

Decision Making in Physical Asset Repair/Replacement: A Literature Review

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Abstract

In modern world, almost all the organisations use physical assets such as buildings, vehicles, equipment and machinery, etc. to carry out their business operations. These assets consume a considerable amount of money during their life cycle and therefore, physical asset management has become an important aspect which affects the profitability of any organisation. All assets deteriorate over time and failures of assets will raise the need for maintenance. Proper maintenance can extend the life time of a physical asset. However, at the end of useful life time, organisations have to replace them with suitable new ones. Replacement of an asset requires enormous investments and therefore mostly, they try to extend life time of assets through repair and maintenance. However, in some situations organizations decide to replace assets even when they are in a good condition.

As per previous researchers, many assets in the industry are older than the life they were originally designed for and in many cases, failure to replace them have led to high energy consumption, high maintenance costs and increased risk of accidents and calamities. On the other hand, organizations have experienced negative impacts due to unnecessary replacement of physical assets. Hence, making a decision between these two contradictory options presents a big challenge for asset owners. Decision making in physical asset repair/replacement involves selecting a logical choice and determining the option, which is the best for the particular situation. Knowing how to decide which option is best for organization's operations and when assets should be replaced will help to control downtime and unexpected costs. Though asset maintenance has received an increasing attention, there is a lack of a comprehensive research in the area of asset replacement. Therefore, the aim of this paper is to review the literature on physical asset repair/replacement decision making practices. A comprehensive literature review identified the reasons for replacement of assets and the factors that trigger physical asset repair/replacement decision making process. The literature findings will be used to evaluate the current practice of physical asset repair/replacement decision making in Sri Lanka, in the next phase of study.

Key Words: Physical Asset Replacement; Physical Asset Repair; Decision Making

INTRODUCTION

The primary aim of physical asset management is the effective use of physical assets across their lifecycles. Therefore, the decisions taken within physical asset management process ranges from acquisition to disposal of assets. Physical asset repair/replacement decisions require substantial capital investment and have a significant effect on the financial performance of any organisation. Thus, effective decision making is necessary to compete in physical asset intensive industries. The aim of physical asset repair/replacement decisions is to create value through the eventual outcome of the decision. This value includes making a balance between cost of physical assets, their performance and risks. Therefore, apart from financial gains, a variety of other factors need to be considered such as health and safety, social and environmental sustainability and availability of new technologies during decision making process of asset repair/replacement. Moreover, asset Repair/replacement decisions making process considers impacts of multiple, financial and non-financial criteria which will vary depending on the organisational requirements. However, the researches which have been carried out on the above area is limited and thus, the objective of this paper is to review the literature on physical asset repair/ replacement decision making practices and to identify the factors which are considered in making physical asset replacement decisions. The first section of the paper provides background to physical asset management while the second section focusses on factors considered in decision making in asset repair/replacement. Final section concludes the paper and proposes future prospects.

PHYSICAL ASSETS

According to the ISO (International Standard Organisation) 55,000 asset management system standard; asset is an item, something or an entity that has actual or potential value for an organisation (ISO 55000, 2014). This value can be tangible or intangible, financial or non-financial, and includes consideration of risk and liabilities. It can also be positive or negative, at different stages of the asset life. The assets used by organisations have been classified by different authors in different ways. As per Then (1996), assets can be divided into two types as current assets and non-current assets. Both kinds of assets are important for organisations to continue their activities. Fixed assets or non-current assets such as buildings, machinery, plants and land, etc. provide value to the organisations for more than one year while non-current assets such as inventory, cash, finished goods and materials provide value for less than one year. Publicly Available Specification (PAS) 55 (2008) on asset management

published by the British Standards Institute (BSI), described five types of assets which can be found in an organisation. The standard main five categories are financial assets, physical assets, human assets, information assets and intangible assets(Hastings, 2010).

According to Hastings (2010), physical assets are referred to items such as machinery, vehicles, plants, buildings, etc. which are used to carryout business functions. A physical asset is defined as any physical core and acquired elements of significant value to the organisation, which provides required services for that organisation (Ouertani et al., 2008). Physical assets represent long-term investments in tangible, visible, physical resources acquired or developed for income-producing purposes. Because they are held for a long-term and physical in nature.The physical assets are also referred to as capital assets. Wallingford and Sticklen (1992 cited Theron, 2016) defined a capital asset as an asset that ‘has a useful life greater than a year and is expected to earn income sufficient to cover the operating expenses and amortized acquisitions cost associated with it.Depending on the size and structure of the organisation, the value of these physical assets may differ.

