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Life Cycle Cost Analysis Under Ireland's Capital Works Management Framework

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LIFE CYCLE COST ANALYSIS UNDER IRELAND'S CAPITAL WORKS MANAGEMENT FRAMEWORK

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The Capital Works Management Framework (CWMF) is a structure that has been developed to deliver the Irish government's objectives in relation to public sector construction procurement reform. This research provides practical guidance and assistance for construction cost professionals in carrying out Whole Life Cycle Cost Analysis (WLCCA) and producing Life Cycle Cost Models (LCCMs) under the CWMF. The research outlines how LCCA calculations can be carried out for cost planning purposes and recommends a standard methodology for presenting LCCMs under the CWMF. The CWMF states that Whole Life Costs (WLC) are an important consideration throughout the design process and should be integrated at each stage of the cost planning process. This research investigated a number of international methodologies and standard method of measurements on Life Cycle Costing (LCC) along with a literature review of journal papers, professional publications and research articles. A template was subsequently developed that can be used to aid construction professionals in producing LCCMs. The template puts forward a standard response to the CWMF and was produced in consultation with one of the international methodologies in LCC. A WLCCA case study of a secondary school building in Dublin, Ireland was carried out using the template outlined above. The WLCCA was prepared to provide an example of how LCCA could be carried out and presented in accordance with Ireland's CWMF. The resultant WLCCA outlines a sixty year analysis of the school considering the proportional present value breakdown between investment costs and operational costs. The construction costs represent 42% of the overall present value WLC of the building over a 60 year study period.

Keywords: life cycle, life cycle cost analysis, whole life cycle cost, sustainability

INTRODUCTION

The Society of Chartered Surveyors Ireland (SCSI) is the professional body for construction, land and property professionals in Ireland. The SCSI has a number of working groups researching best practise and procedures within the Institute's professional groups. The SCSI 'Working Group in Life Cycle Costing' has as its aim to provide practical guidance and assistance for quantity surveyors and the Irish government in carrying out WLCCA and producing Life Cycle Cost Models (LCCM). The working group as part of their research put forward a number of definitions of Life Cycle Costing (LCC) and WLCC. The group's research as outlined in this paper examined a number of international methodologies and standard method of measurements on Life Cycle Costing (LCC) along with a literature review of journal papers, professional publications and research articles. In addition, the group outlined how LCC calculations can be carried out and proposed a structure and methodology for presenting LCCMs through a standard template. As part of the project the working group undertook a WLCCA of a secondary school in the greater Dublin area. The objective of the analysis was to provide SCSI members with a worked example of a WLCCA under the proposed structure and methodology and to investigate the overall proportional breakdown between investment and operational costs on a recently built school in Ireland.

The project commenced in mid 2010 and was in the final stages of development in October 2011. The working group started its research by discussing with its members, whether they carried out LCC and if they used any methodology or standard method of measurement in the production of WLCC estimates. Many cost professionals and local governments are unfamiliar with the concept of LCC, how to carry out LCC calculations and how to present this in a meaningful way (Hunter et al. 2005).

The SCSI invited Robert Charette from the Building Engineering Faculty of Concordia, University in Montreal, Canada, in May 2010 to carry out a seminar and workshop for its members on WLCC. Mr Charette guided the participants through the calculation methodology and practical application of LCC exercises (Charette 2010). The attendees gained the knowledge required to carry out isolated option appraisal of building components over a selected study period. After the workshop it was established by the SCSI that

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there was a requirement to cumulatively present these calculations within a standard structure, so that a WLCCA on an entire project could be presented to a perspective client (Kehily 2011).

Carrying out individual LCC calculations of every component of a building is very time consuming, even with the aid of financial tables (Hunter et al. 2005). The working group set out to provide a common approach within a recommended template, so that LCC calculations could be carried out in a manner which automates the mechanical and time consuming calculations. This approach provides the user with an application to quickly and accurately present a WLCC estimate to a client within a standard structure. This requirement in Ireland was heightened by the introduction of the CWMF in May 2010 by the Irish government, which contains an "integrated set of contractual provisions, guidance material, technical templates and procedures, which cover all aspects of the delivery process of a public works project from inception to final project delivery and review" (G N 2.2. 2009). One of the provisions to be provided by quantity surveyors on all future projects is the requirement for WLCC on public works contracts as a standard service.

