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Economic Time Impacts on HTMA

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Abstract**: *There are many stages in the medical device management lifecycle to consider, and from the planning stage to commissioning, dismantling and decommissioning, replacing equipment is a critical decision. This phase encompasses several key pieces of information that inform intelligent replacement decisions. Technical, monetary and safety principles are taken into account when replacing medical equipment. One of the most frequently cited criteria is service life. In recent times, delivering a sustainable competitive advantage through the optimisation of non-essential activities has become increasingly relevant. A non-essential example is the Lifespan management of capital goods, which are required to support the processes involved in healthcare operations, ranging from acquiring assets to maximising operation, sustaining performance, and concluding the right time to dispose of them properly. The objective is to determine whether Total Cost Ownership (TCO) can provide recommendations for decision-making, even though it is capable of helping us identify the optimal economic life of the medical device. Overall, 40% of our specimens indicated that monitoring the total cost of ownership (TCO) is essential for continuously mapping the cost of these devices in service.***

Keywords**: *Economic Life Cycle, Replacing, Depreciation value, Economic Life time.***

I. INTRODUCTION

Health technology has undergone significant developments, which have had a substantial impact on the costs of technological investment and sustainability. Keeping up with new technology continues to play the most crucial role in increasing investment [1] [2]. Therefore, there is a need to track and manage the costs of new technology. For this purpose, competency certificates have been produced by the organisation, and biomedical services have become one of the leading indicators of these certificates.

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In a challenging environment where faster hospital services are expected and budgets are under pressure, healthcare systems are becoming increasingly complex. However, the financial management and worth planning of medical devices would be the sole responsibility of the Healthcare Technology Management Administration (HTMA) in future health management policies. Therefore, HTMA has a primary mission that depends on tracking and controlling operational costs. [3] It is critical to pursue cost effective and sustainable health policies, considering the essentials, significances, resources and capabilities of health service development. [4] Financial resources have a decisive impact on the performance of the health system. [5] Medical Technology allows for the attainment of the highest quality care, and it remains a vital solution to the improvement of productivity and control of costs. HTMA employs experienced and professional staff to ensure that facilities are appropriately designed, taking into account the latest medical technology and equipment. HTM is committed to delivering effective and sustainable service plans promptly, translating needs and vision into actionable work and results. This is achieved by utilising advanced methods and tools to provide solutions and results in a significantly reduced timeframe. Throughout the process, ample time is dedicated to listening to stakeholders while keeping them informed, and service planning solutions are delivered for each element of the project. Regardless of the activities being carried out, HTM professionals have a significant impact on the entire healthcare system. HTM is noticeable to assume responsibility through its management of medical equipment, prediction needs, display, competitive definitions, market analysis, service area analysis, clinical planning for supply, detailed features and resource features, business condition development, feasibility studies, economic impact analysis, as we need to evaluate the following activities: The employee and regulatory definition files, organizational policies and procedures, care models and patient flow modes, and innovative procurement plans that leverage lessons learned from three integrated efforts:

- Project and Procurement:
- Maintenance
- Integration & Development:

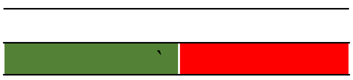
The impact of medical device management can be compared to an asset. Assets are tools with monetary value. Anything owned or controlled by an individual, company, or country with the expectation that it will bring some forthcoming profit. Assets, therefore, represent the economic properties of the hospital. Towards improving the quality of medical services and making accurate cost projections, managers and decision-makers in the hospital rely on economic value information [6].

Additionally, the well-organised distribution of resources and the capacity to enhance the hospital's performance rely on the hospital's cost. The hospital is also responsible for providing the community with high-quality information at a suitable level for the target user. In addition, it may be valuable to implement a prepayment technique as a way to achieve better coverage while attempting to build up proprietary financing systems [7].

The healthcare system heavily relies on hospitals, as they are responsible for providing and delivering health services, as well as training health professionals. The utilisation of funds for professional staff and medical devices also relies on hospitals, as they are the largest source of financing. In Health Economic Evaluation (HEE), numerous practical and beneficial health interventions can be employed to enhance the health of a population. If we had money to spend, we could utilise it for every beneficial health program. If money is spent on intervention, and there is none left for others, this is referred to as opportunity cost. As a result, there is a need to utilise the remaining funds to make a beneficial decision. In making the best decision, the HEE is effective. For such a decision, the purchasing price is just the tip of the iceberg, as there are many other significant costs to be considered, especially those related to capital equipment procurement.

TCO = Purchasing price + costs incurred over the useful life = Pre-Acquisition cost + purchase cost + running Costs + Maintenance Costs + Down Time Costs + End of Life cycle cost. There is the Remaining Useful Life (RUL) concept, which involves the deterioration profile for a machine over time. Depending on the machine, time can be represented in terms of days, miles, cycles, or any other unit of measurement. When determining the model to be used, attention is paid to the available information. RUL Estimator Models:

- Similarity Model



Health State Failure

If we have information about the run-to-failure history of a similar Machine

Threshold

- Survival Model

Health State Failure

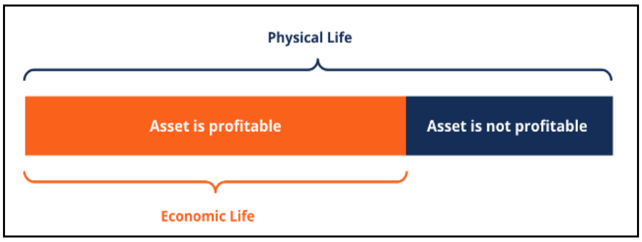
If we have information on the failure date from similar

- Degradation Model

Health State Failure

We have information about the threshold of the same indicator that indicates failure. The business climate in the highly competitive and regulated healthcare industry requires creative ways for healthcare facilities to achieve lower costs while ensuring high-quality patient care is still provided.

Economic life, which refers to the expected useful life for the owner of an asset, is also recognised as the valuable life or depreciation period. A measure of an asset's efficacy is how much profit it will make to hold it, i.e., the period during which the asset will generate more income than it expends.



When calculating useful economic life, it is generally assumed that asset operations are determined based on normal usage levels that allow for preventative maintenance. In particular, the economic life of an asset is not always equal to its physical life, as an asset can continue to function correctly when it is no longer considered economically sound. Because the economic life is an estimate, the physical life of an asset may exceed its economic life and vice versa. This is true even when innovations make old technology obsolete. To estimate this number, owners should consider the net present value (NPV) of the asset, the internal rate of return (IRR), and the return on investment (ROI). Several factors contribute to the shortening or ending of an asset's economic life. For example, equipment wear, deterioration, or damage is a factor that reduces the economic life of equipment and increases maintenance and repair costs. Asset obsolescence occurs when innovations and technologies render existing ones obsolete. The economic life of an asset can also come to an end as increased maintenance costs reduce its economic viability, rendering the asset less efficient compared to current alternatives.