PHYSICAL ASSET MANAGEMENT OF BUSINESS ORGANISATIONS

Proper management of physical assets is one of the most critical factors that leads towards the achievement of organisational goals and objectives.According to the Wenzler (2005), asset management of a business organisation is a process of identification, design, construction, operation, and maintenance of physical assets. Further, as stated by Mitchell and Carlson (2001), physical asset management which is hereafter referred in this paper as asset management is a strategic and integrated set of comprehensive processes to gain greatest lifetime effectiveness, utilisation and return from physical assets. Moreover, it is a process of organising, planning and controlling the acquisition, use, care, refurbishment, and/or disposal of physical assets to optimise their service delivery potential and to minimise the related risks and costs over their entire life through knowledge based decision-making applications and business processes (Ouertani et al., 2008).

As asset management involves managing assets throughout their life cycle, having a good knowledge about asset lifecycle and costs which are occurring in the whole asset life time is very important to manage assets. Asset lifecycle includes the activities related to asset acquisition to asset disposal. As mentioned by Davis (2016), there are four stages in assets life cycle, namely acquisition, commissioning, operation and disposal. Planning, designing

and procuring of assets come under the acquisition of assets while installation or building assets and checking whether they are in a good condition come under the commissioning. Operation of an asset is the most important stage of an asset lifecycle. During the operational stage, monitoring, maintenance, refurbishment and potential upgrading is important in order to meet the conditions of operational requirements. Last stage is the disposal of an asset. When disposing an asset, there should be a replacement (Schuman et al., 2005).

As per the Hastings (2010) and Cessa (2012), physical asset management responsibilities and activities are not confined to a specific department. However, large organisations have asset management groups which have expertise knowledge with technical background. Asset management group should have personnel in legal, procurement, finance, accounting and engineering roles. This group should have knowledge on what assets they possess, where are they located, what is the business significance of major assets, what is the position of profit and loss of major assets, what is the utilisation of assets considering seasonal factors and peak seasons, major shortages, surpluses or misallocations of equipment, what is the condition of each asset, are reliability or availability issues are significant, are there any significant risks, is maintenance cost a significant factor, what asset related to developments and market opportunities exist and what has the market got to offer in terms of assets that might usefully acquire, etc. (Hastings, 2010).

According to Wendling (2011), most of the facilities such as hospitals, hotels, public utilities, and manufacturing organisations, etc. depend deeply on physical assets. Further, as mentioned by Charles and Brent (2005), every organisation has to face significant challenges to manage their physical assets. However, physical asset management is one of the most important disciplines to maximise the profitability of any organisation. Proper asset management leads an organisation to optimise benefits such as reducing the repairing and operational cost of assets, reducing the health impacts of operating assets and reducing the legal risks associated with their life time and increasing the attraction of the customers and employees (Davis, 2016).

PHYSICAL ASSET REPAIR/REPLACEMENT OF BUSINESS ORGANISATIONS

All physical assets deteriorate with time as well as with usage. Proper maintenance can extend the life time of physical assets. However, physical assets can fail at any time. When there is a failure in assets, there are two options which can be taken. One is replacing the asset with a new one or else, the asset can be repaired. As mentioned by Thorstensen &

Rasmussen (1999), most of the time, physical assets degrade part by part and organisation can repair existing assets by replacing new parts. Hence, generally physical assets can be brought in between the levels of new and by extending the current usage through repairs (Hout, 2016; Love et al., 1998). As mentioned by Whendling (2011), physical assets repair cannot be postponed but while doing continuous repair, replacement of assets can be postponed.

In large, physical asset intensive organisations the renewal and repair of physical assets form a significant part of the ongoing annual capital expenditure. Any physical asset replacement decision is regarded as an investment decision. The main challenge of a physical asset repair/replace decision is determining the period in time when replacing the physical asset is more advantageous to the company, than repairing it. According to Quertani et al. (2008 cited Theron, 2016)) the advantages of replacing physical assets in timely manner include reduced operating and maintenance costs, reaching performance and production targets, compliance with regulatory requirements, maximization of the return on capital and increased shareholder wealth. Proper replacement decision making practices lead improve the performance of physical assets and to extend their useful lifetime and thus it will leads to increase the wealth of shareholders (Theron, 2016).