WHOLE LIFE CYCLE COSTING

The first step in examining WLCC is to clearly define the meaning and scope of LCC and WLCC. The National Institute of Standards and Technology (Fuller et al. 1995) in the United States defines the WLCC of a facility as "an economic evaluation in which all costs arising from owning operating and maintaining a building over a certain study period or building life cycle are considered to be potentially important in option appraisal, design decisions and cash flow forecasting". The Office of Government and Commerce (OGC) (2003) in the United Kingdom defines WLCC "as the costs of acquiring it, the costs of operating it and the costs of maintaining it over its whole life through to its disposal – that is, the total ownership costs". The International Standards Organisation, BS ISO 15686 – Part 5 (2008) describes whole WLCC as a "methodology for the systematic economic consideration of all whole life costs and benefits over a period of analysis, as defined in the agreed scope". In this paper "Life Cycle Cost", Whole Life Cycle Cost", "Whole Life Costs", "Life Cycle Cost Analysis" and "Life Cycle Cost Model" are terms used interchangeably defining the same concept, although not necessarily defining the same action within the concept. This paper, however, predominantly uses the term WLCC as outlined in the definitions above.

A Building Research Establishment (BRE) study of WLCC conducted by Clift and Bourke (1999) found that although the significance of LCC has been recognised on construction projects, as early as the 1980's and substantial amounts of research into the field has taken place, the application has not been implemented into standard practice. A number of papers in the field, including Fischer and Kunz (2004), Chanter and Swallow (1996), Clift and Bourke (1999) and Flanagan and Norman (1984) (as cited in Kaya et al. 2007) has determined that the reason for this includes the lack of historical data and databases on operation and maintenance; the significant absence of standardisation across the construction industry, in terms of scope; and the complexity of calculating the factors involved in LCC. The CWMF is a structure that has been developed to deliver the Irish Government's objectives in relation to public sector construction procurement reform. The CWMF guidance notes on cost management include a requirement to provide LCC on publically procured projects. In response to this requirement the SCSI working group on LCC produced a standardised template that could be used to provide LCC estimates in line with the CWMF.

CAPITAL WORKS MANAGEMENT FRAMEWORK

The CWMF consists of a suite of best practice guidance, standard contracts and generic template documents that form four pillars that support the framework (G N 2.2. 2009). Pillar three and pillar four are applicable to construction cost management. Pillar three consists of cost control, planning forms and suitability assessment forms for construction works and services and pillar four provides guidance notes aimed at facilitating the implementation of the measures and forms in the previous three pillars (G N 2.2. 2009). 'The Planning and Control of Capital Costs, GN 2.2' (2009) in pillar four states that "whole life costs are an important consideration throughout the design process, and should be integrated at each stage in cost plan development". The framework provides cost planning excel templates for cost management throughout the design process and these cost planning templates are included in pillar three to download. However, other than a suggested WLLC summary page included in guidance notes 2.2, there is no template or suggested methodology to present WLCC information.

SCSI: GUIDANCE NOTES ON LIFE CYCLE COSTING

The guidance notes produced, as part of the SCSI's Working Group in LCC provides practical guidance and assistance for the Society's members and quantity surveyors in Ireland, in carrying out LCCA and producing LCCM's in line with the CWMF (Kehily, 2011). The guidance notes are divided into seven sections. Section 1.0 outlines a number of definitions for LCC and WLCC from international methodologies and standard method of measurements in LCC. The section also addresses the Irish governments CWMF and discusses the applicability of WLLC in sustainable construction, risk management and tendering.