The ability to effectively manage assets remains the key to economic life, and an essential consideration about the decision-making process of a healthcare organisation to purchase new assets or replace current assets [8].

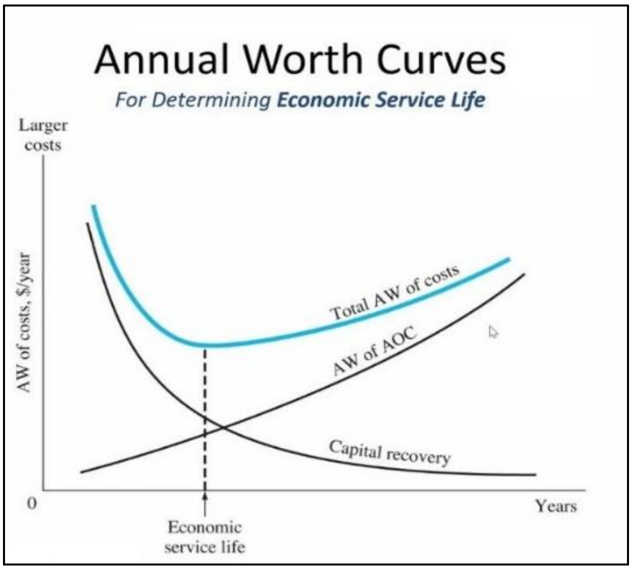


Fig. 1. Chart Showing Annual Worth Curves for Determining Economic Life

The costs associated with the life of the machine are shown in Figure 1. This indicates that the return

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on investment (in terms of the average initial cost) continues to decrease over the equipment's life.

Additionally, maintenance costs increase with the equipment's lifespan. From the beginning, the total cost decreases up to a certain number of lives, after which it begins to rise. Equipment life is the point at which the total price is minimised. It can be realised that the longer the replacement is deferred, the lower the average cost per period. However, there is a period when the average cost per period is likely to increase, and a replacement at this point is justifiable. Over time, the efficiency of a machine decreases, and there is a need to determine when it is best to replace it, i.e., to acquire a new one. If the interest rate is above 0%, use the interest formula to determine the useful life. Exchanges can be valued using a present value basis and an annual equivalence basis.

A machine's maintenance cost is given as an increasing function of time, and its scrap weight is constant.

Since then, maintenance costs experienced during 'n' years have increased, =

$$\int_0^n R_t \, dt \qquad (1)$$

T(n) = Total Cost experienced over „n" years

The total cost incurred on the element will become:

$$T(n) = C - S + \int_0^n R_t \, dt \qquad (2)$$

Where,

C = Property cost of the item,

R_t = Running and Maintenance cost of the element at time „t",

S = Scrap value,

n = number of years the element to be used,

The term 'purchase price' appears to be ambiguous in the procurement process, as medical devices with a long lifespan are often in high demand. This position is supported by numerous studies based on the total cost of ownership (TCO) approach [9].

For healthcare providers, a five-year planning horizon can be employed when purchasing medical equipment, including software updates. During the procurement process, the necessary factors to consider are the safety criteria, the updates of the medical equipment, the efficiency of the device and utilization [10]. The TCO method considers all cost items that need to be taken into account before purchasing technology. In addition to input costs, costs incurred during the operation and retirement stages of the device life cycle are also considered. TCO typically includes acquisition costs, energy, installation costs, routine maintenance, repairs, upgrades, staff training, liquidation, and labour costs (which should be evaluated, especially for new installations) [11] [12].

In many cases, the total cost of ownership of a medical device exceeds the purchase price, so the TCO method appears to be suitable for evaluating the device in the procurement process) [11] [13] [14]. The TCO method has proven to be very useful for the valuation of large-scale capital goods, including sectors such as IT, construction and automotive [15] [11] [16] [17].

The TCO method is rarely factored into the decision-making process in the healthcare system, and as a result, it is not standardized [10] [18].

However, there are certain benefits to enjoy if the total costs is appropriately identified, and these benefits include the rationalization of performance requirements, the ability to make informed decisions, determination of sustainability, reliability, maintenance support, as well as other factors that affect life cycle costs, and thus, the reduction of the total cost of the asset is achieved [19] [20].

Lifetime provides decision-makers with the tools they need to monitor the condition of medical devices and promptly remove or replace them from inventory.

We employ TCO to determine the radiological capital equipment, and in the future, we plan to expand our test to cover other sectors of medical equipment to compare outcomes accurately.

To accomplish the research objectives, an economic time analysis was conducted for selected medical Radiological devices. The TCO calculation process was based on the approach used in the studies of Morphonius [21] and Nierseen [19]. All costs are further discounted to the present value. The case study was also based on the Life-Cycle Costing Manual issued for the Federal Energy Management Program, which was used by Morfonios in his research [21].

The TCO process for the purpose study consisted of five basic steps [22]:

1. Evaluation of the life expectancy of the device
2. Identification of the types of evaluation costs
3. Calculation of charges according to each type
4. Determination of the correlation among charges
5. Calculation of the TCO

$$TCO = Ca + Cc + Co + Cm + Cp + Cd \qquad (3)$$

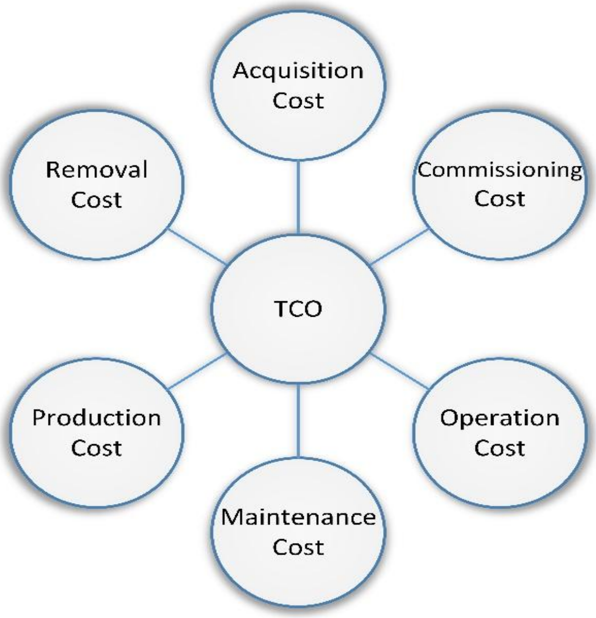

Fig. 2. Total Cost Ownership Component

Where:

Ca- Acquisition Cost

Cc- Commissioning Cost

Cooperation Cost

CM- Maintenance Cost

CP- Production Cost

Cd- Removal Cost

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Different criteria should determine the replacement of medical equipment, and the first of these criteria is the technical criterion, which includes indicators such as proper life ratio, utilisation, downtime, technological change, and vendor support.

