Assessing the level of application of physical asset management core practices at water boards in Malawi

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1. Introduction

Physical Asset Management (PAM) has earned attention, especially in asset-intensive organizations, and will continue to be a key player affecting the performance of businesses (Amadi-Echendu et al., 2010; Maletic D. M.-N., 2020). This is true, because of the roles assets play in the realization of business objectives. Physical assets are fundamental to the success of both current and future growth of any enterprise (Frolov et al., 2010). Many definitions of PAM are evident in the literature. An asset is defined as “an item, an entity or something that has the actual or potential value for an organization”, while PAM, is concerned with “the balancing of costs, opportunities and risks against the desired performance of physical assets, to achieve the organizational objectives” (ISO 55000, 2014). Studies reveal key components in the definition of PAM i.e. alignment of assets and operations with corporate objectives, decision-making, and action with information, life cycle costing, and a process (Too, 2010). Ngwira and Manase (2016), point out that asset management is characterized by the adoption of an integrative approach, defining service levels and performance standards and limiting them to strategic planning objectives, an optimized investment decision-making approach, adopting a long-term (lifecycle) approach to asset management and demand and risk management (RM). All this characterization shows the multi-disciplinary and holistic nature of PAM. Amadi-Echendu et al. (2010), suggest that the definition should generally be flexible and accommodative since research work and practice are not fully matured, hence ongoing. PAM in this study is defined as the process of utilizing physical assets from creation to disposal to strike the right balance between performance, cost, and risks in pursuing the enterprise goals.

Generally, there is a lack of consensus among researchers over the origins of PAM, the discipline has evolved with time from different enterprises hence it attracts diverse understanding and approaches. Hastings (2015) states that the development of PAM has been a trademark of human activity from early times, therefore, a developed system of manufacture, maintenance, and logistic support for these assets must have existed from a very early date. This is supported by the citizens of Ur who were familiar with wagons dating from 2600 B.C. for transportation and war (Hastings, 2015). It is unanimously revealed that World Wars played a key role in the introduction of PAM in military systems. Literature reveals that disasters/accidents, financial constraints, legislation, and the publication of international standards as some of the key factors that influenced the evolution of PAM (Edwards, 2019). For example, in the UK, the Piper Alpha disaster and oil price crash in the late 1980s brought an acceleration of PAM (Woodhouse, 2003). Also, in March 2005, an explosion occurred at BP’s Texas City oil refinery where 15 people were killed leading to lawsuits and inquiries, this led to intensified consideration of PAM (Hastings, 2015). Carolyn Merritt, who chairs the US Chemical Safety Board, said in October 2006 that: In New Zealand, Australia, South Africa, and the UK the implementation of PAM was

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primarily due to reforms by local governments, decentralization, and registrations (Bhagwan, 2009). Most asset-intensive industries started managing their assets in the 1960s with an aim of maximizing the value of asset portfolios throughout their life cycle (Bulita, 1994). Generally, the complexity of asset systems in terms of size, technology, and cost will continue to put more pressure to institutions to prioritize PAM.

Studies reveal many PAM goals such as cost efficiency, capacity matching, meeting customer needs, and market leadership (Too, 2010), each of these goals is needed for the success and sustainability of an asset-intensive enterprise. Therefore, it is important to base PAM practices on the strategic objectives of the business in line with available resources, with customers in mind, and in the best interest of stakeholders. Literature reveals that apart from financial significance, PAM is driven by the aging of assets, changing stakeholder and service requirements, amplified emphasis on public health and safety, and increasing stringent requirements set by regulating bodies (Frolov et al., 2010). Unpredictable natural disasters and climate change will also continue to pose a great challenge in PAM. Patirhana et al. (2021), point out that PAM was born as a response to the poor state of maintenance of infrastructure due to resource constraints and the complexity of infrastructures. Komljenovic et al. (2015), argue that for complex organizations, traditional approaches to strategic planning, asset management, and decision-making cannot adequately solve growing problems in these organizations, so a new approach was required. The study by Maletic et al. (2018), clearly indicates how PAM practices positively influence the performance of asset-intensive enterprises.