Section 2.0 outlines and describes the data required in calculating Present Value (PV) factors, while section 3.0 outlines the different PV formulae used and when they may be used in LCC calculations. A scientific calculator can be used to carry out PV calculations but this method can be quite time consuming as each variable must be inputted to determine the relevant factor (Kaya et al. 2007). The LCC calculation must be repeated for each building component or system to determine the cumulative present value WLCC (Charette 2010). Section 4.0 of the guidance describes how financial tables may be used to quickly calculate the relevant PV factors, outlining an example calculation for each of the PV factors, Single Present Value (SPV), Uniform Present Value (UPV), Single Present Value Modified (SPV*) and Uniform Present Value Modified (UPV*). The excel template provided by the working group includes the PV factors as formulae within the relevant cells. Once the data requirements and cost information are inputted into the template they are automatically calculated.

Section 5.0 of the guidance notes demonstrates how PV factors can be written as formulae into excel cells. Using this information cost professionals can build their own templates and/or manipulate the template recommended by the working group, if they wish to do so. Section 6.0 of the guidance notes provide a fully worked example of an option appraisal of a building system over a given study period. One of the main objectives of the SCSI working group was to research and evaluate a standard methodology that could be recommended to cost professionals carrying out WLLC calculations and presenting WLCCA in accordance with the CWMF. A review of these methodologies is presented in the last section of the guidance notes, Section 7.0 and is also addressed below.

STANDARD METHOD OF MEASUREMENT FOR LIFE CYCLE COSTING

There are a number of methodologies and standard method of measurements on WLCC. In The United States, the National Institute of Standards and Technology (NIST) published handbook 135 (1995), thirteen years before a similar standard methodology from the International Standard Organisation (ISO). 'NIST handbook 135' (1995) outlines in detail the LLC method "defining the criteria used and describing the assumptions and procedures to follow in performing evaluations and gives examples on to how to carry out LCC calculations". The handbook, however, does not give a breakdown structure for preparing LCC. In 2007 Davis Langdon published a report on the contribution of LCC to sustainable construction; the report provides an account of a research and development project to develop a common European methodology for LCC in sustainable construction within the European Union (Davis Langdon 2007). Hunter and Kelly, (2009) published a Royal Institution of Chartered Surveyors (RICS) research paper which also considers LCC as an economic evaluation of sustainable construction. The Office of Government Commerce (OGC) in the UK provides, as part of their suite in 'Achieving Excellence in Construction Procurement Guides', a guide for WLCC and cost management (2003), the guide outlines the principles of WLCC and describes a process made up of a framework for cost management and WLCC. The equivalent document in Ireland was published by the Department of Finance in 2009. 'Planning and Control of Capital Costs GN 2.2' (2009) is one of a number of guidance notes aimed at facilitating the implementation the measures in the CWMF. Although the OGC and the CWMF documents are guides rather than methodologies the CWMF guidance notes do provide a simple summary page for presenting LCC and sets out the different stages that LCC should be carried out on publically procured projects in Ireland. However, in order to carry out a detailed LCC or provide backup to the CWMF summary page a quantity surveyor carrying out LCCA should consult with one of the methodologies outlined above or refer to the International Standard Organisation's, 'BS ISO 15686-5' (2008) or the BSI/BCIS supplement (2008).

BSI/BCIS 'STANDARISED METHOD OF MEASUREMENT FOR LIFE CYCLE COSTING'

International Standards Organisation, 'BS ISO 15686' (2008)' "is a multi part series of international standards giving guidance on various aspects of planning the service life of buildings and constructed assets". Part 5 of the series "provides guidelines, definitions, principles and informative text on the application of LCC techniques in the context of service-life planning". The British Standards Institute (BSI) and the British Cost Information Service (BCIS) in the UK jointly published a document which put forward a standardised method for producing LCC (2008) applicable to the Irish/UK construction industry and to the key stages of the procurement process. The document provides a cost data structure and a method of measurement for LCC which aligns with the ISO 15685-5. The SCSI working group used this methodology and standard format in the production of the recommended WLCC template and WLCC example. Table 1 below represents the cost breakdown structure applicable to both the ISO document and BSI/BCIS supplement documentation. The table indicates that WLCC are broken up into four classification categories, non construction costs, life cycle costs, income and externalities. Life cycle costs are in turn broken up into a number of sub-categories construction, maintenance, operation, occupancy and end of life costs.

