: Volume 1, 4th edition (2021)
- ★ International Construction Measurement Standards (ICMS), 2nd edition (2019)




Source: AIQS Information Paper: LCC Analysis (2022), table 1: Cost Management Life Cycle


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WHEN? Cost Management Life Cycle




FACILITY LIFE PHASES *	PROJECT STAGES PER ACMM & ICMS COMBINED	BASIS & DOCUMENTS REQUIRED	COST MANAGEMENT ACTIVITIES	LCC INTERFACE & DELIVERABLES
DESIGN	1. Concept	Study brief, business case, business information	Start Stage Coordination Plan	Business Case or Feasibility Study reports based on facility policy and functional objectives
	2. Outline Proposal or	Scope of works (Site, layout, location, plan, building shape etc.)	Outline Proposal Cost Estimate/Summary Estimate	Life Cycle Report related to project planning, business and life cycle planning
	3. Select Design	Conceptual design plans, site plan, architectural drawings, structural drawings, etc.	Basic Design/Outline Cost Estimate/ Cost Plan	Life Cycle Planning with comparative analysis and value selection
	4. Development	Final working drawings and specifications	tender (Site, Plan, Details, etc.)	Life Cycle Plan per design to tender
Project planning (including all risks, benefits, business, technical and environmental of total and single LCC requirements)				
CONSTRUCTION	5. Tender to	Final Bill of Materials of Works	tender (Contract, administration and pricing)	Life Cycle Plan per tender administration and pricing
	6. Construction	Final specification and construction management plan	Final Construction Management Plan	Project Monitoring and Construction Management
Performance Evaluation of facilities (including monitoring and reporting target LCC requirements)				
ASSET / FACILITIES MANAGEMENT	7. Asset	Costs of operating a facility (Operational Asset cost) or major components since they reach the end of their life, and other related information, including the impact of climate and other factors on the asset's life cycle	CAPEX Budget to support the service delivery plan	Business Case or Feasibility Study reports based on facility policy, functional objectives and value selection
	8. Operation	Costs of running and managing a facility, including maintenance, support services, etc. (including energy and other resources)	OP&M Budget to support the service delivery plan	Business Case or Feasibility Study reports based on facility policy, functional objectives and value selection
	9. End of Life	Costs of decommission, repurpose and potential maintenance or a facility (Operational Asset) or its parts and all associated management, including the impact of climate and other factors on the asset's life cycle, including the impact of climate and other factors on the asset's life cycle	Management Plan to support the service delivery plan	Management Plan to support the service delivery plan




Source: AIQS Information Paper: LCC Analysis (2022), table 1: Cost Management Life Cycle

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WHEN? Cost Management Life Cycle – design




FACILITY LIFE PHASES *	PROJECT STAGES PER ACMM & ICMS COMBINED	BASIS & DOCUMENTS REQUIRED	COST MANAGEMENT ACTIVITIES	LCC INTERFACE & DELIVERABLES
DESIGN	1. Brief ☆	Study Brief, sketches or relevant information.	Brief Stage Cost/indicative Cost.	Business Case or Feasibility Study inputs based on facility policy and functional objectives.
	2. Outline Proposals ☆	Scope of works (size, type, location, plan, building shape, etc.) and functional areas.	Outline Proposal Cost/ Preliminary Estimate.	Life Cost Budgets related to project planning horizons and life expectancy targets.
	3. Sketch Design ☆	Dimensioned sketch plans, elevations and sections, structural sketches and specifications.	Sketch Design (Limit of Cost Estimate) Cost Plan.	Life Cost Planning with comparative analysis and option selection.
	4. Documentation ☆	Final working drawings and specifications prior to tender.	Tender Cost Plan (Tender Estimate).	Life Cost Plan per design.
Project planning: reflective of current policies, standards, strategic objectives and understanding of risks and target LCC requirements.				

