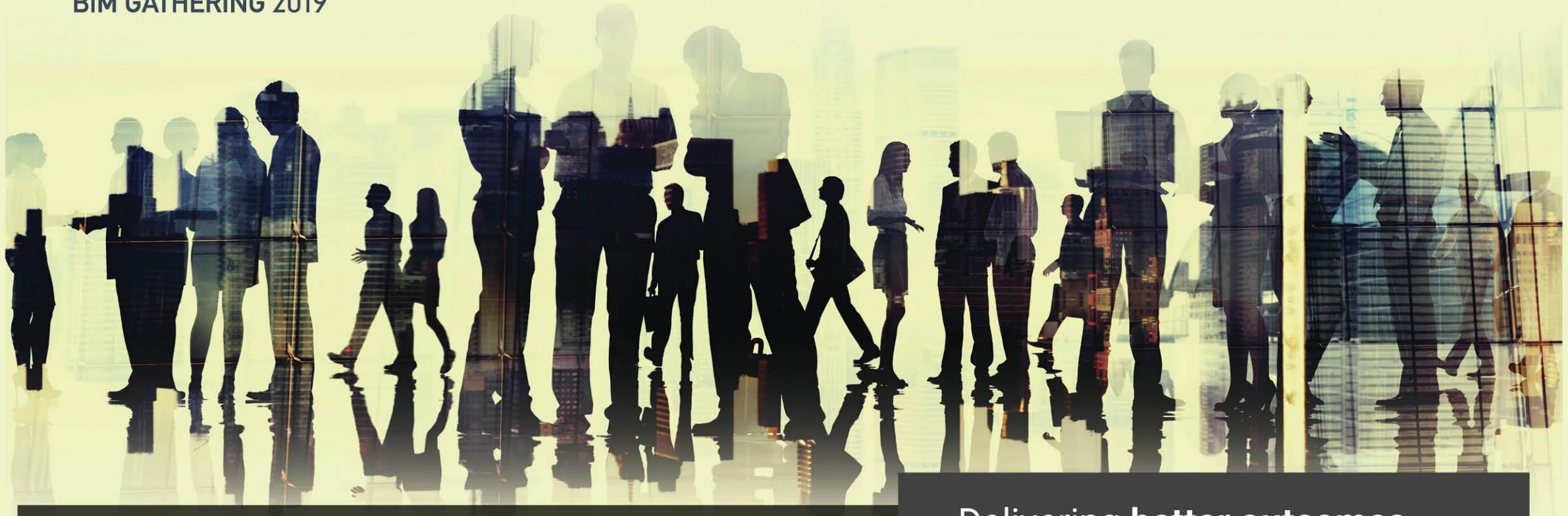


CitA

BIM GATHERING 2019



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Delivering **better outcomes**
for Irish Construction



Daniel Clarke Hagan

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Whole Life / Life Cycle Costing during the Design Stage of a Construction Project: A Qualitative Review



- ❖ Introduction and Background to the Research
- ❖ Development of Whole Life and Life Cycle Costing
- ❖ Costs incurred over the life of the building
- ❖ Definitions
- ❖ Time Frame of Whole Life Costing
- ❖ Calculations and Cost Data for WLC / LCC
- ❖ Use of WLC and LCC
- ❖ Research Methodology
- ❖ Advantages identified
- ❖ Disadvantages identified
- ❖ Economic Advantages
- ❖ Sustainability Advantages
- ❖ Corporate Advantages
- ❖ Main findings for WLC / LCC and Recommendations



Research Title: *“Early Implementation of BIM in Architectural firms to promote Whole Life Costing and Lean Construction”*

Presented paper is based on preliminary research carried out for Ph.D.