Table 1: Classification of Life Cycle Costs, ISO 15868-5

Whole Life Cycle Costs	Non Construction Costs	
	Life Cycle Costs	Construction, Maintenance, Operation, Occupancy, End of Life Costs
	Income	
	Externalities	

LIFE CYCLE COST TEMPLATE

The SCSI working group in LCC produced a template to aid construction professionals producing LCCMs under the CWMF. The template is designed and formatted per the 'classification categories' of the ISO 15868-5 (2008), identified in Table 1 and is also produced in consultation with the BSI/BCIS supplement to the ISO standard (2008). This template provides a suggested layout and includes descriptions and formulae that can be changed and manipulated to suit the building type, client requirements and the stage of the project the LLC analysis is carried out. The template provides a step-by-step process to carrying out a WLCC estimate supported through a series of spreadsheets. The tool is not very complex, providing only the key elements of WLCCA. The spreadsheet, however, can be expanded to include more information, including graphical representation of the data for cash flow forecasts and maintenance and replacement profiles. The key benefits to cost professionals are; the ability to complete a WLLC exercise without having to do any of the PV calculations; the format is standardised per the ISO 15885-5; and the document can be saved to record data that may be used on estimates in the future. In total there are seven sheets in the tool representing the LCC classifications in Table 1, including input screens for project details, parameters, areas and scope.

The first sheet is a blank sheet, which provides for the company preparing the WLCC to include their company details or 'cover page'; the second sheet is a index page outlining the 'table of contents' and subsequent detail to follow; the third sheet includes input cells for relevant project details and 'parameters'; and the fourth sheet outlines the 'basis of the estimate', which includes information on overall areas, exclusions, inclusions and the documents used in the preparation of the LCCA.

The next sheets outlined in Figure 1 and Figure 2 below provides a summary of the information, included in the WLLC estimate. There is no data input required in these sheets, as all the succeeding input sheets are linked and formulated to roll the input forward to populate the summarises within the coded classification categories. The overall summary, shown in Figure 1, provides a breakdown of the high level cost classification categories from ISO 15868-5 as shown in Table 1. Each classification category is represented in 'Life Cycle Cost' (costs without escalation and discount) and also 'Present Value' costs. The summary includes a pie chart at the bottom of the page to graphically represent the LCC breakdown. This chart is not shown in Figure 1, as it is not clear in monochrome print.

WLCC Life Cycle Cost Summary Years 60

		Life Cycle Cost	€/m2	Total Present Value	€/m2	
WLCC	**Whole Life Cycle Cost**					
CC	**Construction Costs**	**0**	**0.00**	**0**	**0.00**	
2.0	Maintenance Costs	17,004	0.00	9,550	0.00	
3.0	Operations Costs	1,800,000	0.00	1,057,691	0.00	*1*
4.0	Occupancy Costs	0	0.00	0	0.00	
5.0	End of Life Costs	0	0.00	0	0.00	
LLC	**Life Cycle Cost (2.0 - 5.0)**	**1,817,004**	**0.00**	**1,067,241**	**0.00**	
TLLC	**Total Life Cycle Cost (Incld Construction)**	**1,817,004**	**0.00**	**1,067,241**	**0.00**	
6.0	Non Construction Costs	0	0.00	0	0.00	
7.0	Income	0	0.00	0	0.00	
8.0	Externalities	0	0.00	0	0.00	
WLC	**Whole Life Cycle Cost (ex VAT)**	**1,817,004**	**0.00**	**1,067,241**	**0.00**	
VAT	Vat	245,296	0.00	144,078	0.00	
WLC VAT	**Whole Life Cycle Cost (Inc. VAT)**	**2,062,300**	**0.00**	**1,211,319**	**0.00**	

		Annual Costs	€/m2	%
NAE	**Net Annual Expediture**			
2.0	Maintenance Costs	283	0.00	1%
3.0	Operations Costs	30,000	0.00	99%
4.0	Occupancy Costs	0	0.00	0%
NAE	**Net Annual Expeniture**	**30,283**	**0.00**	**100%**
7.0	Annual Income	**0**	**0.00**	
WNAE	**Whole Net Annual Expeniture**	**30,283**	**0.00**	

Figure 1: Level 1 – Life Cycle Cost Summary

The next sheet is a more detailed summary, outlined in Figure 2, which provides further breakdown within each of the ISO classification categories.