Source: AIQS Information Paper: LCC Analysis (2022), table 1: Cost Management Life Cycle


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WHEN? Cost Management Life Cycle – construction



FACILITY LIFE PHASES *	PROJECT STAGES PER ACMM & ICMS COMBINED	BASIS & DOCUMENTS REQUIRED	COST MANAGEMENT ACTIVITIES	LCC INTERFACE & DELIVERABLES
CONSTRUCTION	5. Tender ☆	Priced Bill or Schedule of Prices.	Tender Report/contract administration and analysis.	Life Cost Plan per tender.
	6. Construction ☆	For construction documents.	Final Account/contract administration and evaluation.	Project Monitoring management review and option refinement.
Performance Evaluation: reflective of facility plans, standards, monitoring, benchmarking and meeting target LCC requirements.				


Note: ACMM#4 and ICMS#3 define "Construction" differently but it provides a useful pivot between these two (2) reference documents.


★ Facility Life Cycle Phases shown here are nominal, the groupings are not exclusive or confined. By definition design, construction and asset/facilities management should co-exist, overlap & integrate.

★ AIQS' Australian Cost Management Manual: Volume 1, 4th edition (2021)


★ International Construction Measurement Standards (ICMS), 2nd edition (2019)

Source: AIQS Information Paper: LCC Analysis (2022), table 1: Cost Management Life Cycle


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WHEN? Cost Management Life Cycle – operational




PROJECT LIFE PHASE #	PROJECT STAGES PER PHASE & TIME CONSUMED	BASIS & DOCUMENTS REQUIRED	COST MANAGEMENT ACTIVITIES	LCC INTERFACE & DELIVERABLES
DESIGN	1. Concept	Concept brief, description, business information	Start Point Coordination Plan	Normed Cost or Feasibility Study (based on facility policy and functional objectives)
	2. Outline Proposal (1)	Scope of work (LOI), high level plan, building phases (1, 2)	Outline Proposal Cost	Life Cost Budget (based on project planning, business and life cycle objectives)
	3. Detail Design	Conceptual design, technical design, structural, services, electrical, mechanical, plumbing, fire, etc.	Detail Design Cost	Life Cost Planning with comparative analysis and value engineering
	4. Construction	Final working drawings and specifications	Builder (Life Cost) (based on design)	Life Cost Plan per design
CONSTRUCTION	5. Tender to Contract	Final contract documents	Final Contract Cost	Life Cost Plan per contract
	6. Construction	Final contract documents	Final Contract Cost	Final Contract Cost
ASSET / FACILITIES MANAGEMENT	7. Renewal	Costs of replacing a Facility, Constructed Asset and/or major components once they reach the end of their life, and which the client decides are to be included in the capital rather than the revenue budget.	CAPEX budget to support the service delivery plan.	
	8. Operation	Costs of running and managing a Facility, Constructed Asset, including administrative support services, rent, insurances, energy and other environmental/regulatory inspection costs, taxes and charges.	OPEX budget to support the service delivery plan.	
	9. Maintenance	Costs of corrective, responsive and preventative maintenance on a Facility, Constructed Asset or its parts and all associated management, cleaning, services, repainting, repairing or replacing of parts.	Maintenance Plan to support the service delivery plan.	
10. End of Life	Net costs or fees for disposing of an asset at the end of its service life after deducting the salvage value and other income due to disposal, including costs resulting from disposal inspection, decommissioning and decontamination, demolition and reclamation, reinstatement, asset transfer obligations, recycling, recovery, disposal of components and materials, and transport and regulatory costs.	Business Case or Feasibility Study inputs based on facility policy, functional objectives, performance status and applicable regulatory and statutory requirements.		


FACILITY LIFE PHASES *	PROJECT STAGES PER ACMM & ICMS COMBINED	BASIS & DOCUMENTS REQUIRED	COST MANAGEMENT ACTIVITIES	LCC INTERFACE & DELIVERABLES
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Source: AIQS Information Paper: LCC Analysis (2022), table 1: Cost Management Life Cycle


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HOW? LCC applications and processes




❑ LCC analysis has two (2) main applications:


1. **Comparative tool** to evaluate different options, design solutions, components, or materials in support of strategic planning and investment decisions – typically *Design and Construction life cycle phases*.
2. **Management tool** to provide a basis for improved budget planning and expenditure forecasts to support longer-term operational performance – more commonly *Asset / Facilities Management project life cycle phases*.




D.M.A.I.C. is an improvement cycle commonly used as a core tool used to drive Six Sigma projects.




LCC analysis improved communication and informed decision-making.



