


LIFE CYCLE COST ANALYSIS



An AIQS Information Paper

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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.



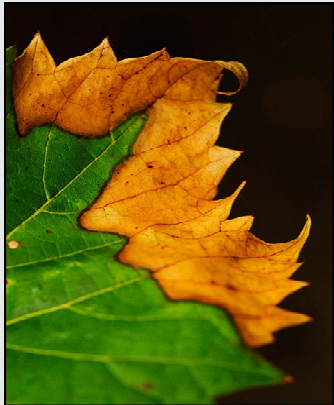
Author, AIQS' Information Paper: Life Cycle Cost Analysis (2022)

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About Today's AIQS Webinar

- AIQS Information Paper: LCC Analysis (2022)
- Cost Prediction, Service Life and C.R.O.M.E.
- Relationship between WLC and LCC
- Cost Management Life Cycle
- LCC applications, processes and benefits
- Sustainability and stewardship
- Our LCC vocabulary and resources



This document has been prepared for the AIQS webinar on 17 February 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 not 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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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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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




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1ST EDITION
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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.

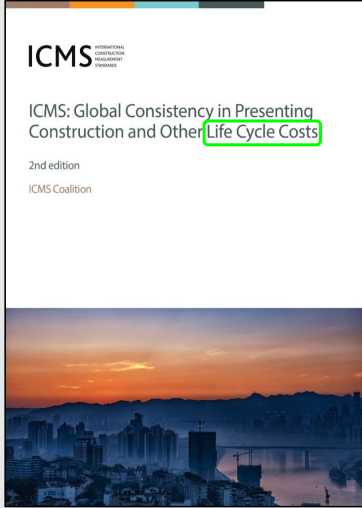
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International Construction Measurement Standard (ICMS)

- ❑ **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/>




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

Source: ICMS Coalition media release, 30 November 2021

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 works and time)

×

RATE
(costs per unit)

+


RISKS / Contingencies
(known unknowns)



=

COST PREDICTION
‘out-turn cost’
(in accordance with the defined ‘remit of work’)

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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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) – ANALYSIS
(in accordance with the defined ‘service life’)

=

Initial Acquisition / Capital Costs

–

Tax Depreciation Entitlements

+

Replacement / Upgrade & Disposal Costs


+



Operation and Maintenance Costs

–

Residual / Recycling / Recovery Value

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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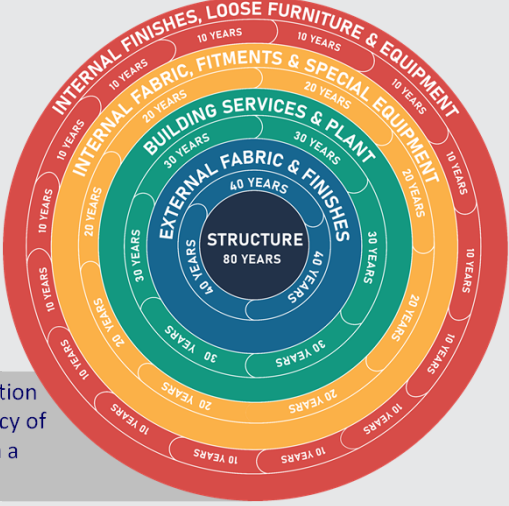




Service Life



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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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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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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WHOLE LIFE COSTS (WLC)

	NON - CONSTRUCTION COSTS	LIFE CYCLE COSTS (LCC)	INCOME	EXTERNALITIES	
ACQUISITION COSTS (AC)	C	R	O	M	E
	CONSTRUCTION COSTS (CC)	RENEWAL COSTS (RC)	OPERATION COSTS (OC)	MAINTENANCE COSTS (MC)	END OF LIFE COSTS (EC)
	COST GROUPS	COST GROUPS	COST GROUPS	COST GROUPS	COST GROUPS
ASSOCIATED CAPITAL COSTS					

ICMS 1st EDITION
 ICMS 2nd EDITION (CONSTRUCTION AND OTHER LIFE CYCLE COSTS)

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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 communications tool.