- ❖ The research aim is to explore the interoperability between BIM and other processes such as Whole Life Costing and Lean Construction whilst examining any effect they may have on the wider built environment and on sustainable construction



- ❖ The aim of this research paper is to examine Life Cycle Costing, Whole Life Costing and the possible advantages and disadvantages to their introduction and use, against the possible benefits or advantages to be derived from their use and their influence on economic decisions at the design phase of a construction project



- ❖ In 1962 Sir Harold Emmerson, in a report to the House of Commons on problems in the construction industry stated ... ‘in no other important industry is the responsibility for design so far removed from the responsibility for production’
- ❖ This was followed in 1994 with a report by Sir Michael Latham, titled “Constructing the Team.”
- ❖ Sir John Egan was Chairman of a task force set up to further examine the construction industry and build upon the Latham Report. The task force report, titled “Rethinking Construction” of 1998
- ❖ These initiatives and reports encouraged change
 - One result has been the gradual transfer of selecting projects on the basis of lowest capital cost, to the costing of a project over its lifespan from inception to demolition

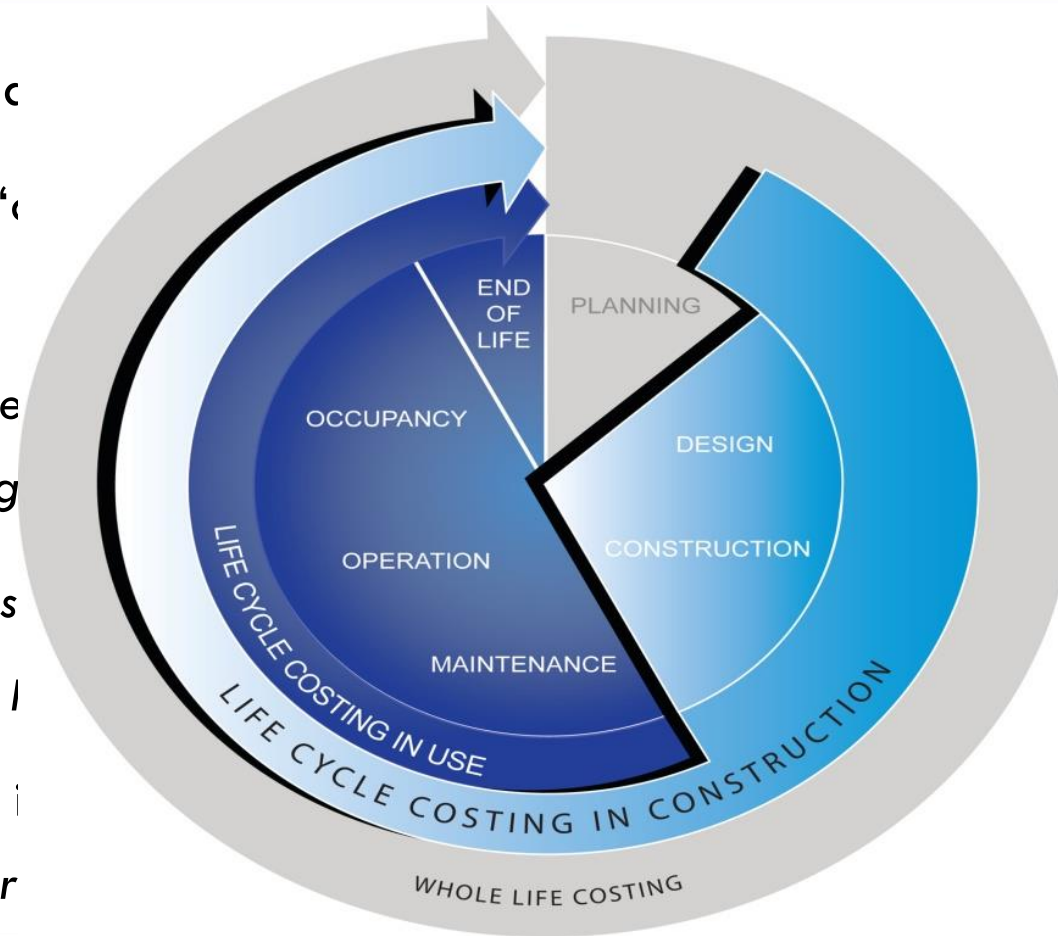
Costs incurred over the life of the building



- ❖ These are costs associated with the use of building and may occur periodically i.e. cyclic maintenance costs and utilities
- ❖ The life cycle costs are all the costs for that building from its first inception until the day it is demolished and therefore costs in use would be included here
- ❖ Costs in use can be defined as ... *“The costs incurred in owning and occupying a building or other facility whether paid by the owner or occupier. These therefore represent running cost plus the initial cost of the site, construction and associated fees”...* (Mills, 1994)