The second criterion is financial, which may include service and operational costs, as well as backup availability.

According to these standards, the useful life of medical devices remains an essential indicator of technical standards and is generally accepted as a critical factor to consider when replacing [23].

II. MATERIAL AND METHOD

In the Middle East, KFMC remains one of the largest and fastest-growing medical complexes with a total capacity of 1,200 beds. Its technical management team is highly qualified and efficient, with the team's goal being to make KFMC a benchmark in medical care. This is achieved by making KFMC the referral point for patients seeking various treatments or medical assistance from all over the region, and by being recognised for the medical and professional competencies of different disciplines, which are delivered annually to an estimated 30,000 inpatients and 500,000 outpatients. As a result of KFMC's working environment, which allows it to have qualified employees, it provides, overall, more quality care and commitment to dealing with patients [24].

Regarding the HTMA Mission, it is to ensure the provision of distinctive, high-speciality, safe, and cost-effective use of healthcare technologies in KFMC. The vision is to be the benchmark of health technology through the application of international standards [24].

HTMA manages 36,347 medical devices, and these devices are controlled and monitored through 4 different sections (Bio-Laboratory, Bio-Mechanical, Bio-Electronics and Bio-Radiology)

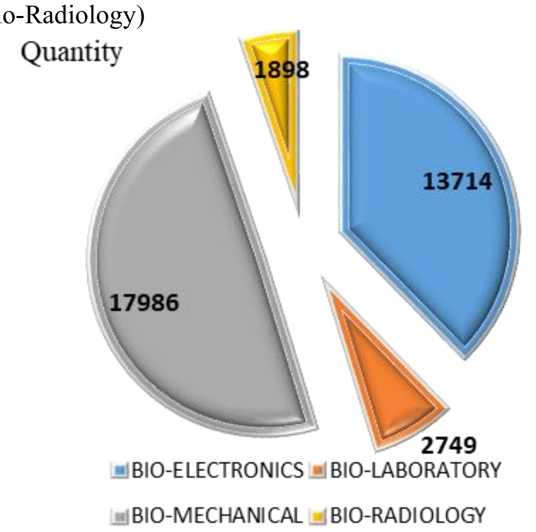

Fig. 3. Medical Equipment Categorization and Quantities in HTMA KFMC

HTMA owns the management system AssetPlus, GE Healthcare's Asset Management Solution, to make work more effective. AssetPlus is a versatile solution that combines multiple intuitive and easy-to-use technologies designed for hospital teams. Biomedical Staff, General Technical Services, Medical Technicians, Financial Services, Information Technology Departments, Nursing Teams [25].

Medical equipment management remains an essential aspect of the healthcare system. [26] It is a process that is used by hospitals to establish, supervise and manage existing equipment for the promotion of safe, effective, and economical use of equipment [27]. There are several stages involved in the life cycle of medical equipment management. To ensure the protection of people and the environment, it is important to follow established safety procedures when disposing of or replacing medical devices.

An ideal medical technology replacement planning system would cover all clinical devices across the facility, leverage accurate and objective data for analysis, and be flexible enough to consider non-device factors. There is. It is also futuristic if it includes strategic plans related to clinical market trends and strategic initiatives by hospitals related to technology [27]. [28] An analysis procedure for replacement: In answering the question of how long to use equipment or when to discard an old piece of equipment, the simple answer remains when the performance of that equipment has become compromised.

i. Reduced Performance (reliability/productivity) eventually results in higher operating costs, decreased safety, lost sales, and diminished quality.

Additionally, replacement of equipment should be considered when repair costs are high or when it is no longer safe to use the old equipment, resulting in a reduced quality of operation.

Another possibility could simply be that the old equipment no longer meets new specifications

ii. Altered requirements: This refers to new specifications that cannot be met by existing equipment.

iii. Obsolescence: The improved performance of newer technologies makes the current equipment less competitive.

A quantitative procedure is employed to determine the optimal duration for owning equipment, taking into account the associated costs of ownership. It is essential to note that the costs of owning something extend to operating costs, and it is not just about the initial upfront expense of purchasing that item. Total ownership comes from:

- The capital recovery represents the amount of an annualized equivalent of the initial purchase price minus the sales price in the future.
- The ongoing maintenance and operation costs

The procedure involves finding the annual operating costs for each year and then combining them all, spreading the total evenly over the entire lifespan to achieve an equal amount. The annual worth of the yearly operating costs, so here AOC means annual operating costs, and over time, operating costs go up, and capital recovery costs get lower and lower the more years you own an item.

The medium of the optimum operating point is the so-called economic life, which is defined technically as the number of years that minimises the total annual cost. So, how long should you own the equipment? It should be owned for many years to reduce the total yearly cost. Determining the carrying value of an asset can be done through various types of depreciation charges. The most

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common depreciation methods are:

1. Straight-line SLN
2. Double declining balance DDB
3. Declining balance DB
4. Sum of years' digits SYD

In accounting, depreciation is used to distribute the cost of an item of property, plant and equipment over its useful life. In other words, the depreciation of an asset over time due to use, wear and tear, or obsolescence. His four primary depreciation methods, as mentioned above, are detailed below.

CA = Cost of an Asset
RV= Residual Value
UL = Useful life of an Asset
P = Period

SLN = (CA – RV)/UL. (4)

DDB = Min ((cost - total depreciation from prior periods) * (factor/life), (cost - salvage - total depreciation from prior periods)). (5)

DB = ((CA - total depreciation from prior periods) * rate * (12-month)) / 12 (6)

SYD = [(CA – RV) × (UL-P+1) × 2] /[(UL) (UL+1)]. (7)

In a replacement study, alternatives will be compared— you will compare the thing that you already own, which is the defender, to a potential replacement, which is called a challenger

- Defender: The currently installed asset
- Challenger: The best potential replacement
- The market value: This is the value of a piece of equipment that you already own if it were to be sold today.
- Economic Service Life (ESL): This is how long you should own the item. The number of years at which the lowest annual cost occurs.
- Defend the first cost. Is it its current market value?
- Challenger First Cost: The actual purchase price of any equipment.
- Sunk Costs: Previous expenditures that cannot be recovered in the future or previous spending that doesn't have a direct relationship with the current value of the item.

In determining the economic service life, the market value will be considered to calculate the capital recovery costs for each year of ownership, and then factor in the operating expenses and their annual worth.