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HOW? LCC applications and processes



Life Cycle Cost (LCC)



= Initial acquisition / capital costs (AC)

less tax depreciation entitlements (TD)


plus operating and maintenance costs (OC)


plus replacement / disposal / upgrade costs (RC)

less residual / salvage value (RV)

Typical LCC* = (AC - TD) + (OC + RC) - RV

***Note:** LCC adjustments should be made for the 'time value of money' or 'discounting' in terms of Net Present Value (NPV) or Annual Equivalent Value (AVE) per AIQS LCC paper (2022).







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HOW? LCC applications and processes



☐ Time Value of Money adjustments

Adjustment for time value using Net Present Value (NPV) formula, to convert a future cost to the present value (cost) at the Common Date:

Present value (PV) = future cost × discounting factor

Rate of interest (R%) = discount rate per annum

Discounting factor for the same cost spent at the end of year N after the common base date:

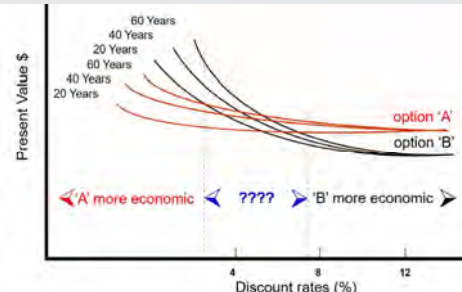
= PV of \$1 after N years

= $1 / (1 + R\%)^N$


Discounting factor for a cost spent annually for N years after the common base date:

= PV of \$1 per annum after N years

= $[1 - 1 / (1 + R\%)^N] / R\%$




NPV outputs can be useful combined with other assessment tools, such as payback period, or return on investment, and subjected to sensitivity analysis to support scenario planning and **decision-making process**.




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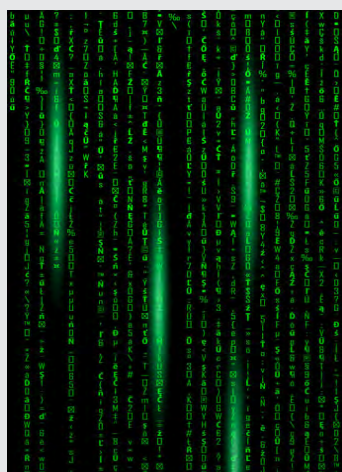


HOW? LCC applications and processes




❑ LCC reporting is more than just numbers:

- **Executive Summary:** a brief synopsis of the objectives, results, conclusions, and recommendations of the analysis.
- **Purpose and Scope:** a statement of the objectives, project/facility description, current/intended use, assumptions, constraints, and alternatives considered.
- **LCC Application:** a presentation of the LCC model results including the identification of cost drivers, sensitivity analyses, and the output from any other related analyses.
- **LCC Analysis:** details of the LCC model, including relevant assumptions, the LCC breakdown structure, and cost elements along with the basis of estimates and exclusions.
- **Conclusions and Recommendations:** a presentation of the current findings and recommendations for further investigations or analysis revisions.





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HOW? LCC applications and processes



❑ Risks, variables and assumptions involved with undertaking LCC analysis and which can contribute to unrealistic expectations and/or failure to achieve desired outcomes.

❑ Overcoming LCC risks:

- **Be systematic**, both quantitative and qualitative, in setting of realistic / agreed goals; project / facility scope; with specified benchmarks and milestones.
- **LCC analysis** should include for assumptions, and full investigation or modelling of alternatives and adequate provision for operational management.
- **Sensitivity analysis** can assist in understanding a range of LCC variables.
- **LCC reporting** should isolate and combine variables presenting 'best-case' and 'worst-case' scenarios.





```

graph TD
    Start([Lamp doesn't work]) --> D1{Lamp plugged in?}
    D1 -- No --> A1[Plug in lamp]
    D1 -- Yes --> D2{Bulb burned out?}
    D2 -- Yes --> A2[Replace bulb]
    D2 -- No --> A3[Buy new lamp]
        
```

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LCC Analysis benefits summary

- ❑ **LCC analysis benefits** lie beyond initial capital cost alone, to support better decision making and minimising risks, uncertainties and bias:
 - Recognition of '**total costs of ownership**' and the delivery '**value for the money**'
 - Understanding of the **consequences of current decisions**.
 - Assessment of **design alternatives** for new assets and facilities.
 - Assessment of **life cycle periods** and refurbishment planning for existing assets and facilities.
 - **Communication, transparency, and accountability** during the life cycle.
 - Productivity, service, safety, sustainability and well-being in terms of **quality-of-life outcomes**.

