Research Paper

Analytic Hierarchy Process in Asset Management Decisions for Public Service Agency Vocational Education

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Abstract

The Ministry of Transportation's Vocational Education Public Service Agency (BLU) has been underperforming in asset optimization, indicating inefficiencies in its asset management plan. This study critically examines existing asset management strategies and leadership effectiveness within the Ministry's vocational education sector. Employing a phenomenological research approach, this investigation prioritizes a deep dove into asset management practices through semi-structured interviews and literature reviews. The findings highlight significant shortcomings in the BLU's asset management and leadership, particularly in failing to meet its asset performance targets. These inadequacies are evaluated using ISO 55000 standards alongside human resources data, assessing five key areas: procurement and supply chain integration, innovative leadership, effective organizational structure, dynamic organizational culture, and human resource development. Analytical Hierarchy Process (AHP) analysis was used to prioritize issues under the Human Resources and Organization criteria. It identified asset management leadership as the most critical focus, with a weight of 0.40. This was followed by organizational culture at 0.23, competency management at 0.17, and both procurement and supply chain management and organizational structure at 0.10. The development of business units was highlighted as a priority over other strategies such as asset utilization and management collaboration. The regulatory framework guiding these strategies includes Minister of Finance Regulation 202/PMK.05/2022, which outlines four strategic asset utilization options. The analysis was proven to be consistent, with all priority weight matrices showing consistency ratios (CR) below 0.1, ensuring the reliability of the findings.

Keywords: *Analytic Hierarchy Process; Asset Management Strategy; Public Service Agency; ISO 55000 HR and Organization*

INTRODUCTION

The Directorate of Public Service Agency (PSA) Financial Administration (Directorate PPKBLU), which operates under the Ministry of Finance of the Republic of Indonesia, is tasked with providing essential financial administration and guidance to PSAs (Van Wart, 2014). This pivotal unit, with a particular focus on asset management, significantly influences the direction and management of PSAs (Windrum, 2008). In its 2016 annual financial report, the Supreme Audit Agency (BPK) of the Republic of Indonesia highlighted a major issue: 57.74% of public tangible assets, valued at IDR 185.7 billion in 2017, were unregistered (Badan Pemeriksa Keuangan (BPK) Republic of Indonesia (2017), 2017). Further investigations by BPK found that 32% of the discrepancies during the Regional Government Financial Statements (LKPD) inspections in 2021 related to fixed assets, highlighting challenges in administration, utilization, alienation, and security (Badan Pemeriksa Keuangan (BPK) Republic of Indonesia, 2021).

Despite a significant emphasis on their core business, PSAs have demonstrated a substantial reliance on the provision of goods and services as a source of revenue, as indicated in the Directorate of PPK BLU's performance report for PSAs. The Ministry of Transportation's Directorate of Financial Management Development of Public Service Agencies (PPK BLU) has observed persistent and recurring asset management issues, particularly within the Transportation Human Resources Development Agency (BPSDMP), from 2017 to 2022, with asset optimization revenues remaining minimal. This underscores the need for PSAs to explore and

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exploit potential beyond their primary services to enhance performance and revenue (Chlivickas, 2014).

The Analytical Hierarchy Process (AHP) is a widely used multi-criteria decision-making (MCDM) technique that has been extensively applied in various fields, including asset management. One of the key applications of AHP in asset management is the prioritization of asset renewals and replacements. Tran et al. (2003) employed AHP and expected maximum utility (EMU) to effectively prioritize irrigation asset renewals in the La Khe irrigation scheme in Vietnam, leading to improved water delivery and service performance. Similarly, Dehghanian et al. (2012) used a fuzzy AHP approach to prioritize critical component types in power distribution systems, enhancing cost-effectiveness and reliability in asset management. AHP has also been utilized in the selection and evaluation of asset managers and maintenance strategies. Maletič et al. (2020) developed an AHP-based framework for selecting asset managers based on their risk management and performance improvement competencies, aiding organizations in planning and developing these competencies. Fouladgar et al. (2012) combined AHP and COPRAS under a fuzzy environment to evaluate and select the most suitable maintenance strategies in mining design, effectively handling uncertainties in ratings and weights.

Beyond asset-specific applications, AHP has been employed in broader asset management contexts, such as facility location selection (Yang et al., 1997), knowledge management tool evaluation (Ngai et al., 2005), and asset and liability optimization in the banking sector (Gupta & Dutta, 2015). The reviewed studies demonstrate the effectiveness of AHP in prioritizing and optimizing asset management strategies across different industries and contexts. The reviewed literature highlights the key benefits of using AHP in asset management, including its ability to effectively prioritize and select asset management strategies, evaluate and select asset managers, and optimize asset-related decisions. The integration of AHP with other techniques, such as fuzzy logic and goal programing, further enhances its ability to handle uncertainties and meet multiple objectives in asset management.