- Present value of cumulative operating costs
- The annual worth of the present value of the cumulative operating costs
- Capital recovery column
- Total annual worth of costs

If prices appear to be increasing again, the total cost of ownership will also rise, as operating costs are increasing. What to look for is the minimum amount, that is the lowest cost, and this gives you the economic service life. Based on this, the equipment should be owned for three years, or the financial service life of the equipment should be three years. Thus, the financial service life refers to the ideal number of years that minimises costs. Below is the analysis:

Y Year for working
MV Market Value if sold in a particular year
OP Operating cost for a specific year
NPV Net Present Value of cumulative operating costs to date
AW. PV Annual Worth of the Present Value of the cumulative cost
CR= Capital Recovery
AWC Total Annual Worth of cost

Table 1. Example of AW for Economic Service Life

Y	MV	Op	NPV	AW. PV	CR	AWC
1	10,000	- 5,000	- 4,545	- 4,999	-12,000	- 16,999
2	8,000	- 6,500	- 9,917	- 5,714	- 7,714	- 13,428
3	6,000	- 8,000	-15,928	- 6,404	- 6,229	- 12,634
4	2,000	- 9,500	-22,417	- 7,071	- 5,878	- 12,950
5	-	- 12,500	-30,178	- 7,960	- 5,275	- 13,236

$$MV = PC_{i=0} \times r \quad (8)$$

r Interest Rate% %

i = number of Years

PC= Purchasing Cost

$$OP = C_{sp} + C_{em} + C_{cnt} \quad (9)$$

CSP Cost of Spare Parts

Cem Cost of employment

C_{cnt} = Cost of contract

$$NPV = \sum_{i=1}^{n} \frac{OP_i}{(1+r)^i} \quad (10)$$

n = specific year of evaluation

$$AW.PV = PMT = PV\left[\frac{r}{1-(1+r)^{-n}}\right] \times \left[\frac{1}{(1+r)}\right] \quad (11)$$

PMT = Payment Value at a specific time
PV = Present value

$$CR = r \times n \times (-PC - MV) \quad (12)$$

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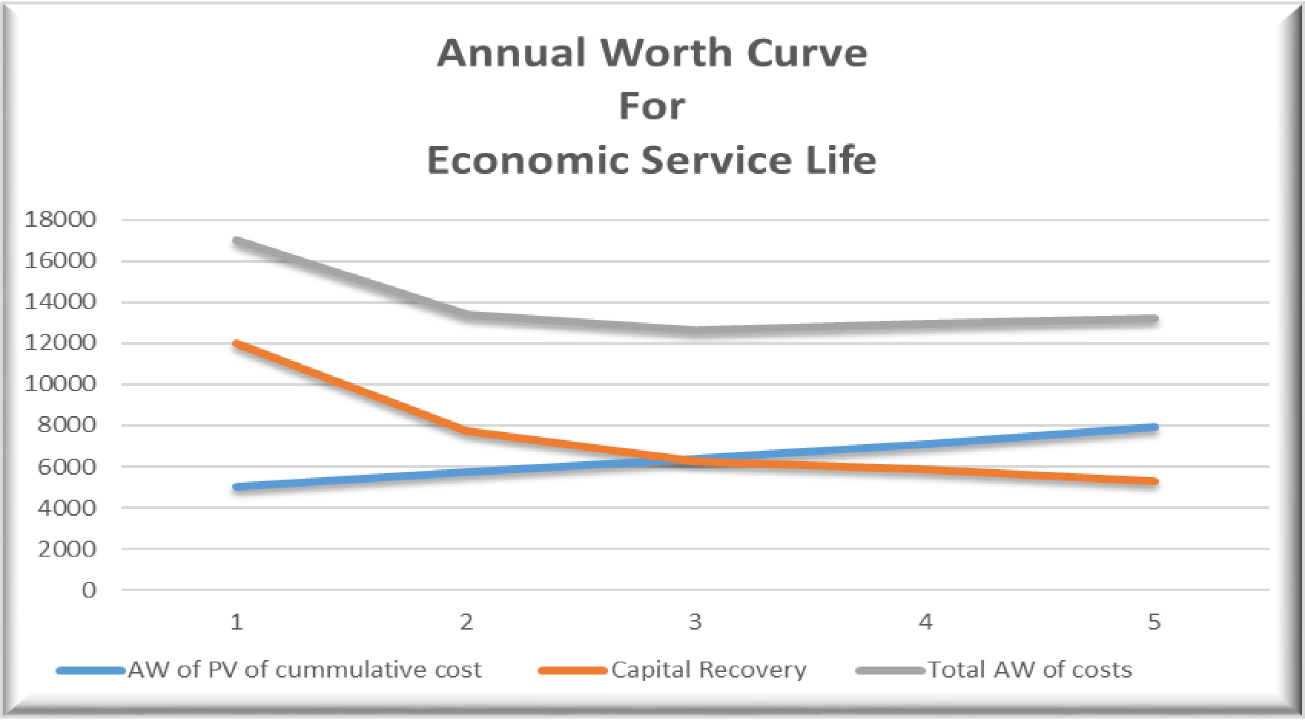

Fig. 4. AW for Economic Service Life

III. RESULTS AND DISCUSSION

Various organisations have attempted to estimate typical equipment lifetimes for healthcare technology. This annexe contains the results from two different sources – the American Hospital Association, and the GTZ (German Government Technical Aid Agency) [29]. The work frame of both organisations includes providing guidance related to the lifespan of medical equipment. The results show that it is essential to consider replacing equipment once its useful life has ended. Also, the equipment is due for disposal once it is discovered that the service costs have increased. The proposed comparison was applied to Bio-Radiological capital equipment Data; KFMC has 33 devices of different types for four hospitals, the National Neurosciences Institute, and three specialised centres. Our focus now will be on radiological equipment.

Here is the list of equipment types that were part of our interest in this research:

- Radiotherapy Simulation Sys, Computed Tomography-Based
- Scanning Sys, Gamma Camera, Single Photon Emission Tomography
- Scanning Sys, Computed Tomography
- Radiographic/Fluoroscopic Sys, Angiographic/Interventional
- Radiotherapy Sys, Linear Accelerator
- Scanning Sys, Gamma Camera
- Radiographic/Fluoroscopic Sys, Cardiovascular
- Radiographic/Fluoroscopic Units, Mobile
- Radiographic Units, Mobile
- Radiographic Sys, Digital

When assessing any device, we in HTMA have, in previous years, typically focused on ensuring the availability of high-performance machines to prevent people seeking to use this service within our organisation from being affected.

Maintenance is a primary concern, as the work involves assessing the spare parts used to repair the machine at a particular time and comparing their cost to the equipment price, which may lead to an incorrect decision. However, the planning of purchasing usually considers the standard lifespan of equipment and how much time the corrective work order has taken for these machines, which may also lead to less precision in their decision to replace the machines.

