Optimising Lifecycle Cost Forecasting and Ensuring Regulatory Compliance

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Abstract:

Future-proofing healthcare facilities requires robust methodologies to accurately forecast asset lifecycle and maintenance costs while ensuring compliance with statutory obligations. This research presents innovative approaches derived from a comprehensive benchmarking study aimed at predicting asset lifecycle and maintenance costs in healthcare facilities.

Central to the research is the development of an Asset Lifecycle and Maintenance Cost Model, which employs a detailed bottom-up approach, utilising the healthcare facility's asset register to forecast costs for preventive and corrective maintenance, lifecycle replacements and refurbishments, as well as the remediation of known issues and non-compliance across the facility.

The processes outlined in this paper also ensure compliance with statutory obligations for maintenance delivery. This is achieved by establishing a line of sight from statutes to regulations, asset classes, and maintenance job plans. The approach provides asset managers with the visibility needed to understand maintenance requirements for each asset type, thereby ensuring compliance across the entire asset portfolio.

Keywords:

Lifecycle Cost Forecasting, Statutory Compliance, Preventive & Corrective Maintenance, Healthcare Infrastructure, Asset Management Planning

1 Introduction

Healthcare facilities require regular and effective maintenance of their physical assets to ensure a safe and secure environment for patients, staff, and visitors. Asset maintenance is a crucial aspect of the facility's asset management process, involving both planned and unplanned maintenance activities. The main requirement of the maintenance strategies is both assuring equipment reliability and compliance with statutory obligations. The process presented in this paper ensures statutory compliance by providing a line of sight from statute to regulation to asset class and then to maintenance job plans.

The lifecycle costs include asset replacement and refurbishment. The primary objective of this study is to establish a cost model to support healthcare facilities in planning, budgeting, and forecasting. The study aims to forecast both capital and recurrent costs to enable lifecycle planning. The findings will serve as a tool for healthcare facilities in their forward planning, including forecasting maintenance and capital expenditures within their Asset Management Plans. The model presented here uses a bottom-up approach to calculate these costs for healthcare facilities. This paper outlines the process for cost modelling and presents the initial findings from the cost modelling for a healthcare facility.

2 Methodology

Figure 1 illustrates the elements of the cost modelling for a healthcare facility. This section presents the steps involved in developing the cost model, which covers a modelling period of 25 years. The cost model uses a bottom-up approach based on the asset register from the healthcare facility's asset management information system to calculate both maintenance and life cycle costs.

The modelling covers maintainable building and facility assets. The accuracy of the results produced by this model depends on the accuracy of the hospital's asset register. If the facility's asset register is inaccurate, an asset data validation exercise may be required prior to cost modelling.

The final component of the cost model involves estimating the cost of proposed works to remediate identified chronic issues. These issues are identified through workshops with the healthcare facility asset management team, site visits to identify non-compliance or issues, and reliability analysis of work order history records from the hospital's asset management system.
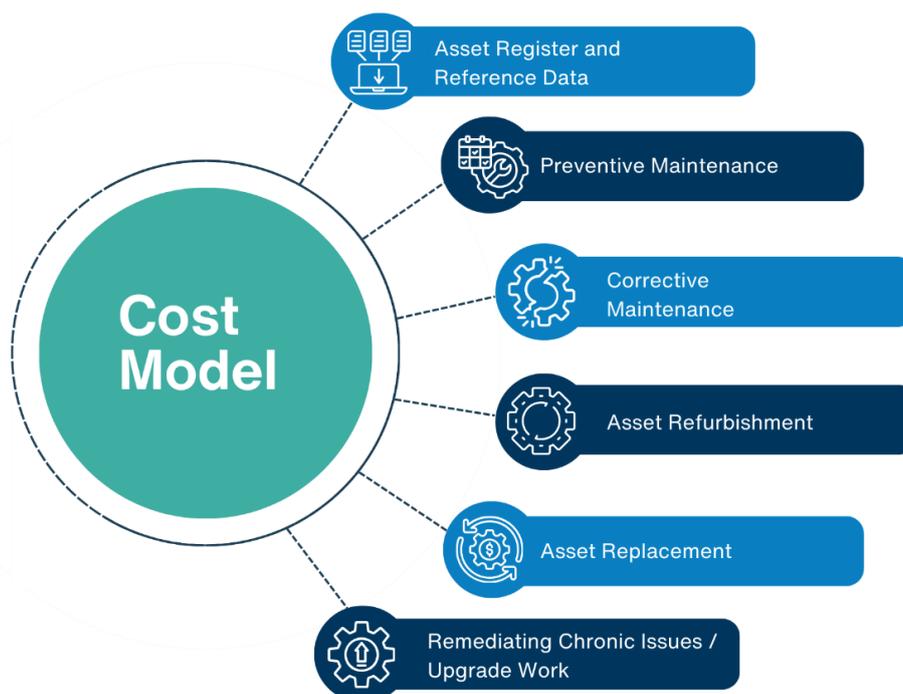