- ❖ BS ISO 15686-5:2017 Building Life Cycle Costing (LCC) is ... ‘the analysis, as defined in the agreement, of the costs and benefits over a period of time, while fulfilling the performance requirements’...
- ❖ Life Cycle Costing as ... ‘the analysis, as defined in the agreement, of the costs and benefits over a period of time, while fulfilling the performance requirements’...
- ❖ Whole Life Costs are... ‘all costs and benefits over a period of time, while fulfilling the performance requirements’...
- ❖ Whole Life Costings (WLC) is the analysis, as defined in the agreement, of the costs and benefits over a period of time, while fulfilling the performance requirements’...



definitions.

while fulfilling the performance

life-cycle costs over a period of

benefits of an asset, throughout its

economic consideration of all whole-life



- ❖ Flannagan et al (1989) stated that there were two different time periods involved, the first of which was the buildings, system or components life expectancy or an analysis period of 25 years
- ❖ HM Treasury (2011) suggests that 15-25 years should be a typical study period for a new building
- ❖ Churcher, (2008) suggests that for long term projects such as infrastructure or prestige buildings then a period up to 301 years may be used
- ❖ Kelly and Hunter (2005) stated that ... *'a whole life cost calculation should not extend beyond 30 years'...*



- ❖ There are many techniques and formulae used in calculating WLC / LCC;
 - Discounted Payback
 - Net Present Value
 - Internal Rate of Return
 - Annual Equivalent Value
 - Single Present Value
 - Uniform Present Value
- ❖ Net Present Value (NPV), where the future costs for options under consideration are brought back to the net present value is generally used



- ❖ NPV used with discounted cash flow analysis, gives a detailed examination of the effects of cash flow over time and calculates the current value of an option to be considered at the chosen discounted rate
- ❖ Each cash inflow/outflow is discounted back to its present value:

$$NPV = \sum_{t=0}^n F_t (1+i)^{-t} = \sum_{t=0}^n (CI - CO)_t (1+i)^{-t}$$

- ❖ Where; CI = cash inflow. CO=cash outflow. i = discount rate. t = period of time.