C R O M E


CONSTRUCTION COSTS RENEWAL COSTS OPERATION COSTS MAINTENANCE COSTS END OF LIFE COSTS

DESIGNER




CONSTRUCTION THINKING
FM THINKING

CONSTRUCTOR




DESIGN THINKING
FM THINKING

FM EXPERT





DESIGN THINKING
CONSTRUCTION THINKING

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



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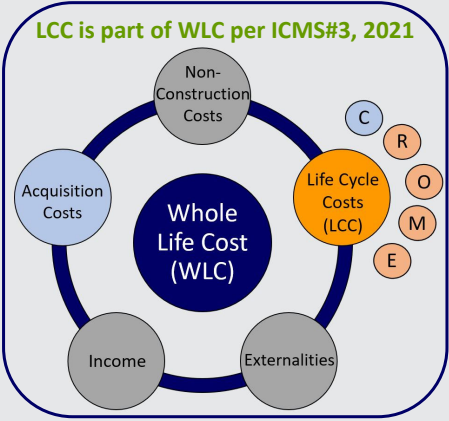




Relationship between WLC and LCC

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)



LCC is part of WLC per ICMS#3, 2021





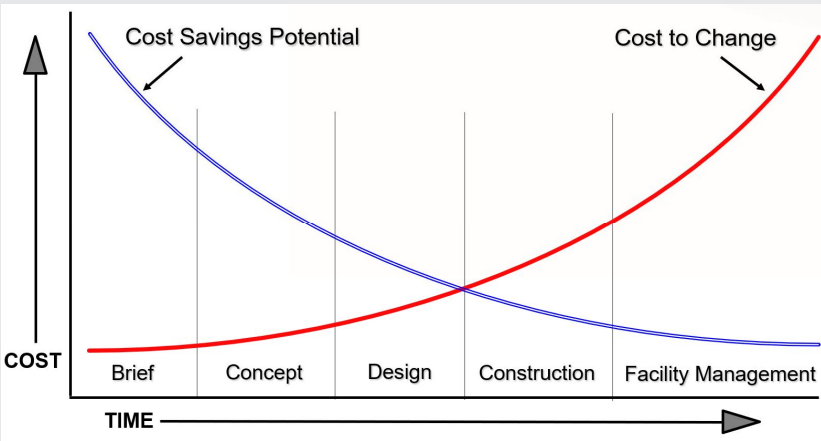
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Relationship between WLC and LCC for VM/VE

❑ **Value Management** without WLC & LCC = merely Capital Cost Reduction? ☹️




Perhaps off topic:

But if VM/VE is not based firmly in **Functional Analysis** techniques, then there is a risk the such savings can result in higher ongoing costs throughout the facility life cycle.




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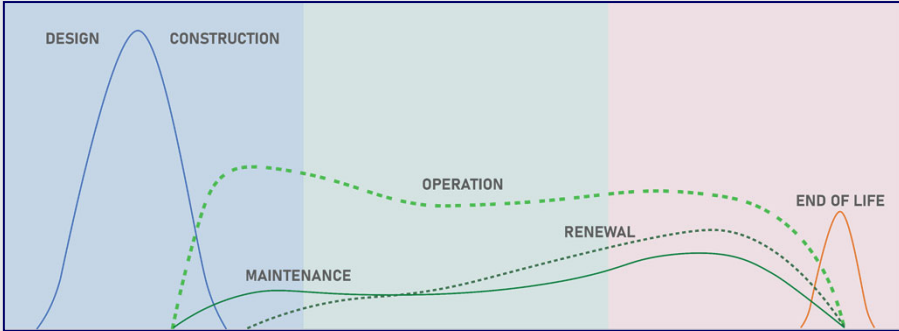
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Cost Management Life Cycle



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**.