DECISION MAKING IN PHYSICAL ASSET REPAIR/REPLACEMENT

Reasons for Asset Replacement

If an asset cannot be repaired, the available option is replacement. Even if the assets are in good condition, there can be other reasons for asset replacement (Hout, 2016; Martin, 2016; Wendling, 2012). According to Wendling (2012), in some situations, organisations decide to replace assets due to obsolescence. Changes in regulations, law, technology and operational requirements also give a push to replace physical assets (Martin, 2016). However, as Hout (2016) mentioned, there are two main reasons for physical asset replacement even if there are no new demands, overriding technology development or laws. According to the researcher, the first reason is higher operational costs compared to the cost of acquiring a new asset. Increased maintenance cost, increased operational cost, loss of output and deterioration can be seen when assets get older (Theron, 2016). Those are financial losses for organisation and therefore they tend to replace assets even they are in good condition. Second reason is high risk of operation due to physical assets deterioration. Without having risk there can be no operation. However, minimizing the risk is more important and therefore, by considering the

risk associated with physical assets, organisations make replacement decisions. In addition, health and safety factors, environmental factors and social factors are also considered (Theron, 2016).

According to Alabdulkarim (2015), in past day's physical asset repair and replacement decisions were made based on technicians' complaints, experience, operational manual recommendations and opinion of management. However asset related decisions should be taken based on evidence. As Alabdulkarim (2015) further mentioned, evidence based asset management based on mainly four areas i.e. decisions related to component replacement, inspection, capital equipment replacement and resource requirement. One of the decisions was component replacement, which involves replacing the component of equipment when component failed or before failure. Replacing the component proactively before a failure more will reduce the risk of sudden breakdown. Another decision is inspection decision which will reduce the breakdown maintenance cost and preventive inspection by enhancing time interval between maintenance inspections. The third decision making practice is capital equipment replacement decision which involves replacing the equipment at the end of economic life of a physical asset. Final decision is resource requirement. Before replacing an asset organisation has to consider whether they have sufficient funds to replace it.

Factors Considered in Decision Making in Asset Repair/Replacement

A decision situation often encountered in business firms is whether an existing asset should be retired from use, continued in service, or replace with a new asset (Munoz-Porcar et al., 2015). There are many factors to be considered before replacing assets in any organisation. In industry, there are more ways to make repair and replacement decision. Most of the time, organisations get decisions considering asset age, asset condition, environmental condition, technical condition, financial condition and other non-financial factors (Cesca, 2012). Following discuss such factors that should be considered in decision making in asset repair/replacement.

Repairing Cost of the Old Asset:

According to Rabbani (2014), repairing cost may not be the same as operational and maintenance cost. We cannot predict repairing cost earlier. Asset failures occur in different times and asset failure rate is different in different years. Therefore, organisations have to be highly concerned about repairing cost of physical assets. Further, as per the

researcher, organisations can reduce repair cost by replacing new equipment. However, replacement cost may be higher than cost of repair and maintenance of remaining existing asset.

Sunk Cost:

In economics and business decision making, the sunk cost is considered as the cost that has already been incurred and cannot be recovered. In other words, sunk cost is a cost which money is already spent and permanently lost (Barham, 2015). Sunk cost influences the investment of an organisation. Before replacing new physical asset, sunk cost of the existing asset should be considered (Muñoz-Porcar et al., 2015). If the sunk cost of existing asset is a considerable amount, organisations try to keep their remaining assets till the end of remaining life time of those assets (Barham, 2015).

Life Cycle Cost of Assets:

One of the major objectives in physical assets replacement is to minimise the overall cost which occurs due to problem horizon (McClurg and Chand, 2002). Therefore, when making decisions on repairing or replacing a physical asset, it is very important to consider the lifecycle cost. Life cycle cost includes all the expenses which have been expended on an asset from its time of acquisition to end of its useful lifetime (White & Ostwald, 1976). Rabbani (2014) identified five cost elements which should be considered before replacing an asset with a new one. According to the researcher, they are, procurement cost (new machines' purchasing cost), holding cost (cost occur when kept in new or ideal machine in warehouse) repairing cost (cost occur restoring asset in sudden breakdown of failure), preventive maintenance cost (cost occur when doing preventive maintenance activity for retaining asset in good condition) and operations cost (equipment running cost such as electricity cost, fuel cost). Further, Akhlaghi (1987) identified some costs which are included in running cost when carrying out life cycle cost analysis. They are maintenance cost, energy cost, cleaning cost, insurance cost, security and management cost.