$$NPV = \sum_{t=0}^N \frac{C_t}{(1+i)^t}$$

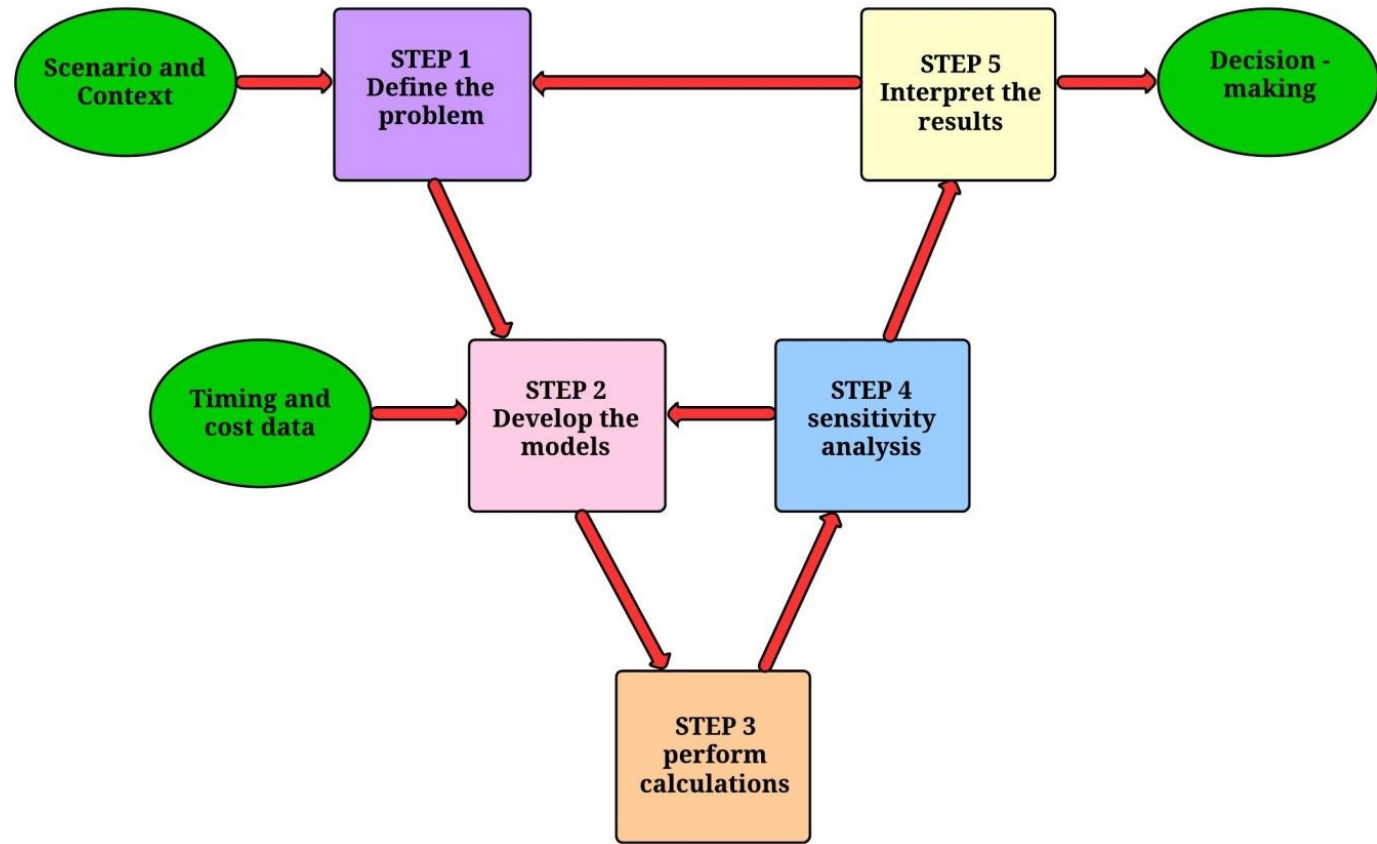
- ❖ Where; C = all future costs, t = period of time, i = discount rate, N = Number of years.
- ❖ Future costs are defined in BS ISO 15686-5:2008
- ❖ Discount rates can be found in HM Treasury, Green Book
- ❖ It should be remembered that any residual value should be deducted from total future costs



- ❖ Whichever method for calculation is used, the basic objective is to produce definitive answers to make an informed decision between the options under consideration
- ❖ Data for the calculations can be from various sources, such as pricing books, organisations own historical data, consultants etc.