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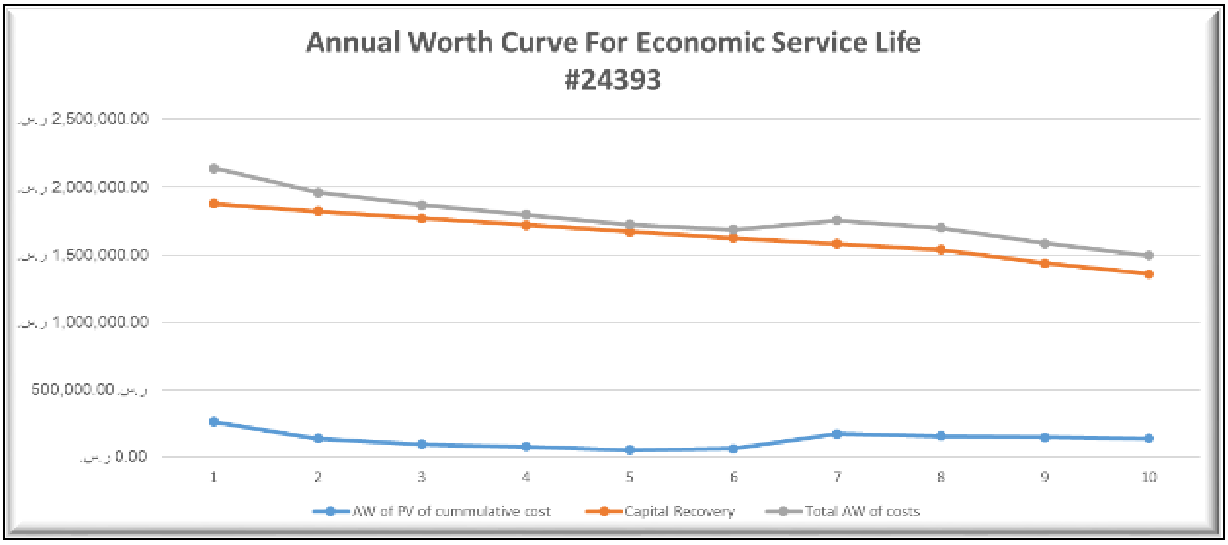