LLC	Life Cycle Costs Analysis - BCIS					60 Years	
	Ref	BCIS	Annual Amount	Life Cycle Cost	Escalated Life Cycle Cost	Total Present Value	
Construction Costs	1.0	**Construction Costs**					
	1.1	Construction works costs					
	1.2	Other construction related costs					
		Total Construction Costs		**0**	**0**	**0**	
Maintenance, Operations and Occupancy Costs	2.0	**Maintenance Costs**					
	2.1	Major replacement	283	17,004	41,273	9,550	
	2.3	Redecoration - internal / external					
	2.4	Minor replacement, repairs and PPM maintenance costs					
	2.5	Unscheduled repairs, replacement and maintenance					
	2.6	Grounds maintenance					
	2.7	Client definable costs					
		Total Maintenance Costs	**283**	**17,004**	**41,273**	**9,550**	
	3.0	**Operations Costs**					
	3.1	Cleaning costs					
	3.1.1	*Windows and external surfaces*					
	3.1.2	*Internal cleaning*					
	3.1.3	*Specialist cleaning*					
	3.1.4	*External works cleaning*					
	3.2	Utilities costs gas and electric					
	3.2.1	*Fuel Costs*	*30,000*	*1,800,000*	*5,038,351*	*1,057,691*	*1*
	3.2.2	*Water and Drainage*					
	3.3	Administration Costs					
	3.3.1	*Property management*					
	3.3.2	*Staff engaged with servicing the building*					
	3.3.3	*Waste management disposal*					
		Total Operations Costs	**30,000**	**1,800,000**	**5,038,351**	**1,057,691**	
	4.0	**Occupancy Costs**					
	4.3	Security					
	4.5	Switchboard / telephones					
	4.6	Postroom - mail services					
	4.7	ICT and IT services					
	4.12	Occupiers furniture, fittings and equipment					
	4.14	Stationary and reprographics					
		Total Occupancy Costs	**0**	**0**	**0**	**0**	

Figure 2: Level 2 Life Cycle Cost Summary

The subsequent sheets provide for data input per the ISO 15868-5 classification categories in construction costs, maintenance costs, replacement costs, operations costs, occupancy costs, end of life costs, income costs and costs related to externalities. The sheet for 'operations and maintenance costs' is outlined in Figure 3. This sheet provides a formatted spreadsheet, which includes the coded cost holding categories and sub-categories and also the PV to automatically calculate the inputted costs. The template provides an example of electricity (ESB costs) which can be traced from the input sheet in Figure 3, to the level 2 summary in Figure 2 and ultimately to the summary page shown in Figure 1.

O&M Operations and Maintenance									Years		60	
Ref	BCIS	Description	Qty	Unit	Rate	Annual Cost	Life Cycle Cost	(e)	Escalated Life Cycle Cost	(i)	Present Value	
2.0		**Maintenance Costs**										
2.1		Major replacement										
2.1		*AP3 - Replacement Costs*				283	17,004		41,273		9,550	
2.2		Subsequent refurbishment and adaptation costs										
2.2		*State client requirements, standards required, working restrictions and procurement context*										
2.3		Redecoration - internal / external										
2.3		*State client requirements, standards required, working restrictions and procurement context*										
2.4		Minor replacement, repairs and PPM maintenance costs										
2.4		*State client requirements, standards required, working restrictions and procurement context*										
2.5		Unscheduled repairs, replacement and maintenance										
2.5		*State client requirements, standards required, working restrictions and procurement context*										
2.6		Grounds maintenance										
2.6		*State client requirements, standards required, working restrictions and procurement context*										
2.7		Client definable costs										
		Total Maintenance Costs				283	17,004		41,273		9,550	
3.0		**Operations Costs**										
3.1		Cleaning costs										
3.1	3.1.1	Windows and external surfaces										
3.1	3.1.1	*State client requirements, standards required, working restrictions and procurement context*										
3.1	3.1.2	Internal cleaning										
3.1	3.1.2	*State client requirements, standards required, working restrictions and procurement context*										
3.1	3.1.3	Specialist cleaning										
3.1	3.1.3	*State client requirements, standards required, working restrictions and procurement context*										
3.1	3.1.4	External works cleaning										
3.1	3.1.4	*State client requirements, standards required, working restrictions and procurement context*										
3.2		Utilities costs gas and electric										
3.2	3.2.1	Fuel Costs										
3.2	3.2.1	*ESB*	1	LS	30,000.00	30,000	1,800,000	3.00%	5,038,351	5.00%	1,057,691	*1*
3.2	3.2.2	Water and Drainage										
3.2	3.2.2	*State client requirements, standards required, working restrictions and procurement context*										