Figure 1 Cost Model Elements

2.1 Asset Register and Asset Classification Reference Date

The first step in the cost modelling of a healthcare facility is to identify the list of assets which is used for the bottom-up modelling approach. The required asset data are:

1. Asset Details: asset id, asset name, asset classification as a minimum plus additional asset details if available (e.g., manufacturer name, model number …);
2. Asset Lifecycle Details: in service date, purchase cost / replacement value; and
3. Asset Condition Assessment (if available): observation date, Condition Rating, Current Usage, Operating Environment, Criticality. If asset conditions were not available, asset condition was assigned based on the age of the facility.

An asset reference data library is required for building and facility assets to enable the modelling of maintenance costs for healthcare facilities. The reference data have been developed for all asset classifications used in the hospital's asset register. This information drives the calculation of maintenance costs and includes the following:

1. Identifying the maintenance strategy for assets with applicable asset classifications. All assets will be identified as requiring planned maintenance or unplanned maintenance.
2. Price Book: This important reference data provides the current replacement value for assets. If the healthcare facility asset register has accurate purchase cost/replacement value, these values will be used in the calculation of refurbishment and replacement costs. If cost data is not available, the average price from the price book for the applicable asset classification will be used.
3. Life Expectancy (years): Provides the expected life by asset classification. Assets will be replaced when they reach the end of their expected life (see Table 1).
4. Planned Refurbishment (years): The expected frequency of the refurbishment by asset classification (see Table 1).
5. Planned Refurbishment (%): The percentage of the asset cost required for the planned refurbishment (see Table 1).

Asset Classification Name	PM Strategy Name	Life Exp. (yrs)	Refurb. Freq. (yrs)	Refurb. Cost as % of Repl. Cost	Library Minimum Cost	Library Maximum Cost	Library Average Cost
Chilled Water Pumps	Centrifugal Pump	15	5	25%	$1,900	$19,200	$8,041
Chillers	Screw Chiller	15	10	30%	$65,000	$288,000	$97,600
Cooling Towers	Cooling Tower	20	10	30%	$35,495	$180,000	$119,297
Distribution Boards	Distribution Board	20	10	20%	$2,400	$250,000	$16,434
Goods Lifts	Lift	25	10	20%	$200,000	$356,600	$242,960
Fire Doors	Fire Doors	20	5	5%	$300	$2,500	$877
Fire Hose Reels	Fire Hose Reel	10	5	20%	$250	$5,000	$459

Table 1 Sample Asset Reference Data Library

2.2 Compliance with Statutory Maintenance Requirements

Before estimating the cost of preventive maintenance delivery, it is necessary to ensure that the maintenance strategies for all maintainable assets comply with statutory obligations. The process presented here ensures the statutory compliance by providing the line of sight from statute to regulation to asset class and to maintenance job plans. It provides the asset manager the visibility of the requirements of maintenance for each asset type and ensures the compliance on the maintenance requirement of the asset portfolio. The process follows the following steps:

1. Ensure we have a current asset register with the required attributes including asset types.
2. Identify the applicable Acts, Regulations or Codes of Practice for the asset types which exist in the facility.
3. Identify the applicable Australian Standards, technical standards, such as industry or sector regulations, with regards to the maintenance of the asset types have been identified.
4. Establish a clear tracking of work to statutory obligations for each asset type by
   a. Listing of known statutes
   b. Alignment with asset classes based on their need to be compliant with the regulations referred
   c. Alignment with maintenance job plans
5. Establish a clear tracking of statutory maintenance obligations for individual assets.

Figure 2 details the process for identifying statutory maintenance requirements and developing the statutory maintenance procedures for each equipment type. Figure 3 shows an example for the development of statutory maintenance procedures for fire hose reels.
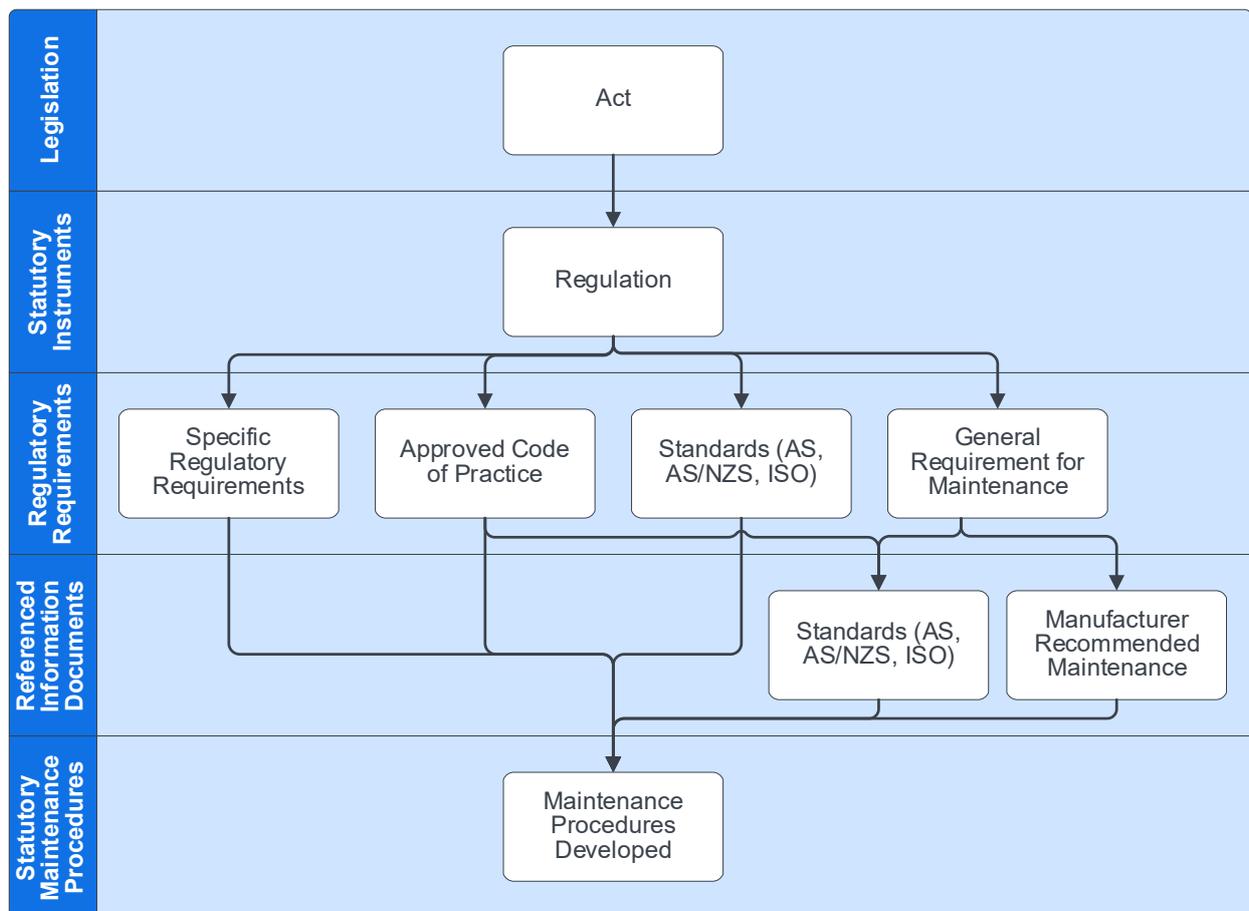