Past and present details of assets are used to estimate the future cost of physical assets and by considering those costs, organisations make decisions about physical asset repair and replacement (Hastings, 2010). Moreover, by comparing the life cycle cost of proposed replacement asset with sunk cost and the lifecycle cost of existing asset, the replacement decision should be made.

Remaining Life Time of Old Assets:

Other than financial factors, there can be some other factors which should be considered in physical asset repair and replace decision making (Theron, 2016; Hastins, 2010). According to Gage (2013), age of assets is one such factor. As Hout (2016) and Muñoz-Porcar et al. (2015) mentioned, organisation should occasionally decide the remaining life time of old assets. Generally it is more economical to replace equipment after its lifetime except in some situations. Most of the time, organisations decide to repair, if the remaining life time of the asset is long (Hout, 2016). However, it is more economical to repair the asset as soon as possible after a breakdown (Charles et al., 2005).

Economic Life of the Remaining Asset:

Economic life time of an asset differs from the remaining life time of asset. According to Cesca and Novaes (2012), economic life is the maximum length of usefulness, where asset expenses is minimum. Further, as stated by Vanier (2000), generally, physical life time of an asset is higher than economic life time of asset. As researchers described, when considering the economic life of a physical asset, organisations have to consider the maintenance cost as well as capital cost which will occur during the asset lifetime. Moreover, researchers described that if the physical assets are kept more than their economic life, asset expenses such as maintenance cost will increase. And if the assets are replaced before their life time, it is a loss to the organisation as assets were not optimally used. Even though there is a remaining life time of asset, organisations go for asset replacement when there is no economic life of physical asset (Muñoz-Porcar et al., 2015). Therefore, before replacing an asset it is necessary to consider the economic life of the physical asset which organisation initially predicted.

Future Strategic Plan of the Organisation:

Strategic planning is the process of defining an organisation's plans for achieving its mission. An organisational strategy is a derived approach to achieve its mission (Gates, 2010). According to the future plan of organisation, the future asset needs can be changed and hence, future strategic plan of the organisation will affect the physical asset repair replacement decision. Therefore, physical asset replacement decisions should be taken based on the future strategic plan of the organisation. There is no point of repairing and remaining existing assets if the organisation is going to change their business activities. Based on the

situation, organisations can take decision regarding of physical asset repair/ replacement (Gage, 2013).

Reparability of the Asset:

In an asset failure, components fail to meet their performance requirement and it will naturally lead to arise a need for repair. Some of the failures cannot be repaired due to lack of suitable technicians, expertise (qualified technician), and lack of spare parts (Gage, 2013). Most of the organisations have their own technicians. They may not be familiar with high technology equipment. Therefore, organisations have to hire suitable technicians. Cost of hiring technicians may be higher and also in some situations, there may not be suitable technician as well as there may not be some parts. In such a situations, organisations cannot repair existing assets and the only option available is to replace the asset with a new one (Gage, 2013).

Recognition and Acceptance of Past Errors:

While considering the past errors of physical asset, organisation can make decisions regarding physical asset repair and replacement (Muñoz-Porcar et al., 2015). Moreover, identifying the areas where the assets have failed in the past and accepting such failures while redirecting towards correction of such errors is important in physical asset repair/ replacement decision making. Past estimation error should also be recognised before making the asset replacement decisions in an organisation (Sullivan, 2011).

Existing Asset Value and the Outsider Viewpoint:

The book value or market value of assets in the existing business could be different to outside value within the company. Their view point is in the form of potential growth of the company and it will be reflected in company share price. Before replacing an asset, it is necessary to consider the existing asset value (Munoz-Porcar et al., 2015). The outside view point is also known as the opportunity cost approach to determine the value of the defender (Sullivan, 2011).

Profitability:

Profitability is the ability of a business to earn profits. According to Tiwari (2015), there is a relationship between profitability and asset repair and replacement decision making. Organisations decide to remain the existing physical asset or replace with new one in a way that it maximise the profitability of organisation (Hastings, 2010).