Figure 3: Operations and Maintenance

LIFE CYCLE COST EXAMPLE

The SCSI working group carried out an example WLCCA for Colasite Bhride, Secondary School in Clondalkin, Dublin. The WLCCA was prepared in excel using the recommended template and carried out with cost information provided by Kerrigan Sheanon Newman (KSN) Quantity Surveyors. The WLCCA was prepared by the working group to provide an example of how a WLCCA could be carried out and presented on a school building using the template. Figure 4 represents a screen-shot of the WLCCA summary page. The total PV WLCC of the school building over a sixty year study is €34,332,870. This figure is broken down into eight coded classification categories from the ISO 15868-5. The WLCC summary in figure 4 outlines the proportional breakdowns of the WLCC estimate. Given that non-construction costs, including wages and salaries, income and externalities are not included in the estimate, the construction costs account for 42% of the 'Total Present Value' costs. Maintenance accounts for 32%, operations costs 15% and occupancy costs 11%. Once the model is complete it can be used to run sensitivity analysis on the effects of different escalation and inflation rates, additional costs and alternative replacement profiles. A significant change in proportional breakdown of the WLLC was observed when the escalation rate for electricity and fuel costs was changed from 5% to 10% pa. The total present value WLCC increased from €34 million to €45 million with occupancy costs significantly increasing from 15% to 43% of the total WLLC. The affects of this change also had a bearing on the overall proportional breakdown of construction costs which decreased from 42% to 29% of the present value WLLC.

WLCC Life Cycle Cost Summary Years 60 KSN

		Life Cycle Cost	€/m2	Total Present Value	€/m2
WLCC	Whole Life Cycle Cost				
CC	Construction Costs	12,774,063	1716.94	12,774,063	1716.94
2.0	Maintenance Costs	17,412,454	2340.38	9,636,031	1295.17
3.0	Operations Costs	5,640,000	758.06	4,625,512	621.71
4.0	Occupancy Costs	5,469,000	735.08	3,213,619	431.94
5.0	End of Life Costs	0	0.00	0	0.00
LLC	Life Cycle Cost (2.0 - 5.0)	28,521,454	3833.53	17,475,162	2348.81
TLLC	Total Life Cycle Cost (Incld Construction)	41,295,517	5550.47	30,249,225	4065.76
6.0	Non Construction Costs	0	0.00	0	0.00
7.0	Income	0	0.00	0	0.00
8.0	Externalities	0	0.00	0	0.00
WLC	Whole Life Cycle Cost (ex VAT)	41,295,517	5550.47	30,249,225	4065.76
VAT	Vat	5,574,895	749.31	4,083,645	548.88
WLC VAT	Whole Life Cycle Cost (Inc. VAT)	46,870,412	6299.79	34,332,870	4614.63

		Annual Costs	€/m2	%
NAE	Net Annual Expediture			
2.0	Maintenance Costs	290,208	39.01	61%
3.0	Operations Costs	94,000	12.63	20%
4.0	Occupancy Costs	91,150	12.25	19%
NAE	Net Annual Expeniture	475,358	63.89	100%
7.0	Annual Income			
WNAE	Whole Net Annual Expeniture	475,358	63.89	