PAM core practices are progressively maturing on the ground. Literature reveals; strategy and planning, risk management, life-cycle delivery, asset information, and asset review as PAM core practices (Frolov et al., 2010; Thashayini and Rajini, 2017; Thashayini et al., 2018; Gavrikova et al., 2020; Maletic D. M.-N., 2020). While literature is generally showing several studies regarding PAM globally (Maletic et al., 2018; Al Marzoqqi et al., 2019; Maletic D. M.-N., 2020), very little is known to the best of the authors’ knowledge, research that addresses PAM core practices and their link to operational performance in water utilities. Recent studies on PAM core practices concentrated only in organizations located in Europe and mostly in the manufacturing industry with less than 1% data in water utilities (Maletic et al., 2018; Maletic D. M.-N., 2020). Although studies reveal that most utilities have adopted PAM practices, optimized PAM practices are not practiced (Rajala and Hukka, 2018). The lack of optimized PAM practices may be attributed to a lack of awareness of the benefits associated with it or other factors requiring further studies. Literature regarding PAM in developing countries in Africa such as Malawi is scarce. As part of the ongoing research, studies relating to critical success factors and factors that trigger PAM in Water Boards (WBs) in Malawi were earlier done by the authors (Msongole et al., 2022). The key findings in these studies were that response to incidents or high-profile events, financial constraints, increasing system demand for maintenance, reconstruction, performance, and management, and regulation and registration by the government were the top factors that triggered PAM at WBs in Malawi. Also, top management support, availability of financial resources, and portfolio intelligence were among the key critical success factors for PAM at WBs in Malawi. There is a need for further studies that link the performance of organizations to PAM core practices. Therefore, this study sought to address that gap by assessing the level of application of PAM core practices in WBs in Malawi.

1.1. Methodology

This is a quantitative research study, primary data from a survey of all water supply professionals in all (five) WBs in Malawi (refer to Figure 1) based on PAM core practices that were identified through literature review and experts’ opinions was used. The questionnaire was preferred because it is suitable, easier, rapid, uniform, and economical to collect data, and the main objective of its use is to obtain relevant information most reliably and validly (Samani, 2016; Sekaran and Bougie, 2016). The objectives of the research and the pattern of the questions were explained in detail to the respondents. All questionnaire items were subjected to validity and reliability tests. Validity explains how well the collected data covers the actual area of investigation, while reliability concerns the extent to which a measurement provides stable and consistent results (Kumar, 2010). Respondents were asked to rate (refer to appendix 1) according to the aggregated experience in their company on a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) to what extent their organizations were applying PAM core practices. The mean score of 3 and above was considered an indication that PAM core practices are fairly applied in the study area.

2. Results

A total of 33 questionnaire items under five core practices were developed using a 5-point Likert scale. The pilot test was done for 10 water utility professionals followed by a questionnaire review. Out of 141 questionnaires distributed to all water utility professionals managing water supply systems in all five WBs in Malawi, 106 were completed and were declared valid, representing a 75% response rate. This reflected the importance the respondents put on the research area. The sample size is considered sufficient to carry out an analysis and is within what is provided in other earlier PAM studies (Emmanouilidis and Komonen, 2013; Maletic et al., 2017). All 33 factors had 2-tailed significance values of less than 0.05, therefore, all the 33 items were valid, and also, had Cronbach's Alpha of 0.931, which suggests excellent reliability (Hinton et al., 2004). For an exploratory or pilot study, the literature reveals that reliability should be equal to or above 0.60 (Straub et al., 2004).

From the analysis, 16% of the respondents work with Lilongwe Water Board (LWB), 17% with Blantyre Water Board (BWB), 21% with Central Region Water Board (CRWB), 22% with Northern Region Water Board (NRWB), and 23% with Southern Region Water Board (SRWB). The majority of the responses were from managers and officers (35 %), supervisors (23 %), and directors (6%). In terms of qualifications, 36% of respondents possessed a master's degree and above, 40% had undergraduate degrees, and 23% had diplomas. The results indicate that all the respondents possessed diplomas and above but also were at supervisory level and above. Therefore, it would be expected that such respondents were capable of understanding the contents of the questionnaire and interpreting the results and had considerable knowledge of water supply and PAM. The level of education is also crucial in the integration of new knowledge and implementation of PAM projects.