Fig. 5. AW for Scanning Sys, GAMMA CAMERA, SPECT

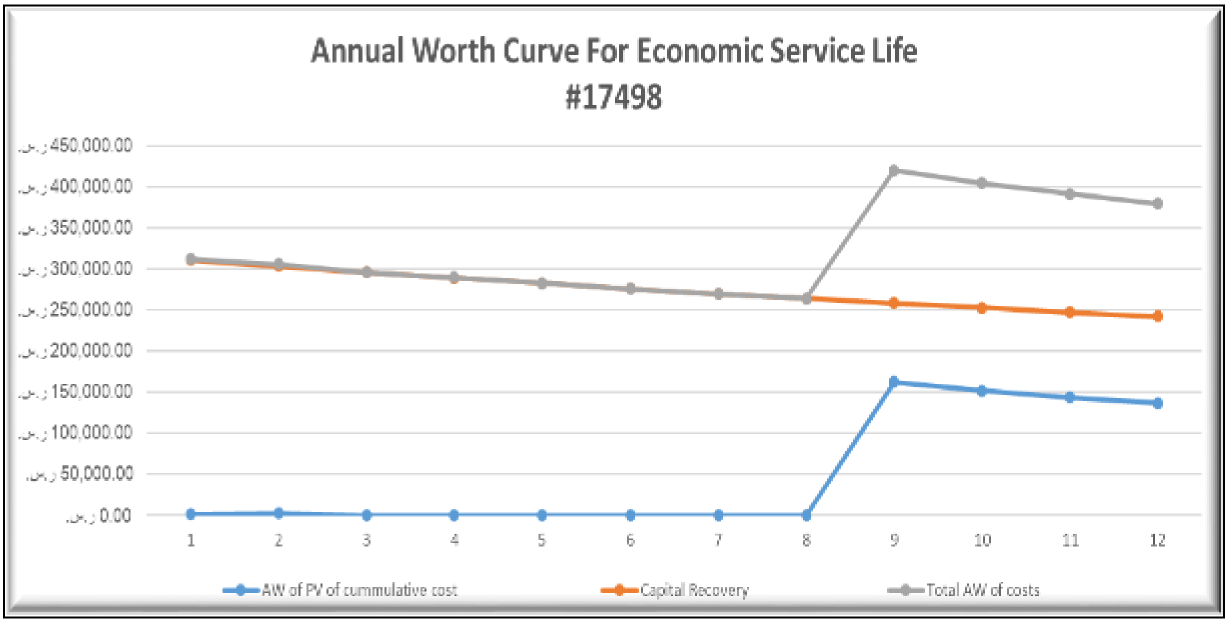

Fig. 6. AW for Radiographic Sys, Digital

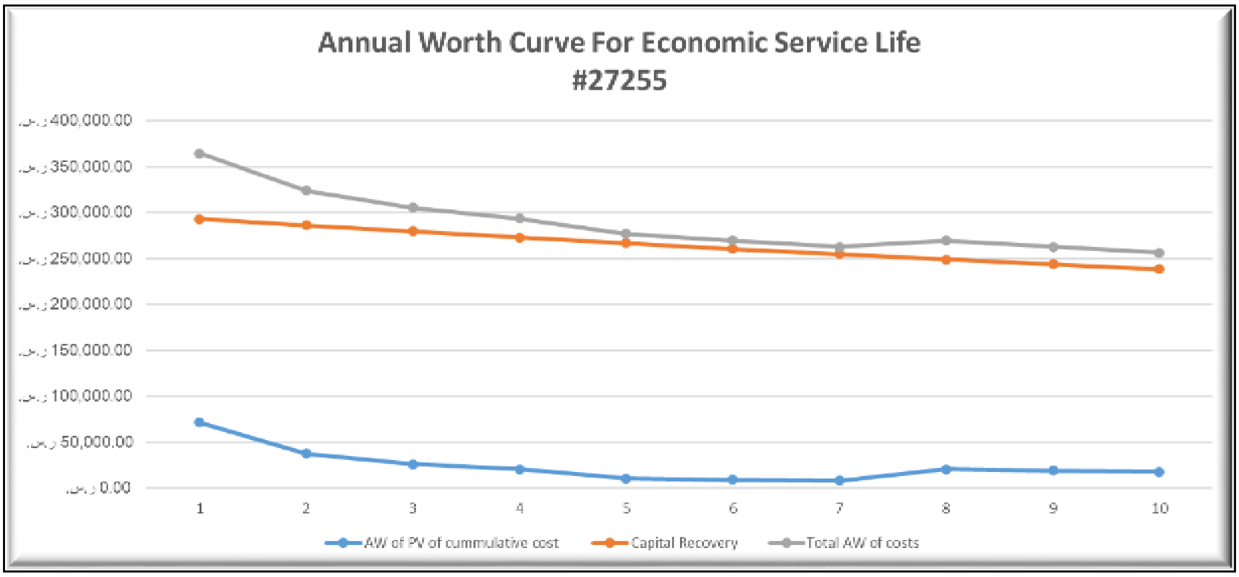

Fig.7. AW for Radiographic Units, Mobile

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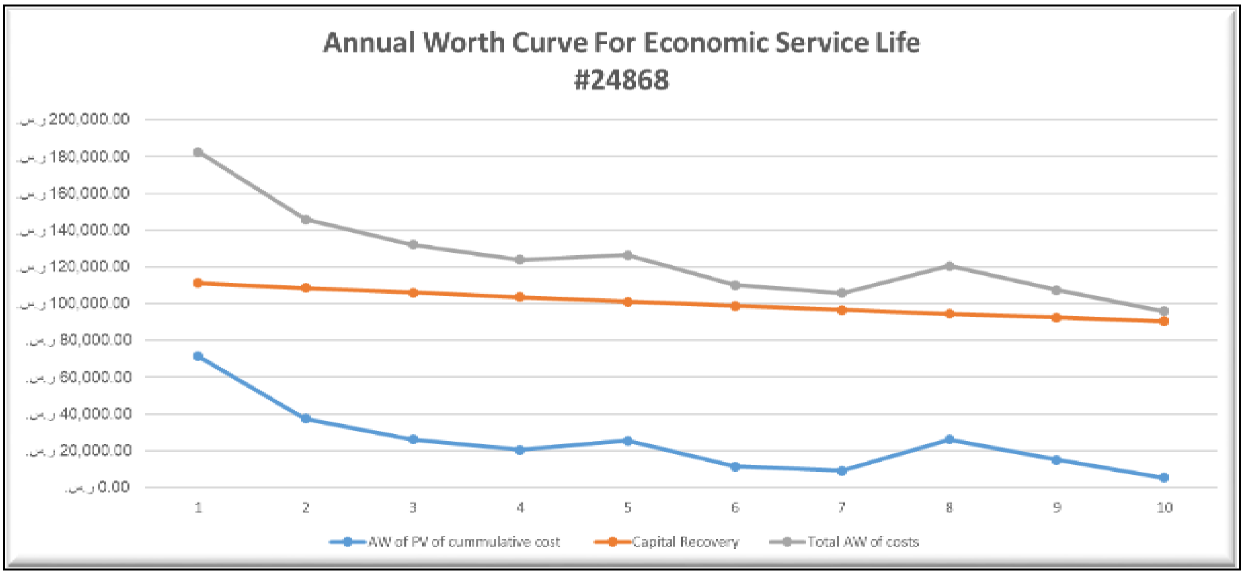

Fig.8. AW for Radiographic/Fluoroscopic Units, Mobile

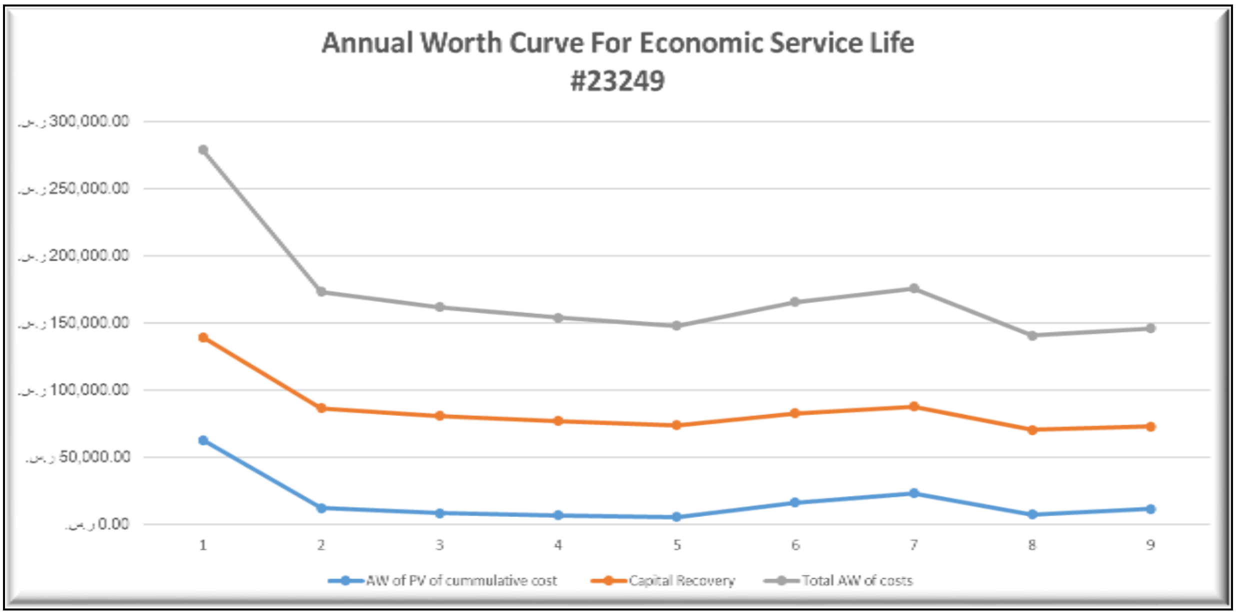

Fig.9. AW for Radiographic/Fluoroscopic, Mobile

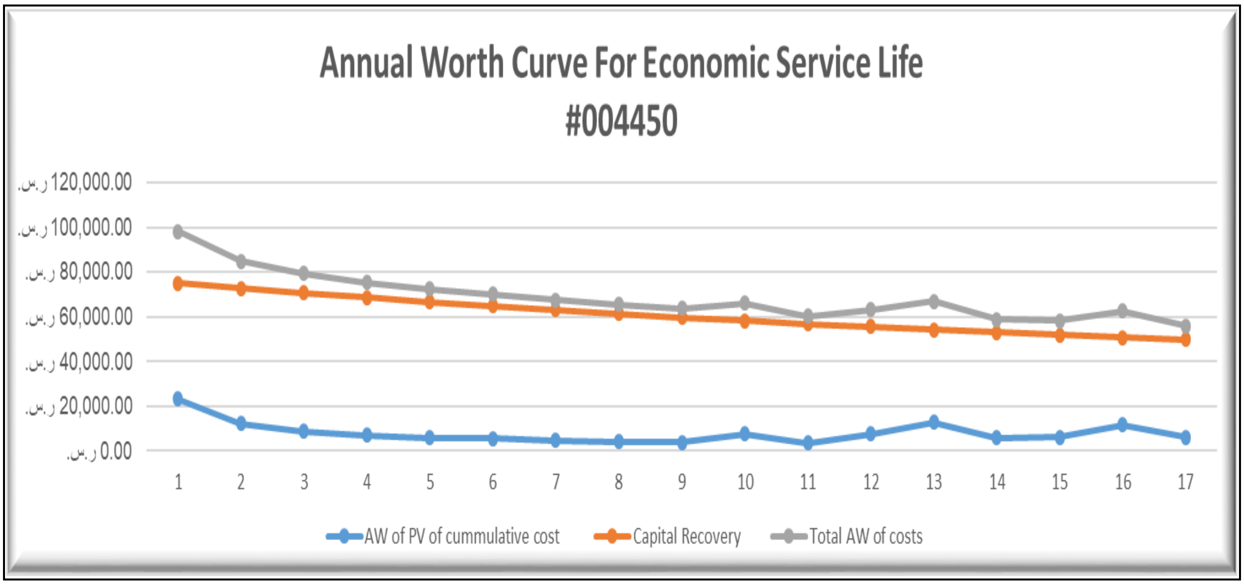

Fig.10. AW for Radiographic/Fluoroscopic, Mobile

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Table 2. Economic Lifetime Effect on Service Lifetime