- ❖ WLC analysis (
- ❖ The number of assumptions made for project activity



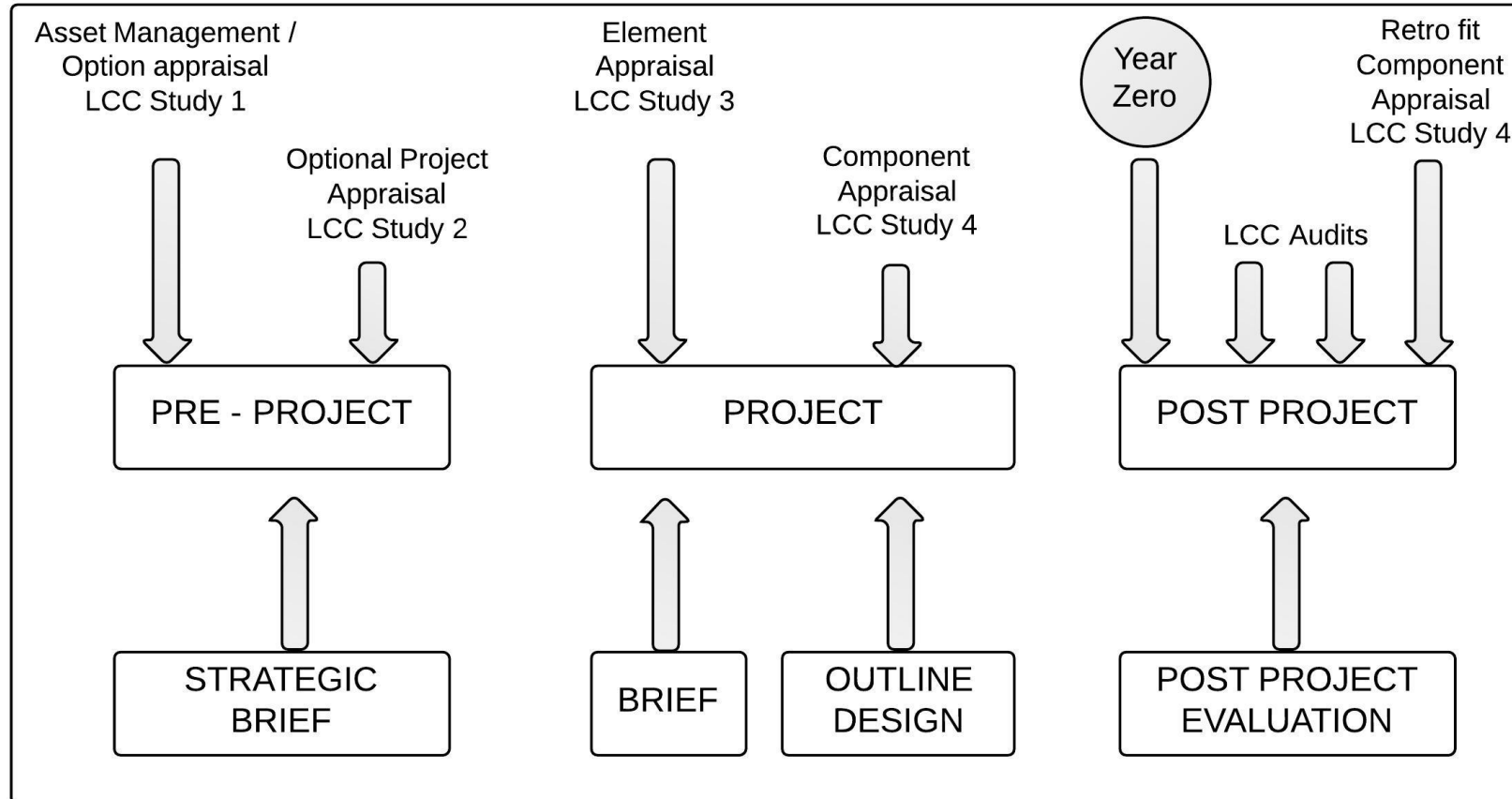
, types of
costs and timings

(Adapted from Churcher 2008).



- ❖ The focus on whole life cycle costs should start, if possible at the feasibility stage and when looking at the financial viability of a project
- ❖ The five basic steps (RICS, 2009) in making decisions are;
 1. 'Identify project objectives, options and constraints'
 2. 'Establish basic assumptions'
 3. 'Compile data'
 4. 'Discount cash flows to a comparable time base'
 5. 'Compute total life cycle costs, compare options and make decisions'

Use of WLC and LCC



(Adapted from Kelly and Hunter 2009)