2.1. Descriptive statistics and correlations

Table 1 and Table 2 show ranked descriptive statistics and bivariate correlations respectively for PAM core practices in this study. The means for the 5 core practices range from 1.909 to 2.865, and the standard deviation (SD) varies from 0.291 to 0.549, which is generally low and this shows some kind of consensus among professionals on the assessment of PAM practices in the water supply. The standard error mean, varies from 0.028 to 0.053, which is small, this shows that the sample means closely represent the true population mean. All five core practices show that they have a statistically significant positive linear relationship among themselves (correlation is significant at the 0.01 level (2-tailed)). It is also observed from Table 2 that asset information at 0.659, is the strongly related factor to risk management, and asset review at 0.368 is the lowest related factor to asset information. Generally, all these core practices tend to increase together.

3. Discussion

3.1. Life cycle delivery

Life cycle delivery was rated first in this study with an average score of 2.865. PAM involves all stages of asset life i.e. from creation to
disposal, hence it impacts every stage of the asset lifecycle. It is observed from this study that utilities are putting more emphasis on life cycle delivery practices which are also under the exploitation phase possibly because of the huge operational and maintenance costs involved, yet most of these costs were already factored in during the creation and establishment phase (Amadi-Echendu, 2004; Edwards, 2019), hence each of the stages in asset life cycle must be seriously managed for total utilization of asset management system.

Figure 1. Study area showing Water Board Headquarters Offices in Malawi (Source: NRWB GIS Section 2022).
Table 1. PAM Core Practices – Descriptive statistics.

Descriptive Statistics of Physical Asset Management Core Practices at Water Boards in Malawi