EXPENDITURE OVER TIME


LIFE CYCLE

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Cost Management Life Cycle

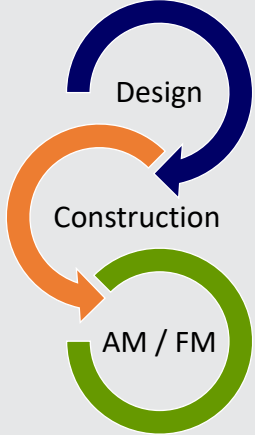


FACILITY LIFE PHASES *	PROJECT STAGES PER AIAA & CMA COMBINED	BASIS & DOCUMENTS REQUIRED	COST MANAGEMENT ACTIVITIES	LCC INTERFERENCE & RISKS
DESIGN	1. Brief	Study brief, sketches or relevant information	Brief Stage Cost/Valueation Cost	Business Case or Feasibility Study inputs based on facility order and functional objectives
	2. Studies Proposals	Scope of work, risks, type, location, plan, building stage, etc	Outline Proposal Cost/ Preliminary Estimate	LCC Cost Budget/impact on project planning function and the regulatory targets
	3. Sketch Design	Conceptual sketch plans, elevations and sections, structural specifications	Sketch Design/Value of Cost Estimate/ Cost Plan	LCC Cost Planning with comparative analysis and value selection
	4. Documentation	Final working drawings and specifications prior to tender	Tender Cost Plan (Tender not specifications prior to tender)	LCC Cost Plan per design
Project planning: understand current policies, standards, strategic objectives and understanding of risks and target LCC requirements.				
CONSTRUCTION	5. Tender	Final Bill or Schedule of Prices	Tender Report/Contract administration and control	LCC Cost Plan per tender
	6. Construction	For construction documents	Final Account/Contract administration and control	Project Monitoring management review and control
	7. Renewal	Costs of replacing a Facility, Component Asset and/or major components once they reach the end of their life, and which the client decides to be included in the capital rather than the revenue budget	Performance Evaluation/assessment of facility performance, identifying, monitoring, measuring target LCC requirements.	CapEx budget to support the service delivery plan
ASSET / FACILITIES MANAGEMENT	8. Operation	Costs of running and managing a Facility, Component Asset, including administrative support services, rent, insurance, energy and other environmental/regulatory expenses, costs, taxes and charges	Costs of running and managing a Facility, Component Asset, including administrative support services, rent, insurance, energy and other environmental/regulatory expenses, costs, taxes and charges	OpEx budget to support the service delivery plan
	9. Maintenance	Costs of corrective, responsive and preventative maintenance on a Facility, Component Asset or its parts and all associated equipment, cleaning, security, reporting, repairing or replacing of parts.	Costs of corrective, responsive and preventative maintenance on a Facility, Component Asset or its parts and all associated equipment, cleaning, security, reporting, repairing or replacing of parts.	Maintenance Plan to support the service delivery plan
	10. End of Life	As an asset or part of the disposal of an asset or the end of its useful life, including costs resulting from disposal, including decommissioning and decontamination, demolition and relocation, management, asset transfer obligations, recycling, recovery, disposal of components and materials, and transport and replacement costs.	As an asset or part of the disposal of an asset or the end of its useful life, including costs resulting from disposal, including decommissioning and decontamination, demolition and relocation, management, asset transfer obligations, recycling, recovery, disposal of components and materials, and transport and replacement costs.	Business Case or Feasibility Study inputs based on facility policy, functional objectives, performance status and applicable regulatory and statutory requirements.

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

AIQS' Australian Cost Management Manual - Volume 1, 4th edition (AIQS-ACMM#4, 2021).

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



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Cost Management Life Cycle – a new framework

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 and specifications per design).	Life Cost Plan per design.
Project planning: reflective of current policies, standards, strategic objectives and understanding of risks and target LCC requirements.				
CONSTRUCTION	5. Tender	Final Bill or Schedule of Prices.	Tender Paper/Contract administration and evaluation.	Life Cost Plan per tender.
	6. Construction	For construction documents.	Final Account/Contract administration and evaluation.	Project Monitoring management review and control.
ASSET / FACILITIES MANAGEMENT	7. Operational	Performance Evaluation reflective of facility plans, standards, monitoring, benchmarking and meeting target LCC requirements.	Costs of replacing a Facility, Committed 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, Committed Asset, including discretionary support services, rent, insurance, energy and other environmental/regulatory requirements, taxes and charges.	Costs of running and managing a Facility, Committed Asset or its parts and all associated management, charging services, reporting, repair or replacing of parts.	OpEx Budget to support the service delivery plan.
	9. Maintenance	Cost of preventive, responsive and preventative maintenance on a Facility, Committed Asset or its parts and all associated management, charging services, reporting, repair or replacing of parts.	Cost of preventive, responsive and preventative maintenance on a Facility, Committed Asset or its parts and all associated management, charging services, reporting, repair or replacing of parts.	Maintenance Plan to support the service delivery plan.
	10. End of Life	For costs or fees for disposal 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 regulations, decommissioning and decontamination, demolition and relocation, management, asset transfer obligations, recycling, recovery, disposal of components and materials, and transport and regulatory costs.	For costs or fees for disposal 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 regulations, decommissioning and decontamination, demolition and relocation, management, 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 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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Cost Management Life Cycle – design phase

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.				