#	Equipment Name	Q	E.T
1	Scanning Systems, CT	1	6
2	Scanning Systems, Gamma Camera, SPECT	1	8
3	Radiographic Systems, Digital X-RAY	5	7
4	Radiographic Units, Mobile X-RAY	6	4
5	Radiographic /Fluoroscopic Units, Mobile C-ARM	4	9

Table 3. Economic Lifetime Match with Expected Lifetime by Standard for Medical Equipment

#	Equipment Name	Q	E.T
1	Scanning Systems, Gamma Camera	1	8
2	Radiographic /Fluoroscopic Systems, Angiographic/Interventional	1	7
3	Radiographic /Fluoroscopic Systems, Cardiovascular	1	7
4	Radiotherapy Simulation Systems, CT-Based	1	10
5	Scanning Systems, Gamma Camera, SPECT	1	8
6	Scanning Systems, CT	2	7
7	Radiographic /Fluoroscopic Systems, Angiographic/Interventional	2	7
8	Radiographic Units, Mobile X-RAY	1	10
9	Radiotherapy Systems, Linear Accelerator	2	7
10	Radiographic /Fluoroscopic Units, Mobile C-ARM	4	8

The survey results indicate that healthcare centre managers, clinical technicians, physicians, and economists are the most concerned with the manner of procurement of costly medical equipment. This corresponds to the pointings of Konschak [28], however the illustration of economists withinside the evaluation of long-time period funding ought to be plenty higher. The shopping rate became the maximum standard choice parameter for some healthcare centres, which inquired, probably because of the long-established method of comparing public procurement. At present, the evaluation of bids in public procurement makes use of the principle of "maximum economically effective tender". For the assessment of healthcare equipment, factors such as the pleasantness and reliability of the provided answers, the bottom bid rate, and the variety of services could be considered.

The frequency and motives for deciding on complete provider contracts are similar to those found in the existing literature. Sferrella states that the maximum not unusual place motives for negotiating complete provider contracts from deliver corporations are as follows: carefree operation, assurance of response, and bargaining at the provider settlement while signing the contract collectively with the acquisition of the instrument [30]. TCO was calculated for the selected devices, which constitute the entire life of the instrument. It has already been demonstrated that the operational value currently outweighs the purchase value. The value object that still appreciably accelerated the TCO became the provider and restored value group. Therefore, it can be concluded that the buying enterprise must also recall the scope of the negotiated service agreement. In addition, we have to get

Worried and fitness care centres have to give attention to selecting a dealer of consumables, as observed effects reveal that those gadgets are the third most vital class in TCO. Personnel charges covered within the TCO calculation are an object that is usually covered in operational charges [28]. It must be noted that in the case of the current operation, this object should be considered inappropriate and brought into consideration in the normal calculation only in terms of additional salary charges (incremental). The inclusion of employee value into the calculation is suitable, especially for new departments.

During the tool operation, it's also helpful to remember the wide variety of examinations and to adjust the standard working charges accordingly. The approach also can be supplemented via means of tracking marginal charges, i.e. charges incurred with every incremental unit of output (a wide variety of such units) [31] [32].

The above graphs of annual worth for economic service life depend only on HTMA data regarding the costs of purchasing, installing, servicing, and spare parts used for these machines, regardless of the cost of operation, including manpower for running these equipment from medical staff and their assistants, as well as consumables costs that may be used for running these equipment. Although the annual value of economic services in life is high, critical techniques should be included in HTMA consideration, as calculations show that it remains an effective method for monitoring each device throughout its entire lifespan.

IV. CONCLUSION AND FUTURE WORK

The economic time of medical equipment is essential for enhancing medical equipment

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management decisions. A radiological device was selected for the case study. These gadgets have been recognised with the assistance of scientific technicians and departmental managers at the Department of Medical Technology. The prices of the gadgets involved for the chosen gadget are listed in Table 1. The financial time technique was unknown to most of the respondents, and they typically make decisions primarily based on the economic cost of the medical device. The working lifetime price of the gadgets selected for the case study is similar to the acquisition price. According to the calculated total cost of ownership (TCO), this parameter isn't the most essential price driver in the life cycle of medical devices in hospitals. The Economic Life method is helpful in the case of strategic decision-making regarding the acquisition of specialised, highly particular technologies, where sustainability is the primary decisive factor. When the era comes to the idea of a subsidy or donation, Te can suggest the probable economic burden connected with its operation and renovation throughout its lifetime. Further studies are recommended, primarily in the areas of working expenses and techniques for estimating price items. The financial price increased with the use of scientific technology in medical institution services, as observed through patients, the utilisation of available resources, the type of medical services provided, and the medical practice of the physicians. Variation was also observed among strategies in the use of Te. The findings offered simple records concerning the financial cost of healthcare in public hospitals while utilising the green usage of available resources.