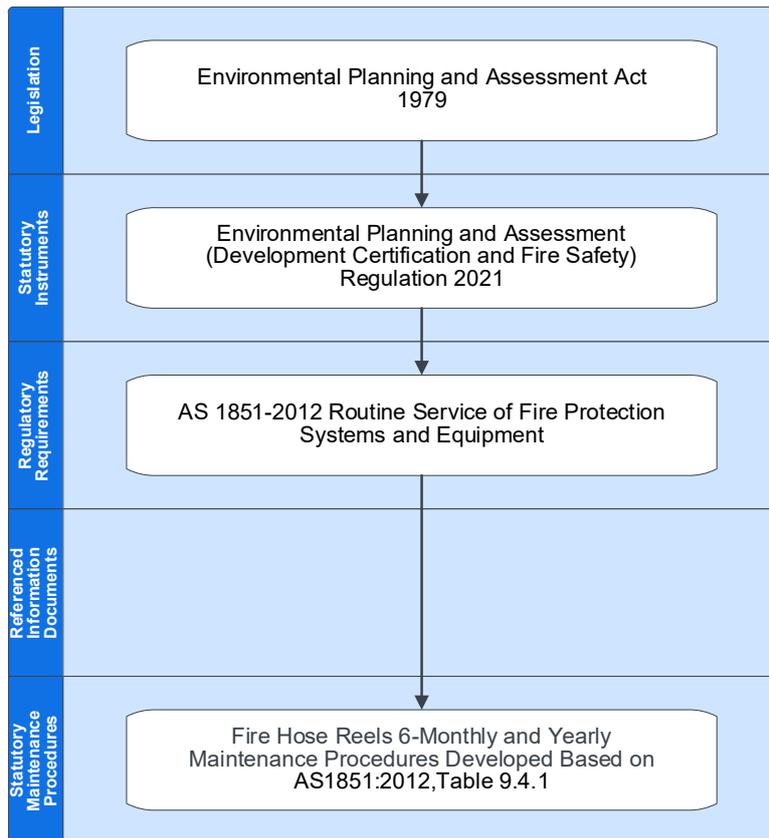*Figure 2 Statutory Maintenance Procedure Development Process*

Figure 3 Statutory Maintenance Procedure Development for Fire Hose Reels

2.3 Estimated Cost of Preventive Maintenance

The first cost component in the model is developing the bottom-up budget for preventive maintenance. This includes calculating the preventive maintenance cost for all maintainable assets using the following steps:

1. Allocate Maintenance Type to each asset: At the end of this stage, each asset will have a type of maintenance allocated (planned or unplanned) based on the asset reference data library.
2. Develop Asset Maintenance Plan: This stage involves developing an Asset Maintenance Plan for all assets identified with a planned maintenance type, based on the developed Planned Maintenance Service Plans. The maintenance service plans are aligned with the statutory maintenance requirements for the applicable asset classification. At the end of this stage, the Asset Maintenance Plan developed will contain a detailed maintenance schedule and resource requirements.
3. Indicative Costs for PM Delivery: Develop an annual PM maintenance cost forecast for all assets in the site-specific asset register. This includes calculating the annual cost of PM delivery based on the estimated duration and hourly rate of the required resource. PM delivery costs include trade resource hours, work quality checks, administrative support, supervisor/building manager, and spares cost.