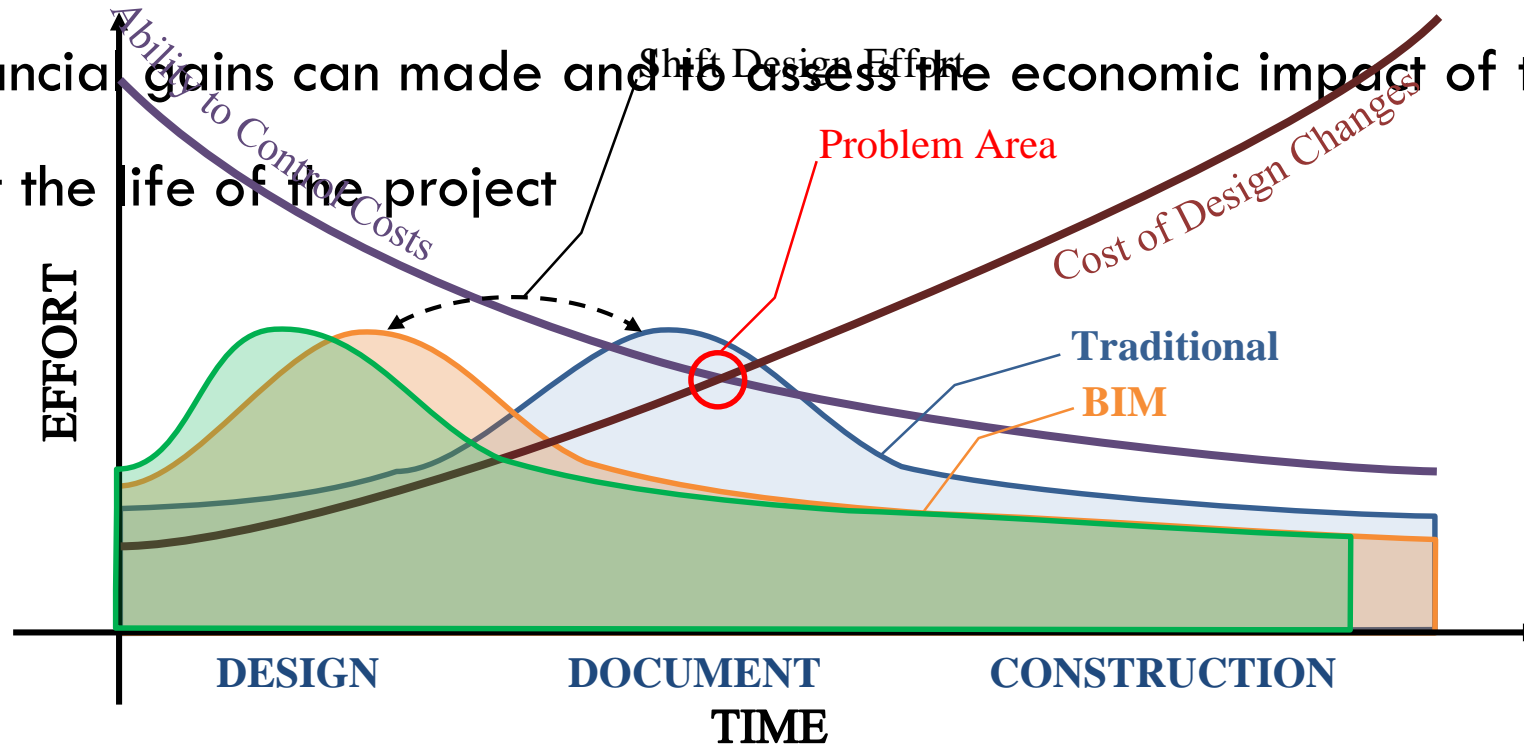
- ❖ Previous figure demonstrates the stages in which LCC studies should be carried out
- ❖ LCC allows comparisons to be made between project options with differing cash flows and time frames
- ❖ Analysis undertaken should take into account all factors throughout the serviceable life of the building, clients brief and project specific life performance of components within the building



- ❖ WLC / LCC can be used as a constituent part in the investment appraisal process
- ❖ This process is used to make decisions on capital investment for proposed projects and to balance construction and maintenance costs with the anticipated needs of the building, end users and possible rental values
- ❖ Research into WLC / LCC led to developing a technique whereby the capital costs in acquiring an asset could be compared with the costs in use and maintenance costs over the life span of the asset
- ❖ Life cycle costing can lead the decision to increase capital costs in order to reduce running costs in future use, this will lead to a lowering of overall life cycle costs