| Item | Physical asset management core practices | Mean | Std. Dev. | Std. Error Mean | Strongly disagree % | Disagree % | Neutral % | Agree % | Strongly agree % | Frequency (n) |
|------|------------------------------------------|------|-----------|-----------------|----------------------|------------|-----------|---------|----------------|---------------|
|      | A Lifecycle Delivery                      |      |           |                 |                      |            |           |         |                |               |
| 17   | We evaluate capital expenditure          | 2.877| 0.836     | 0.081           | 39.60                | 34.90      | 23.60     | 1.90    | 0.90           | 106           |
| 18   | requirements considering whole life costs of ownership | 2.708| 0.661     | 0.064           | 40.60                | 48.10      | 11.30     | 0.90    | 0.90           | 106           |
| 19   | We assure the quality of our assets during the whole life cycle phases | 3.019| 0.756     | 0.073           | 27.40                | 43.40      | 29.20     | 0.90    | 0.90           | 106           |
| 20   | We assure execution of maintenance processes within all assets' life cycle phases | 2.877| 0.813     | 0.079           | 39.60                | 33.00      | 27.40     | 0.90    | 0.90           | 106           |
| 21   | We continuously rationalize our assets to reduce the production cost | 2.783| 0.828     | 0.080           | 46.20                | 30.20      | 22.60     | 0.90    | 0.90           | 106           |
| 22   | We execute the disposal of assets in accordance with the asset management plan | 2.925| 0.777     | 0.075           | 34.00                | 39.60      | 26.40     | 0.90    | 0.90           | 106           |
|      | B Risk management                         |      |           |                 |                      |            |           |         |                |               |
| 10   | We continuously perform a risk assessment of the company's strategic objectives | 2.962| 0.729     | 0.071           | 28.30                | 47.20      | 24.50     | 0.90    | 0.90           | 106           |
| 11   | Risk management is an integrated part of the asset management strategy | 2.972| 0.786     | 0.076           | 32.10                | 38.70      | 29.20     | 0.90    | 0.90           | 106           |
| 12   | We perform risk assessment in order to minimize business losses | 3.075| 0.786     | 0.076           | 17.90                | 61.30      | 17.90     | 2.80    | 0.90           | 106           |
| 13   | We embed risk into all activities which could affect assets performance | 2.943| 0.768     | 0.067           | 11.30                | 0.90       | 61.30     | 26.40   | 2.80           | 106           |
| 14   | We analyze equipment failure causes and effects to address risk | 2.858| 0.682     | 0.066           | 30.20                | 54.70      | 14.20     | 0.90    | 0.90           | 106           |
| 15   | We analyze the operation, production, quality, and logistic process and address the risk | 3.057| 0.688     | 0.067           | 17.90                | 61.30      | 17.90     | 2.80    | 0.90           | 106           |
| 16   | We analyze IT-system, business systems, human resources, competence, etc., and address risk | 2.481| 0.707     | 0.069           | 0.90                 | 61.30      | 26.40     | 11.30   | 2.80           | 106           |
|      | C Asset Information                       |      |           |                 |                      |            |           |         |                |               |
| 23   | We exploit information systems to support asset management activities (ERP, CMMS, AMS, or similar ones) | 2.972| 0.525     | 0.051           | 14.20                | 75.50      | 9.40      | 0.90    | 0.90           | 106           |
| 24   | The company collects and analyses data related to asset management activities | 2.481| 0.502     | 0.049           | 15.10                | 16.00      | 43.40     | 10.40   | 15.10          | 106           |
| 25   | We exploit asset history to enhance asset knowledge | 2.943| 1.218     | 0.118           | 15.10                | 16.00      | 43.40     | 10.40   | 15.10          | 106           |
| 26   | We undertake to benchmark to support asset management activities | 2.698| 0.692     | 0.067           | 43.40                | 43.40      | 13.20     | 2.80    | 0.90           | 106           |
| 27   | We search for external sources (e.g., partners, customers, research institutions) in order to obtain the newest knowledge and expertise | 2.528| 0.556     | 0.054           | 50.00                | 47.20      | 2.80      | 0.90    | 0.90           | 106           |
|      | D Asset review                            |      |           |                 |                      |            |           |         |                |               |
| 28   | We monitor the organization's asset management performance | 2.387| 0.489     | 0.048           | 61.30                | 38.70      | 0.90      | 0.90    | 0.90           | 106           |
| 29   | We monitor the condition of critical assets | 2.934| 0.887     | 0.086           | 39.60                | 30.20      | 27.40     | 2.80    | 0.90           | 106           |
3.2. Risk management

Risk management with an average of 2.853, was rated second in this study. Although respondents acknowledged that some practices in the study area relate to RM, many of those practices are a result of regulatory and other financial global standards other than PAM. It should be emphasized that RM is an essential element of PAM (Thatshayini et al., 2018), hence it should be vigorously promoted. Apart from reducing risks, RM sustains a competitive advantage to enhance performance and has a direct impact on business success (Wang and Yuan, 2011). RM is best known to reduce the possibility of many threats such as financial uncertainties, legal liabilities, accidents, and natural disasters, hence top management must promote its practice in PAM.

3.3. Asset information

Asset information with an average of 2.725, was rated third in this study. Portfolio intelligence is very key to the success of PAM.

Table 1 (continued)

| Item | Physical asset management core practices | Mean | Std. Dev. | Std. Error Mean | Strongly disagree % | Disagree % | Neutral % | Agree % | Strongly agree % | Frequency (n) |
|------|----------------------------------------|------|-----------|-----------------|---------------------|------------|-----------|--------|-----------------|---------------|
| 30   | We regularly review the overall efficiency of asset management activities | 2.208 | 0.686 | 0.067 | 15.10 | 49.10 | 35.80 | 106 |
| 31   | We regularly review the overall effectiveness of asset management activities | 2.236 | 0.724 | 0.070 | 17.00 | 42.50 | 40.60 | 106 |
| 32   | We monitor key performance indicators (KPIs) to verify the achievement of the organization’s asset management goals | 2.189 | 0.634 | 0.062 | 12.30 | 56.60 | 31.10 | 106 |
| 33   | We proactively pursue continuous improvement of asset management activities | 2.377 | 0.487 | 0.047 | 62.30 | 37.70 | 106 |