2.4 Expected Cost of Corrective Maintenance

The second cost component in the model is developing the budget for corrective maintenance, which is estimated based on the asset condition across the site using the following steps:

1. Rate of CM/PM: Corrective maintenance annual labour hours are estimated as a percentage of calculated PM labour hours based on the asset condition.

a. The ratio for CM labour hours as a percentage of PM labour hours is estimated at 30.3% for new assets/facilities. This ratio was identified from actual data provided by a maintenance services provider over a three year period for a hospital less than 10 years old.

b. The ratio for CM labour hours as a percentage of PM labour hours is estimated at 40% for assets/facilities with average asset condition.

c. The ratio for CM labour hours as a percentage of PM labour hours is estimated at 60% for assets/facilities with poor asset condition.

d. The CM/PM labour hourly rate is 125% (on average, the hourly rate for corrective work is 25% higher than the preventive work hourly rate).

2. Indicative CM Material Costs: The estimated cost of materials for CM work is estimated at 20% of the CM labour hour costs.

3. Indicative costs for delivery: Develop an annual corrective maintenance cost forecast for all assets in the site-specific asset register. CM delivery costs include trade resource hours, work quality checks, administrative support, supervisor/building manager, and spares cost.

2.5 Life Cycle Replacement

The third cost component in the model is the Life Cycle Replacement cost which is calculated for all assets included in the site-specific asset register based on the following steps:

1. Life Expectancy (years): Expected life of each asset is identified based on the asset classification. The expected life for the applicable asset classification is identified in the asset reference data library.

2. Installed date and Replacement Value: Identify the installed date and asset replacement value from the asset register. If the data is not available, identify the installed date by consulting healthcare facility asset managers or the age of the facility. The replacement value can be estimated based on the asset classification and the replacement value for the applicable asset classification as identified in the asset reference data library. If the healthcare facility asset register has accurate purchase cost/replacement value, these values will be used in the calculation of refurbishment and replacement costs.

3. Annual Replacement Cost: Develop an annual life cycle replacement cost forecast for the life of the assets for the site-specific asset register. For the 25-year Cost Modelling, assets may be replaced multiple times based on their expected life.

2.6 Life Cycle Refurbishment

The last cost component in the model is the Life Cycle Refurbishment cost which is calculated for all assets included in the site-specific asset register based on the following steps:

1. Refurbishment Frequency (years): The refurbishment frequency of each asset is identified based on the asset classification as identified in the asset reference data library.

2. Installed date / Refurbishment Value: The installed date is identified from the asset register, if available. If the data is not available, the installed date is identified in consultation with healthcare facility asset managers or the age of the facility. The refurbishment value for each asset is a percentage of the replacement value of the asset based on the applicable asset classification as identified in the asset reference data library.

3. Annual Refurbishment Cost: Develop an annual lifecycle refurbishment cost forecast for the site-specific asset register. For the 25-year Cost Modelling, assets may be refurbished multiple times based on their refurbishment frequency.

2.7 Remediating Chronic Issues / Upgrade Work

This cost component covers the development of recommended solutions to address reliability issues and non-compliance across the healthcare facility. The issues and corresponding initiatives are developed in consultation with the healthcare facility asset management team and should be aligned with the health service requirements. Figure 4 shows the methodology for developing this cost element.