Capacity and Capability:

Capacity is the maximum level of output that a company can sustain to make a product or provide a service and the capability is the measure of the ability of an entity to achieve its objectives, especially in relation to its overall mission (Hastins,2010). The capacity of the assets to cater the required purpose/ performance should also be considered in decision making in asset repair/ replacement.

Capital Budget:

Capital budget is the plan for raising large and long-term sums for investment in plant and machinery, over a period greater than the period considered under an operating budget. According to Leitner and Behrens (2014), organisations highly consider about their investment. Therefore, capital budget also affects the physical asset repair/replacement decision making process. If the organisations do not have purchasing capacity to acquire a new asset, organisation has to go for repairing decision.

Criticality:

Organisations cannot survive or run their operations without having some assets, i.e. assets which are critical to their operations. Therefore, organisations have to consider about the criticality of the physical assets. Further, it is important to predict the reliability of complex repairable systems accurately, especially during long periods of operation (Sun et al., 2007). Replacement of new asset is better than repairing when the state of the equipment is in high criticality (Hastins,2010). Ranking the physical assets according to their criticality will help the organisations to make repair/ replacement decisions easily based on them. Criticality assessment for physical asset repair/replacement can be done by using various techniques. According to Healy (2006), most common technique is quantitative assessment. Quantitative assessment depends on historical data and past experience and also it is based on probability of failure and cost of each failure event.

Technology:

Technology/ technological innovation also affects the decision making in physical asset repair and replacement (Hastins,2010; Park, 2002). New physical assets perform better than the existing assets. And also lower deterioration, minimum operation and low maintenance cost due to technical changes can be seen in new assets (Mardin,2012).

Obsolescence:

Obsolescence is the significant decline in the competitiveness, usefulness, or value of physical assets. Obsolescence occurs generally due to the availability of alternatives that perform better or are cheaper or both, or due to changes in user preferences, requirements, or styles (Hout, 2016). It is distinct from fall in value (depreciation) due to physical deterioration or normal wear and tear (Hastings,2010). Physical asset obsolescence occur when asset get older (Hout,2016). Obsolescence is a major factor in operating risk, and may require write off of the value of the obsolete item against earnings to comply with the accounting principle of showing inventory at lower of cost or market value. Insurance companies take obsolescence into account to reduce the amount of claim to be paid on damaged or destroyed property. Due to obsolescence of existing physical asset, organisations have to replace them with new ones(Theron,2016).

Risk Condition:

The risk condition is the description of specific effects that could occur under the assumptions of a plan, and their impact on inputs and resources supporting the plan. However, in asset management process, organisations have to consider the risk and health and safety issues in existing physical assets (Hastains,2010). The main areas of risk associated with assets are safety, finance and environment (Johnson et al.,2011).

CONCLUSION AND FUTURE RESEARCH AGENDA

Optimal asset utilization and operational performance of business organisations are critical to sustain a competitive advantage. Optimal asset utilization leads to increased production, reliability as well as improving the organisation's return-on-capital, and consequently increasing shareholder value. Decision making in physical asset repair/replacement involves knowing how to decide which option is best for organisation's operations and when assets should be replaced will help to control downtime and unexpected costs. Though asset maintenance has received an increasing attention, there is a lack of a comprehensive research in the area of asset replacement. Therefore, the aim of this paper is to review the literature on physical asset repair/replacement decision making practices. A comprehensive literature review identified the factors that trigger physical asset repair/replacement decision making process and tools. More often organisations make decisions considering asset age, asset condition, environmental condition, technical condition, financial condition and other non-financial factors. Some of the other factors identified through literature review include

repairing cost of the old asset, sunk cost, life cycle cost of assets , remaining life time of old assets, economic life of the remaining asset, future strategic plan of the organisation, reparability of the asset, recognition and acceptance of past errors, existing asset value and the outsider viewpoint, income tax consideration, profitability, capacity and capability, capital budget, criticality, technology, obsolescence and risk condition. The literature findings will be used to evaluate the current practice of physical asset repair/replacement decision making of business organisations in Sri Lanka and develop a multi criteria decision making framework for asset repair/ replacement decision making of business organisations in Sri Lanka, in the next phase of study.

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