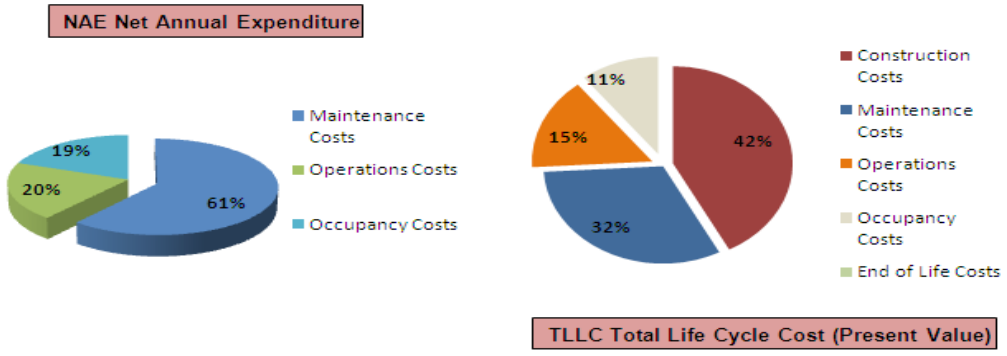

Figure 4: Whole Life Cycle Cost Summary

Table 2 provides an example of the input involved in the input sheets (operations and maintenance sheet). The PV factor calculations are carried out outside the print area; the factors are calculated from formulae, which extract the escalation (e), discount rate (i) and study period (n) from the relevant cells to include them in the calculation. If any of the variables are changed the result would proliferate through the estimate. The 'utilities gas and electric costs' are one of the costs associated with the ISO15868-5 classification category, 'operations costs'. Changing variables in this sheet, through the inherent linkages will have an effect on the total present value WLLC, as can be seen from the change in escalation rates above. Table 2 provides an example of a UPV* formulae used in the sheet which is typical to the other sheets used in the template. The UPV factor (column f2/row 3.2.2) which is calculated outside the print area is calculated with the relevant escalation rate (e), discount rate (i) and study period (n) through a number of calculations in the cells of row 3.2.2, columns f, f1 and f2. The formulae in f accounts for the top half of the UPV formulae, f1 accounts for the bottom half and f2 is a result of dividing f1 into f to achieve the UPV factor in f2. The resultant UPV* factor in f2 is multiplied by the annual amount to determine the PV cost (35.2564 x 6000 = 211,538). The text boxes above the screen shot show the formulae in the cells outside the print area. The formulae are included to show how the UPV* factor is broken up into three calculations.

Table 2: Example of PV Calculation

=(((1+K36)/(1+I36))-1)

=(1-((1+I36)/(1+K36))^R36)

=IF(O36=0,R36,O36/P36)

BCIS	Description	Qty	Unit	Rate	Annual Cost	Life Cycle Cost	(e)	Escalated Life Cycle Cost	(i)	Present Value	f	f1	f2	(n)	Annual Amount
Utilities costs gas and electric															
3.2.1	Fuel Costs														
3.2.1	Heating	1	LS	23,000.00	23,000	1,380,000	5.00%	8,539,047	5.00%	1,380,000	0.0000	0.0000	60.0000	60.00	23000
3.2.1	ESB	1	LS	30,000.00	30,000	1,800,000	5.00%	11,137,887	5.00%	1,800,000	0.0000	0.0000	60.0000	60.00	30000
3.2.2	Water and Drainage														
3.2.2	Water	1	LS	6,000.00	6,000	360,000	3.00%	1,007,670	5.00%	211,538	0.6846	0.0194	35.2564	60.00	6000

CONCLUSIONS

The SCSI 'Working Group in LCCA has developed a template that can be used to aid construction professionals in producing LCCMs. The template puts forward a standard response to the CWMF and is produced in consultation with the International Standard Organisation 15686-5. The template which is available in a spreadsheet includes the relevant factors and formulae required to carry out PV calculations automatically. The template will be available to quantity surveyors in Ireland to aid them in carrying out WLLCA and should be analysed and used in conjunction with the SCSI guidance notes on LCC. A WLCCA case study of a secondary school in Dublin, Ireland was carried out using the template outlined above. The WLCCA was prepared to provide an example of how WLCCA could be carried out and presented in accordance with Ireland's CWMF. The resultant WLCCA outlines a sixty year analysis of the school considering the proportional present value breakdown between investment costs and operational costs. The construction costs represent 42% of the overall present value WLC of the building over a 60 year study period.

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