As part of this component, known issues are itemised, and a top-level cost estimate is developed to support budgeting for the specified issues. In addition to the estimated cost to remediate each issue, a priority level and recommended start date are assigned in consultation with the healthcare facility asset management team. An example of this type of work is the remediation of mould in sections of the hospital's HVAC ductwork.
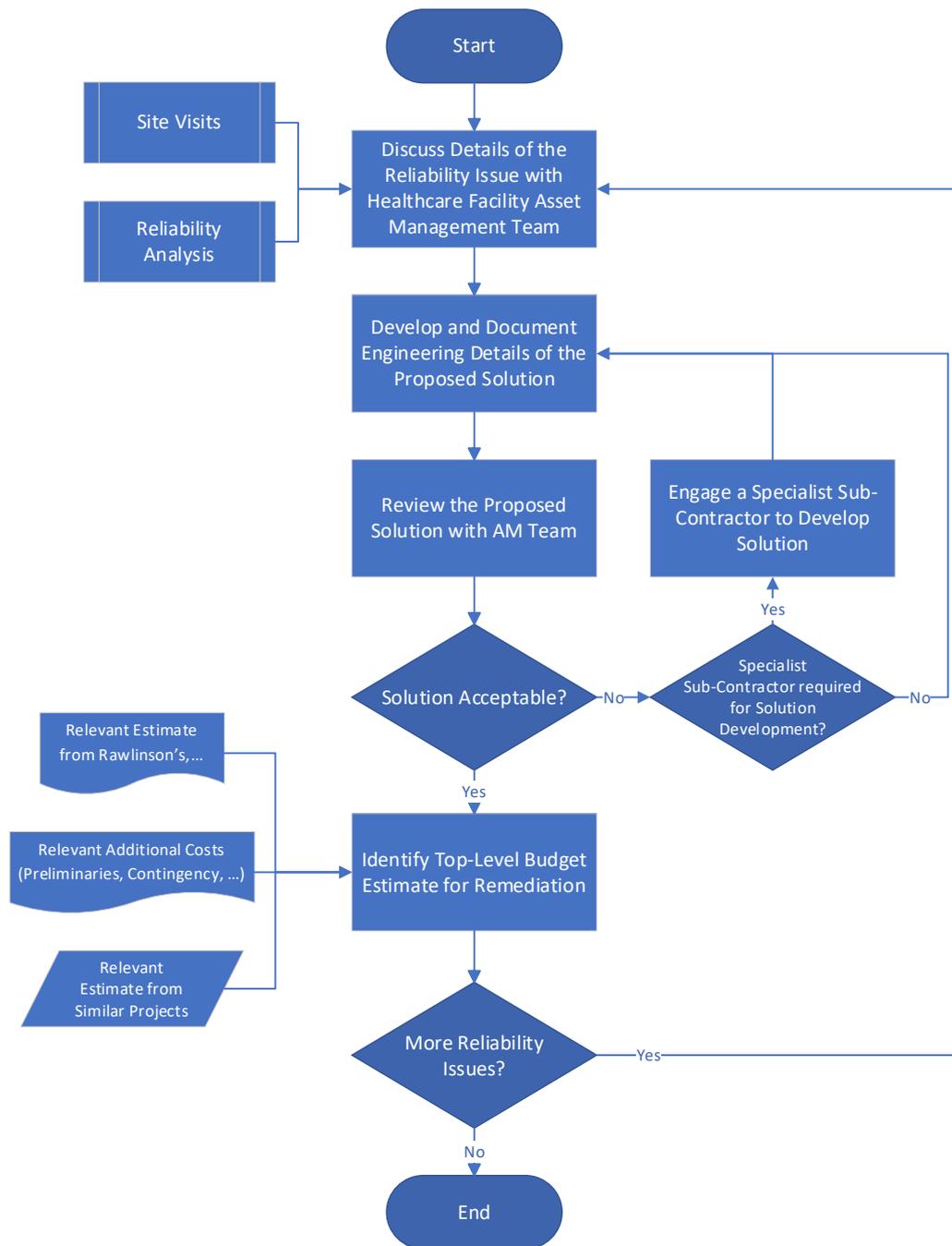

Figure 4 Methodology for Developing Costed Solutions for Chronic Issues

3 Findings

3.1 Cost Modelling Limitations

It is important to note that the cost model may underestimate the full amount required for maintenance and capital costs of the hospitals for the following reasons:

1. The modelling only covers maintainable building and facility assets recorded in the asset management information system. If assets are not recorded in the asset management information system, the modelling underestimates the required costs across all maintenance categories.
2. The modelling excludes fixtures, fittings, furniture, and equipment.
3. ITC & digital assets were excluded from the modelling.
4. Fleet, food services, and laundry services assets were also excluded from the modelling.
5. Biomedical assets were not included in the modelling.