- ❑ In conjunction with other evaluation tools (e.g. value analysis, cost:benefit analysis, sensitivity analysis, etc.) the above can be further enhanced.






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Sustainability and stewardship (now & the future)

- ❑ LCC practitioners should consider **current and future implications** of a range of project / facility decisions, and be aware of carbon emissions, the circular economy, and the UN's Sustainable Development Goals (SDGs), etc.

- ❑ The 17 **SDGs** support the United Nations' 2030 Agenda as a pathway to end extreme poverty, fight inequality and injustice, and protect our planet through sustainable development.
<https://sdgs.un.org/goals>

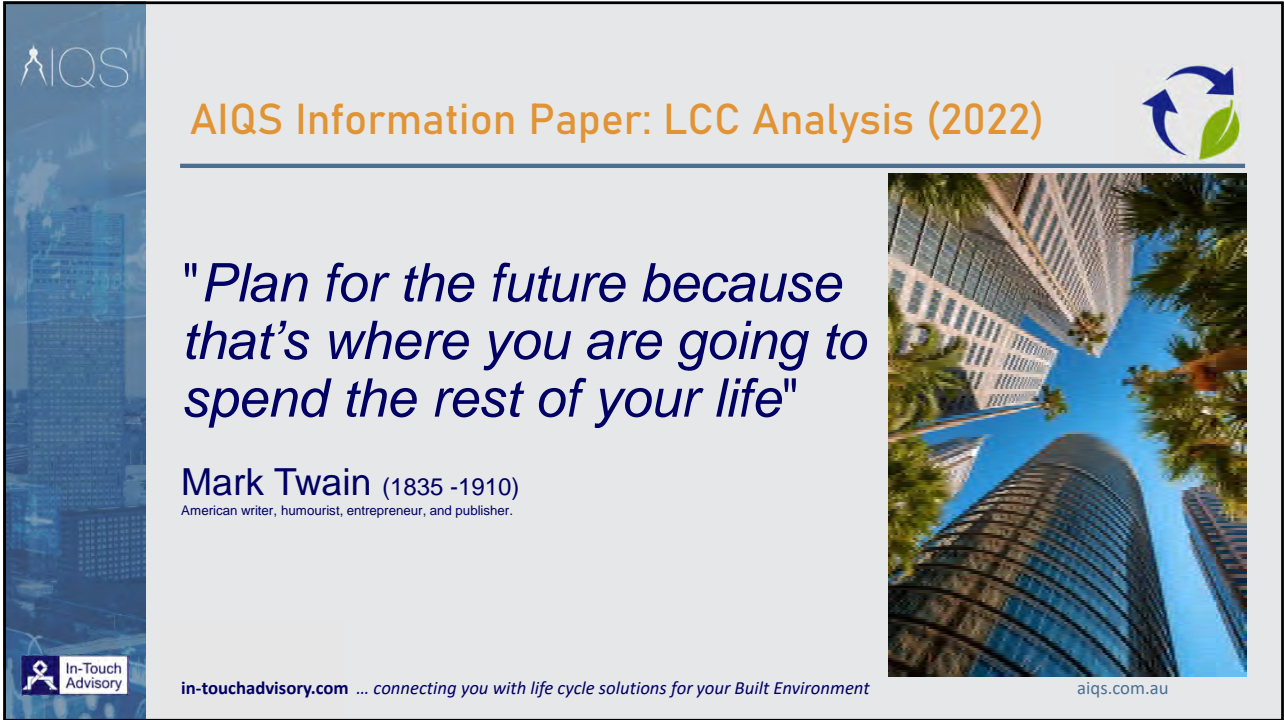




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"Plan for the future because that's where you are going to spend the rest of your life"

Mark Twain (1835 -1910)
American writer, humourist, entrepreneur, and publisher.

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