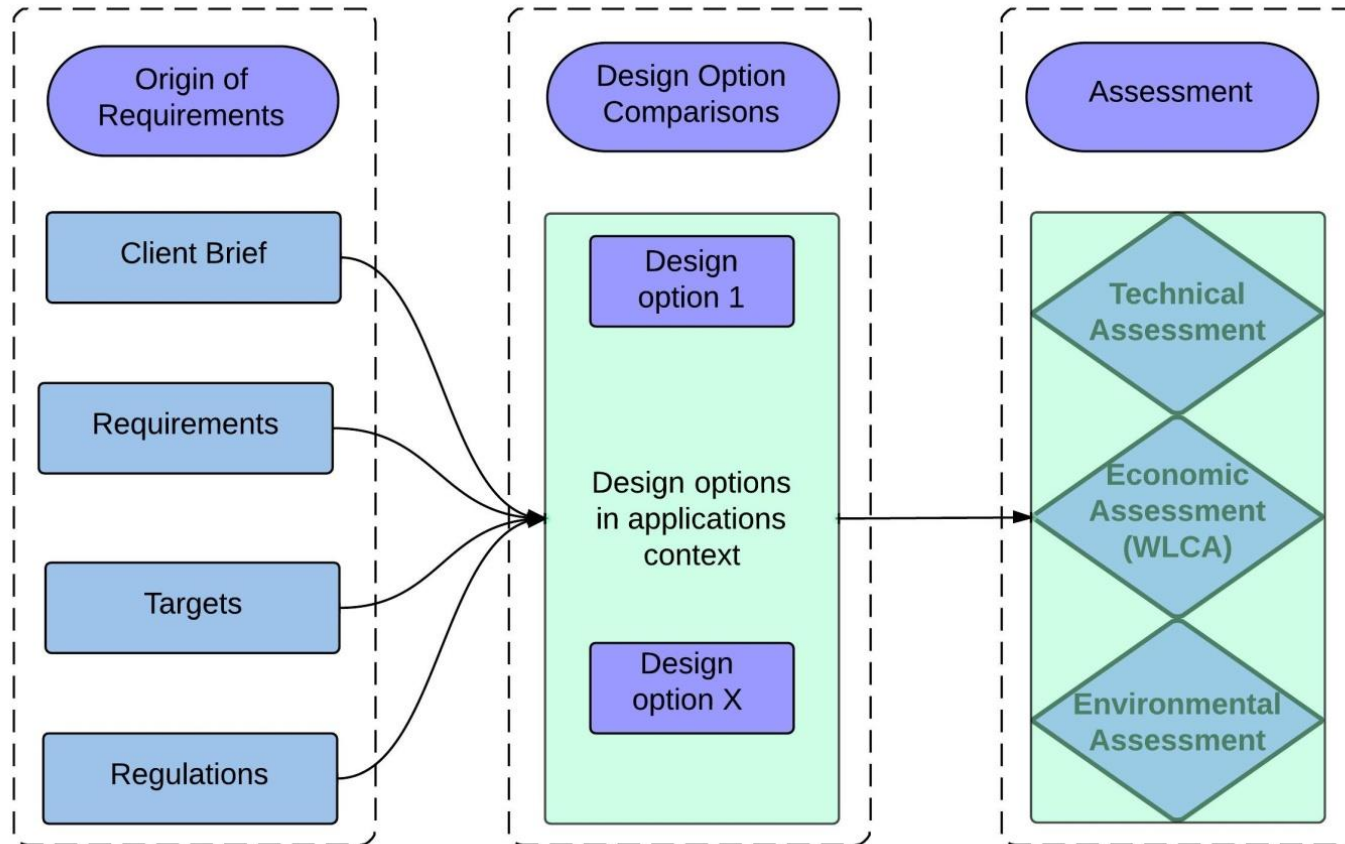
- ❖ WLC /LCC should be used for the evaluation of the various design options presented to see where financial gains can be made and to assess the economic impact of the various designs throughout the life of the project



(Adapted from Mac Leamy, 2014)



- ❖ An integrated r
design quality,
consequently re



enhance, can improve;
enhance needs and



- ❖ Whilst the correct use of WLC/ LCC at the design stage should see the greatest financial benefits, it should not be considered that they have no further use
 - During construction WLC/ LCC should be considered
 - Method of construction can have an influence on expenditure, cash flow and project time
 - Buildability, a more efficiently constructed building will have time and cost saving implications
 - WLC / LCC can be used to determine the most cost effective acquisition of plant, whether the contractor should; lease, hire or purchase
 - Construction managers should provide an input where they could identify LCC issues which may have repercussions on manufacture or construction



- ❖ The use of LCC in the management of risk is increasing
- ❖ The use of LCC as a tool in risk management gives clients better information to make informed decisions on the building and better protect their investment
- ❖ As LCC looks at all possible costs and brings them back to a Net Present Value (NPV) it makes it easier to compare and evaluate different buildings and designs



Three tiers of research sequentially carried out;