The cost models exclude the following cost components:

- Replacement of buildings at the end of their useful life.
- Grounds maintenance.
- Soft services.

Year	Preventative Maintenance	Corrective Maintenance	Asset Refurbishment	Asset Replacement	Remediating Work	Grand Total
2025	$1,717,545	$965,681	$770,747	$714,173	$2,065,208	$6,233,355
2026	$1,736,120	$976,125	$145,904	$863,425	$3,192,173	$6,913,747
2027	$1,717,545	$965,681	$713,834	$1,212,457	$3,914,064	$8,523,582
2028	$1,782,557	$1,002,234	$522,617	$769,298	$3,999,419	$8,076,126
2029	$1,736,120	$976,125	$317,568	$5,510,589	$16,752,628	$25,293,030
2030	$1,717,545	$965,681	$626,816	$577,057		$3,887,099
2031	$1,717,545	$965,681	$522,050	$4,207,312		$7,412,588
2032	$1,736,120	$976,125	$149,663	$5,609,002		$8,470,910
2033	$1,782,557	$1,002,234	$1,443,401	$2,180,851		$6,409,043
2034	$1,717,545	$965,681	$563,448	$685,219		$3,931,894
2035	$1,736,120	$976,125	$9,290	$8,169,335		$10,890,870
2036	$1,717,545	$965,681	$38,794	$689,521		$3,411,541
2037	$1,717,545	$965,681	$426,592	$606,548		$3,716,366
2038	$1,801,132	$1,012,677	$374,008	$12,673,676		$15,861,494
2039	$1,717,545	$965,681	$451,705	$8,540,615		$11,675,546

Year	Preventative Maintenance	Corrective Maintenance	Asset Refurbishment	Asset Replacement	Remediating Work	Grand Total
2040	$1,717,545	$965,681	$327,471	$417,664		$3,428,362
2041	$1,736,120	$976,125	$101,891	$8,662,116		$11,476,251
2042	$1,717,545	$965,681	$156,171	$630,048		$3,469,446
2043	$1,782,557	$1,002,234	$1,677,111	$5,023,845		$9,485,747
2044	$1,736,120	$976,125	$444,003	$1,595,194		$4,751,442
2045	$1,717,545	$965,681	$445,381	$996,591		$4,125,199
2046	$1,717,545	$965,681	$176,911	$100,261		$2,960,398
2047	$1,736,120	$976,125	$200,417	$9,104,996		$12,017,658
2048	$1,782,557	$1,002,234	$768,180	$1,365,467		$4,918,439
2049	$1,717,545	$965,681	$883,752	$3,135,188		$6,702,166
Grand Total	$43,412,287	$24,408,346	$12,257,724	$84,040,447	$29,923,492	$194,042,296
Annual Average	**$1,736,491**	**$976,334**	**$490,309**	**$3,361,618**		**$7,761,692**

Figure 5 Cost modelling results for a sample hospital

4 Conclusions

In conclusion, the Asset Maintenance and Lifecycle Cost Model represents an advancement in forecasting asset lifecycle and maintenance costs for healthcare facilities. The study employed a bottom-up approach to develop the cost model, which was applied to selected healthcare facilities. The model calculates preventive and corrective maintenance costs, as well as lifecycle replacement and refurbishment costs over a 25-year period. This paper presented initial findings from the cost model for a sample hospital. The cost model has the potential to assist healthcare facility managers in their forward planning by providing accurate expenditure forecasts within their Asset Management Plans.

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