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REFERENCES

1. D. Callahan, "Health Care Costs and Medical Technology, ‘in From Birth to Death and Bench to Clinic, the Hastings Centre Bioethics Briefing Book for Journalists, Policymakers, and Campaigners, Mary Crowley (Eds), pp. 79 - 82, 2008.
2. J. R. Joel., "Advancing Medical Practice through Technology," Applications for Healthcare Delivery, Management and Quality: IGI Global, pp. 42 - 52, 2013.
3. J. Dyro, A model clinical engineering department, ‘Clinical Engineering Handbook’ Joseph F Dyro (Eds), pp. 16- 26., San Diego, California, USA: Academic Press, 2004, pp. 16 - 26.
4. T. Boerma, D. Evans, T. Evans, G. Flores, P. Eozenou, D. Hogan, et.al., "Tracking universal health coverage: first global monitoring report. WHO, World Bank Group:" WHO press., Geneva, 2015.
5. f. institute, "Economic Life, The length of time an asset is expected to be useful to the owner," Corporate Finance Institute, 6 Jan 2023. [Online]. Available: https://corporatefinanceinstitute.com/resources/knowledge/accounting/economic-life/.
6. H. Petra and V. Aneta, "The application of the total cost of ownership approach to medical equipment - case study in the Czech Republic," In book: World Congress on Medical Physics and Biomedical Engineering, vol. v2, no. In book: World Congress on Medical Physics and Biomedical Engineering 2018 (pp.361-366), pp. 361-366, January 2019. [CrossRef]
7. Canadian Association of Radiologists, "Lifecycle guidance for medical imaging equipment," in Canada, https://car.ca/wp-content/uploads/car-lifecycleguidance-mainreport.pdf, 2017.
8. D. Hockel and T. Hamilton, "Understanding total cost of ownership," Healthcare Purchasing News, p. 35 (9), 2011.
9. T. Dabbs, "Optimizing Total Cost of Ownership (TCO)," 2014. [Online]. Available: http://www.argointl.com/wp content/uploads/2014/03/goulds-Optimizing-Total-Cost-of-Ownership-final2.pdf. [Accessed 20 12 2017].
10. TRIMEDX: "Total Cost of Ownership: The Influence of Clinical Engineering," [Online]. Available: http://www.hfma.org/brg/pdf/WhitePaperTCO_B5AAD6A0-E673-3BD0-FF9599EB16582879.pdf. [Accessed 20 12 2017].
11. N. C. f. E. Statistics: "Total Cost of Ownership: An Important Piece of Any Sustainability Plan." [Online]. Available: https://nces.ed.gov/programs/slds/pdf/TotalCostofOwnership.pdf. [Accessed 20 12 2017].
12. B. Wiki, "BMET Wiki, Total Cost of Ownership," [Online]. Available: http://bmet.wikia.com/wiki/Total_Cost_of_Ownership. [Accessed 20 12 2017].
13. B. Ferrin and R. Plank, "Total Cost of Ownership Models," Journal of Supply Chain Management, vol. 38, no. 2, pp. 18 - 19, 2002. [CrossRef]
14. a. E. Ministry of Business, "Total Cost of Ownership - An introduction to whole-of-life costing," October 2013. [Online]. Available: http://www.procurement.govt.nz/procurement/pdf-library/agencies/guides-and-tools/guide total-cost-ownership.pdf. [Accessed 20 12 2017].
15. Chakravarty and J. Debnath, "Life cycle costing as a decision making tool for technology acquisition in radio-diagnosis," Medical Journal Armed Forces India, vol. 71, no. 1, pp. 38 - 42, 2015. [CrossRef]
16. W. E. R. F. (WERF), "Overview: What is Life Cycle Costing?" 2011. [Online]. Available: http://simple.werf.org/simple/media/tools/Life Cycle Cost Tool/index.html,. [Accessed 20 12 2017].
17. FWilhelm, "Solutions: International Supply Chain; Total Cost of Ownership," 8 11 2012. [Online]. Available: http://www.iscsglobal.com/files/assets/Total%20cost%20of%20ownership.pdf. [Accessed 20 12 2017].
18. Morfonios, D. Kaitelidou, G. Filntisis, G. Baltopoulos, P. Str and P. Myrianthefs, "Economic Evaluation of Multislice Computed Tomography Scanners Through a Life Cycle," Indian Journal of Applied Research, vol. 4, pp. 158 - 161, 2014. [CrossRef]
19. N. HJ., S. AJ. and O. NM., "Medical Devices Service Life Cycle Cost Management in Al Karak Hospital as a Case Study," J Account Mark., vol. 4, no. 2, pp. 1-8, 2015.
20. J. Heilala, K. Helin and J. Montonen, "Total cost of ownership analysis for modular final assembly systems." International Journal of Production Research, vol. 44, pp. 3967 - 3988, 2006. [CrossRef]
21. M. Weber, M. Hiete, L. Lauer and O. Rentz, "Low cost country sourcing and its effects on the total cost of ownership structure for a medical devices manufacturer." Journal of Purchasing and Supply Management, vol. 16, no. 1, pp. 4 - 16, 2010. [CrossRef]
22. M. Weber, M. Hiete, L. Lauer and O. Rentz, "Low cost country sourcing and its effects on the total cost of ownership structure for a medical devices manufacturer." J. Purch. Supply Manag., vol. 16, no. 1, pp. 4 - 16, 2010. [CrossRef]

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23. K. Ouda, A. Mohamed and N. Saleh, "A Simple Quantitative Model for Replacement of Medical Equipment Proposed for Developing Countries," in the IEEE 5th Cairo International Biomedical Engineering Conference, Cairo, Egypt, Dec 2010.
24. KFMC, "https://www.kfmc.med.sa/EN/About/Pages/default.aspx," [Online].
25. gehealthcare, "http://www3.gehealthcare.co.uk/enGB/Services/Asset_Management /AssetPlus," [Online]. Available: http://www3.gehealthcare.co.uk/enGB/Services/Asset_Management/AssetPlus.
26. J. McClain, "Life expectancy projection benchmarks," American Society for Healthcare Engineering of the American Hospital Association, Healthcare Facilities Management Series, 1996.
27. K. Ouda, M. Neven, S. Saleh and S. Ahmed, "The Effect of Useful Life and Vendor Performance on Replacement Decision of Medical Equipment," in 2012 Cairo International Biomedical Engineering Conference (CIBEC), Cairo, Egypt, December 2012.
28. Konschak and P. Felt, "Understanding the Total Cost of Ownership (TCO) analysis for IS in the healthcare setting," [Online]. Available: http://www.colinkonschak.com/images/TotalCostofOwnership.pdf. [Accessed 29 12 2017].
29. H. Association, "Estimated Useful Lives of Depreciable Hospital Assets," Health Forum Inc. 2004, 2004. Revised 2013 edition..
30. S. Sferrella, "Equipment Service: Total Cost of Ownership," Radiology Business Journal., December 2012.
31. G. Bektemur, N. Muzoglu, M. A. Arici and M. K. Karaaslan, "Cost analysis of medical device spare parts," Pakistan Journal of Medical Sciences, vol. 34, no. 2, 2018. [CrossRef]
32. P. K. a. V. R. Petra Hospodková, "Total Cost of Ownership as a Management Tool for Medical Devices Planning: A Case Study of a ST-Analyser in Perinatology," MEDICON, IFMBE Proceedings, Vols. 76, p. 1078–1084, 2020. [CrossRef]

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2. "Foot Classification and Influence of Pattern Recognition" International Journal of Engineering and Advanced Technology(TM) (218 – 225) Volume 6 – No.4, April 30, 2017.
3. "Automatic Segmentation of Acute Leukaemia Cells International" Journal of Computer Applications (0975 – 8887) Volume 133 – No.10, January 2016.
4. "Decision support system in lymphoma classification", Current Medical Imaging Reviews Journal, Volume 12, No. 4, pp. 1-10, 2016.
5. "A Decision Support System for Acute Leukaemia Classification Based on Digital Microscopic Images", Alexandria Engineering Journal AEJ, 2017 in publication.
6. "Classifiers comparison in Acute Myeloid Leukaemia Classification of Digital Microscopic Images", Journal of Engineering and Applied Science, 2017, in publication.

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