★ 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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Cost Management Life Cycle – construction phase

FACILITY LIFE PHASES ★	PROJECT STAGES PER ACMM & ICMS COMBINED	BASIS & DOCUMENTS REQUIRED	COST MANAGEMENT ACTIVITIES	COST MANAGEMENT ACTIVITIES	LCC INTERFACE & DELIVERABLES
DESIGN	1. Brief	Study Brief, briefs or rebasel 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 (site, type, location, plan, building shape, etc.) and functional areas.	Outline Proposal Cost/ Preliminary Estimate.	Life Cost Budgets related to project planning horizon and life expectancy targets.	
	3. Sketch Design	Developed sketch plans, elevations and sections, structural details, material specifications.	Sketch Design/Outline 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 and specifications prior to tender).	Life Cost Plan per design.	
Project planning objectives: confirm policies, standards, strategic objectives and understanding of risks and target LCC requirements.					
CONSTRUCTION	5. Tender	Final Bill or Schedule of Prices.	Tender Report/Contract Administration and Control.	Life Cost Plan per tender.	
	6. Construction	Final Account/Contract Administration and Control.	Project Monitoring and Reporting.	Life Cost Plan per tender.	
	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.		
ASSET / FACILITIES MANAGEMENT	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.		

CONSTRUCTION

5. Tender ★

6. Construction ★

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

Cost Management Life Cycle – operational phase

FACILITY LIFE PHASES ★	PROJECT STAGES PER ACMM & ICMS COMBINED	BASIS & DOCUMENTS REQUIRED	COST MANAGEMENT ACTIVITIES	COST MANAGEMENT ACTIVITIES	LCC INTERFACE & DELIVERABLES
DESIGN	1. Brief	Study Brief, briefs or rebasel 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 (site, type, location, plan, building shape, etc.) and functional areas.	Outline Proposal Cost/ Preliminary Estimate.	Life Cost Budgets related to project planning horizon and life expectancy targets.	
	3. Sketch Design	Developed sketch plans, elevations and sections, structural details, material specifications.	Sketch Design/Outline 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 and specifications prior to tender).	Life Cost Plan per design.	
Project planning objectives: confirm policies, standards, strategic objectives and understanding of risks and target LCC requirements.					
CONSTRUCTION	5. Tender	Final Bill or Schedule of Prices.	Tender Report/Contract Administration and Control.	Life Cost Plan per tender.	
	6. Construction	Final Account/Contract Administration and Control.	Project Monitoring and Reporting.	Life Cost Plan per tender.	
	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.		
ASSET / FACILITIES MANAGEMENT	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.		

ASSET / FACILITIES MANAGEMENT



7. Renewal ★

8. Operation ★

9. Maintenance ★


10. End of Life ★

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





LCC applications, processes and benefits


- ❑ 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.





improved communication and informed decision-making.



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LCC applications, processes and benefits

- ❑ **LCC analysis** is an economic evaluation technique, for identifying and quantifying all costs, initial and ongoing, associated with a project or an asset / facility over its anticipated Service life.
- ❑ **Effective LCC analysis** combines:
 1. Context or purpose as determined by stakeholders' **objectives**;
 2. Design inputs, construction deliverables, and operational **variables**;
 3. '**Service Life**' and the life expectancies of components; and
 4. Costs associated with the components and **period of analysis** to achieve and maintain outcomes meeting the required function, specified performance, and desired quality (ICMS / ISO 15686-5):
 - **Real Costs**: expressed as a value at the common date.
 - **Nominal Costs**: expected price that will be paid when a cost is due to be paid.
 - **Discounted Costs**: real or nominal costs adjusted for the 'time value of money'.







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LCC applications, processes and benefits




LCC analysis is life expectancy based, and requires an appropriate **period of analysis** is part of the strategic decision-making process.


Service Life cycle of the whole constructed asset or facility, notwithstanding premature obsolescence, is the “**sum of its parts**”.

Effective LCC analysis requires **judgement** and should consider:

- Ownership and Operational objectives.
- Design intent, functional requirements, and variables.
- Project scope, status, and available relevant data/documentation.
- Life expectancy concept related to facility performance.
- LCC analysis techniques, databases, inputs, and risks.
- LCC analysis formulation, presentation, and interpretation.
- Consistent application of LCC terminology, standards and calculation methodology.




Caravan Bridge over the river Meles in Izmir, Turkey. Built around 850 BCE, it is more than 2,870 years old — qualifying as the oldest functioning bridge in the world.
Source: [17 of the Oldest Structures on Earth \(gizmodo.com.au\)](http://17oftheOldestStructuresonEarth.gizmodo.com.au)




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LCC applications, processes and benefits



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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LCC applications, processes and benefits

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

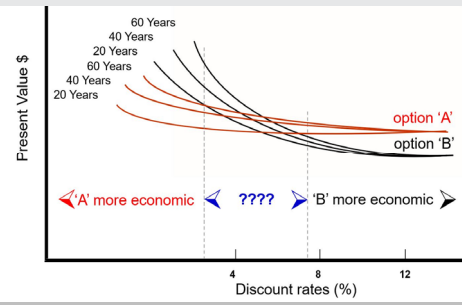
Rate of interest (R%) = discount rate per annum