Table 2. PAM core practices - correlations.

| PAM Core Practices | Lifecycle Delivery | Risk Management | Asset Information | Asset Review | Strategy and Planning |
|--------------------|--------------------|-----------------|-------------------|--------------|----------------------|
| Lifecycle Delivery | Pearson Correlation | .648 ** | .655 ** | .583 ** | .495 ** |
| Sig. (2-tailed)    | 0                  | 0              | 0                 | 0            | 0                    |
| Risk Management    | Pearson Correlation | .648 ** | 1               | .659 ** | .550 ** | .529 ** |
| Sig. (2-tailed)    | 0                  | 0              | 0                 | 0            | 0                    |
| Asset Information  | Pearson Correlation | .655 ** | .659 ** | 1 | .368 ** | .462 ** |
| Sig. (2-tailed)    | 0                  | 0              | 0                 | 0            | 0                    |
| Asset Review       | Pearson Correlation | .583 ** | .550 ** | .368 ** | 1 | .564 ** |
| Sig. (2-tailed)    | 0                  | 0              | 0                 | 0            | 0                    |
| Strategy and Planning | Pearson Correlation | .495 ** | .529 ** | .462 ** | .564 ** | 1 |
| Sig. (2-tailed)    | 0                  | 0              | 0                 | 0            | 0                    |

** Correlation is significant at the 0.01 level (2-tailed).
adage that says ‘what you cannot measure, you cannot improve’. With the increasing complexity of asset systems and technology, having established an asset register there is a need to continuously capture asset information in operation to assist in decision making. There are several packages on the market that can be utilized to capture, analyze and display asset information in operation. Top management needs to support PAM information systems to support decision-making.

3.4. Asset review

Asset review with an average of 2.388, was rated fourth in this study. Having knowledge of asset base and their performance, it is vital that reviews are carried out which would help to provide feedback to management and trigger necessary action on the asset management system. Based on what information is captured in the asset system, an asset review must come in to give direction on the possible course of action. Top management needs to support recommendations from the asset review to fully optimize the asset performance.

3.5. Strategy and planning

Strategy and planning with an average score of 1.909, was rated fifth in this study yet this practice is very crucial in facilitating PAM practices from asset creation to disposal. Although it was rated the least, item 9 (we create strategic asset management plans including costs estimation) at 3.302, was the highest rated of all the factors in the analysis. Most WBs are good at asset creation and establishment phases of the asset lifecycle. All PAM definitions point to a multi-disciplinary and holistic approach with linkage to organizational strategy (Amadi-Echendu et al., 2010; ISO 55000, 2014), therefore, it is expected that executive management supports the establishment of PAM policy, objectives, and plans which should be part of the strategic goals of the organization. Studies show that policy and strategy are positively related to PAM (Maletic et al., 2018). Also, there is great emphasis on the linkage between business objectives and asset performance measurements (Parida, 2016). Therefore, it is expected that as strategy and planning in PAM are prioritized, asset performance is enhanced.

4. Conclusion

This study used a survey to assess PAM core practices at WBs in Malawi. From the results, all the core practices except asset review, and strategy and planning average above half the maximum score of 5 but below the set mean score of 3 and above for fair application of PAM practices, therefore, it can be concluded that PAM core practices are decimally applied in the study area. The low application of PAM practices can be attributed to a lack of linkage between physical asset management and strategic business goals to earn executive management support, this is also depicted by low scoring of strategy and planning. This exposes gaps that exist in PAM in the study area that could be addressed to improve service delivery. The study is significant in that it raises awareness of PAM practices in water supply, and this contributes to the existing literature. The results of this study will assist in the development of an asset management framework for WBs in Malawi as ongoing research work, There is a need to identify more PAM practices in the study area which could have a bearing on the discipline. Also, a study is proposed which could link these PAM practices and how they affect the performance of asset-intensive organizations.

Declarations

Author contribution statement

Stanford Sunday Msongole: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Rhoda Cynthia Bakuwa; Burnet O'Brien Mkandawire: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

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Data availability statement

Data will be made available on request.

Declaration of interest statement

The authors declare no conflict of interest.

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