- ❖ An in depth literature review
- ❖ Two semi structured interviews and a focus group
- ❖ Results from the interviews / focus group were then input into a qualitative mapping software package called 'Decision Explorer'
 - Domain analysis
 - Central analysis



	Advantages Identified	Interview A	Interview B	Focus Group
General	Allows for design changes to be made	✓		✓
	Asset Management			✓
	Comparative data analysis	✓		✓
	Early involvement of specialist contractors	✓	✓	✓
	WLC / LLC can be quickly calculated	✓		✓
Economic	Cost control		✓	✓
	Easier comparison of cost models	✓	✓	✓
	Easy to compare WLC / LLC of designs	✓		✓
	Improved data analysis	✓		
	Increase VFM	✓	✓	
	Increased savings	✓		✓
	Increased value management	✓		
	Marketing opportunities	✓		✓
	Project cost savings	✓	✓	✓
	Reduced WLC / LLC	✓	✓	✓
Sustainability	Encourages sustainable design	✓	✓	✓
	Environmental considerations at an early stage	✓		✓
	Promotion of green credentials		✓	
	Sustainable procurement		✓	
Corporate	Attract new clients		✓	✓
	Improved Company image	✓	✓	✓
	Improved construction management	✓		✓
	Improved corporate image	✓		✓
	Improved CSR	✓		



	Disadvantages Identified	Interview A	Interview B	Focus Group
General	Assumptions to be made (WLC / LLC)		✓	✓
	Early data may not exist	✓	✓	
	Incorrect reports produced	✓		✓
	Incorrect models produced	✓		✓
	Lack of standards and protocols	✓		✓
	Mistakes made by inexperienced staff	✓		✓
	Staff training	✓		
	Time required for calculations		✓	
	Level of difficulty in calculations		✓	



- ❖ Largest group of advantages identified
- ❖ At the design stage they can be used to make decisions that will affect costs over the life time of the building
- ❖ WLC / LCC have the influence to affect cost savings
- ❖ Can lead to increased value management and value for money for the client and end users



- ❖ Method of construction can influence expenditure, cash flow and project time
- ❖ The use of WLC / LCC in conjunction with lean construction can impact upon project costs
- ❖ Can be used to establish the most cost effective procurement method for plant
- ❖ Their benefit can then be felt during occupation and use
- ❖ They can play an important role in the maintenance and facilities management of a building and can take a role in estate management



- ❖ Selected design options can be assessed using WLC / LCC and is therefore becoming increasingly important in procurement and design of buildings in sustainable construction.
- ❖ They can also be used in the procurement of sustainable materials and elements
- ❖ WLC and LCC used in conjunction with energy use analysis can be used to select those technologies which reduce costs over the life span
- ❖ Help reduce reliance on non-renewable energy sources
- ❖ WLC / LCC have demonstrated themselves to be useful tools in the appraisal of procurement, design and construction of sustainable buildings



- ❖ The use of WLC / LCC has obvious economic advantages and elements such as reduced project costs and increased profit margins could be said to be a corporate advantage
- ❖ Their use has other less obvious advantages
 - Correct and accurate use in cost profiling can help reduce their tender prices and increase chances in bid success
 - When linked with lean construction can help improve corporate strategy
 - Research has shown a direct link between; sustainability, corporate image and corporate social responsibility, so using WLC / LCC to improve sustainability has an effect on corporate image



- ❖ Construction project funding is based mainly on capital costs with little consideration for costs for WLC / LCC
- ❖ Current economic climate has increased the emphasis cost reduction
- ❖ An attitude change towards WLC / LCC, within the industry is needed to be convinced of their long term benefits



- ❖ Complicated cost models and calculations are a deterrent for both clients and practitioners and inhibit the use of WLC / LCC
- ❖ A standardised cost model and calculations are required for the construction industry
- ❖ Their use has many socio-economic and environmental benefits and advantages which need to be promoted by the industry and Government



- ❖ An attitude change towards WLC / LCC is needed within the industry to fully promote, adopt and utilise them
- ❖ Further research into WLC / LCC to provide a standardised cost model and framework for calculations is required for the construction industry
- ❖ Further research into WLC / LCC and their use in conjunction with BIM is required
- ❖ Further research into WLC / LCC and their effect on sustainability is required



Thank you