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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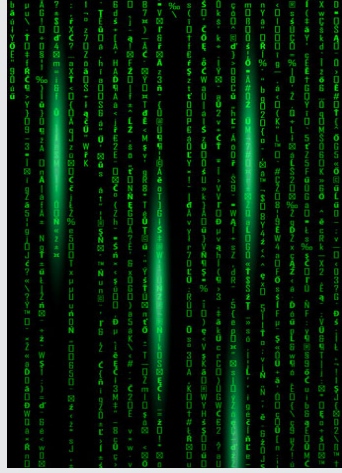
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LCC applications, processes and benefits

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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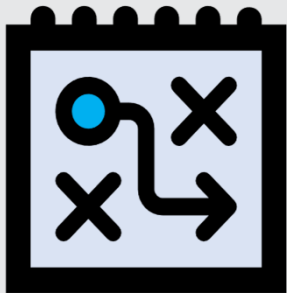
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LCC applications, processes and benefits

- ❑ **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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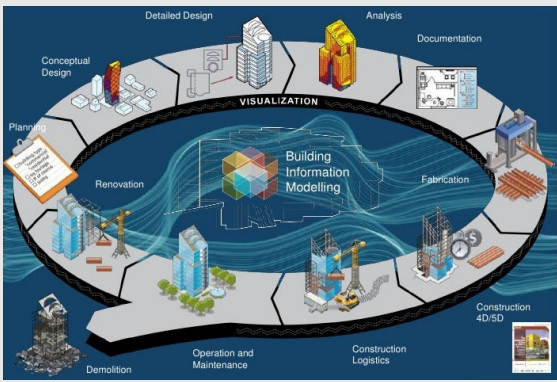
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LCC applications, processes and benefits

- ❑ **Digital design, construction, and management technologies**, such as 'digital twins', and specifically BIM during design and construction, AIM and CAFM operationally, are fundamentally transforming our industry practices in the delivery and management of the Built Environment.

- ❑ **LCC analysis** is no exception. However, the application of **professional judgement** does and will remain a determining factor in successful LCC analysis.




Source: courtesy of WSP




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LCC applications, processes and ~~benefits~~ RISKS




- ❑ **LCC analysis risks** come in multiple forms:
 - **Life Cycles** – use of generic or life expectancies based on published data or physical condition-based criteria alone provides for unrealistic expectations leading to the provision of under or over maintenance and operating costs.
 - **Benchmarks** – use of inappropriate benchmarks or similar over-simplifications can be misleading.
 - **Databases** – the of insufficient or inappropriate data can lead to incorrect outcomes.
 - **Period of Analysis** – use of shorter or longer life cycles can distort the outcomes.
 - **Discount Rates** – use of higher discount rates can lead to the selection of low capital cost and high operating cost alternatives.






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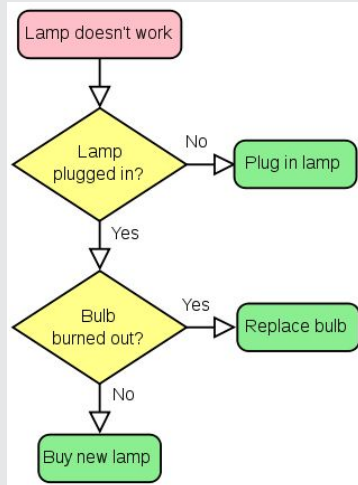
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LCC applications, processes and ~~benefits~~ RISKS



- ❑ **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.





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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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Our LCC vocabulary and resources

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

- ❑ 40 technical terms defined, including:
 - Author’s notes on options and usage.
- ❑ 19 additional references, such as:
 - ISO 15686-5: 2017 Buildings and constructed assets, Service Life Planning - Part 5: Life-cycle costing.
 - ICMS, 2nd edition (2019) and 3rd edition (2021).
 - AIQS’ Australian Cost Management Manual: Volume 1 (4th ed).
 - AS ISO 41000 series of Facility Management standards and AS ISO 55000 series of Asset Management standards.
 - Other leading publications and relevant guidelines.





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LIFE CYCLE COST ANALYSIS (1st edition, 2022)
An AIQS Information Paper

Reflections and questions please to: Stephen.Ballesty@in-touchadvisory.com

AIQS Information Paper: LCC Analysis (2022)

"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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