The reviewed literature highlights the positive impact of implementing the ISO 55000 asset management standard on organizational performance. Alsyouf et al. (2018) found that adopting ISO 55000 led to improvements in financial, customer, business processes, and learning and growth perspectives for certified firms in the United Arab Emirates. The ISO 55000 standards provide a framework for facilities managers to take a "joined-up, whole lifecycle approach" to managing and delivering value from assets, but it requires careful planning and implementation (Kriege & Vlok, 2015). The adoption of ISO 55000 has also been shown to significantly change maintenance management practices, enhancing asset utilization and the role of maintenance employees (Ihemegbulem & Baglee, 2016). Márquez et al. (2018) emphasized that companies and organizations need to follow specific steps and structures to achieve optimal results when implementing the ISO 55000 family of asset management standards. Studies in the electric power industry (Ma et al., 2014) and corporate utility companies (Polimac & Polimac, 2016) further demonstrate the benefits of ISO 55000 in improving system performance and reducing operating and maintenance costs. Importantly, the literature underscores the crucial role of human resources in successful asset management under the ISO 55000 framework (Kriege & Vlok, 2015). Integrating human resources across all functional areas can improve overall organizational performance. Additionally, researchers have provided methodologies and numerical tools to guide the implementation of PAS 55 or ISO 55000 asset management systems (Minnaar et al., 2013; Platfoot et al., 2014). Overall, the reviewed studies highlight the significant potential of ISO 55000 to enhance asset management practices and organizational outcomes across various industries.

The broader literature on asset management consistently underscores the importance of strategic alignment among human resources, organizational processes, and regulatory frameworks

for effective asset management, revealing a significant research gap in the strategic optimization of asset management within vocational education PSAs (Creswell, 2003). It questions how the integration of these elements can identify strategic factors and how the prioritization of asset management leadership and the formation of business units can be effectively applied to improve asset management strategies in vocational education and facilitate other corporate adjustment initiatives (Boyne, 2002). This gap calls for a focused investigation into strategic elements that can significantly enhance asset management practices in PSAs, particularly those dedicated to vocational education, contributing to the existing body of knowledge by offering insights into the optimization of asset management strategies within this specific context (Arundel et al., 2015).

LITERATURE REVIEW

ISO 55000 HR and Organization Subject Group

Implementing an asset management strategy necessitates a fundamental shift in a company's traditional operational mindset and practices, including the reevaluation of roles, responsibilities, contracts, and organizational structures (Demircioglu & Audretsch, 2020). The Institute of Asset Management (Laue et al., 2014) highlights the complexities involved in embedding asset management principles into the daily routines of supply chain personnel, staff members responsible for asset management tasks, and senior managers. This transition challenges the status quo, making it difficult for personnel at all levels to adapt to and embrace new asset management concepts and practices (Howarth, 2006). As the literature suggests, the success of implementing such strategies hinges on developing an organizational culture conducive to effective asset management, underpinned by strong leadership (Currie et al., 2008). This requirement underscores the intricate relationship between organizational and human factors and their collective impact on an organization's ability to effectively implement and integrate asset management practices (Campbell et al., 2010).

The ISO 55000 series on asset management underscores the importance of integrating human resources (HR) and organizational issue groups to evolve business practices toward more sophisticated asset management capabilities (White et al., 2011). Specifically, Table 1 delineates critical subject groups under ISO 55000 HR, including Procurement and Supply Chain Management, Asset Management Leadership, Organizational Structure, Organizational Culture, and Competency Management (Jackson, 2013). Each of these areas plays a vital role in aligning outsourced asset management activities with organizational objectives, fostering a whole-life asset management approach, establishing effective organizational structures, cultivating an innovative corporate culture, and managing competencies to meet both organizational and asset management objectives (Grubišić, 2009). This structured approach ensures that all aspects of asset management are strategically aligned with the organization's goals, highlighting the necessity for a comprehensive and integrated approach to asset management (Table 1).

In the broader context of asset management literature, these elements are consistently emphasized as fundamental to achieving excellence in asset management (Ali et al., 2015). The emphasis on Procurement and Supply Chain Management, for example, reflects the need to ensure that external asset management activities are in harmony with the company's objectives, a principle echoed in studies focusing on the integration of supply chain operations with asset management strategies (Uddin et al., 2013). Similarly, the focus on Asset Management Leadership, Organizational Structure, Organizational Culture, and Competency Management aligns with scholarly discussions on the pivotal role of leadership in cultivating an asset management-oriented culture, structuring organizations to support asset management objectives, and ensuring staff competencies align with these goals (Hegazy et al., 2012). This holistic view presented by ISO 55000 is not only about the technical aspects of managing assets but also about fostering an organizational environment where

asset management can thrive, a narrative strongly supported by asset management research and literature (Alabdulkarim et al., 2015).

Strategic human resource management aligns an organization's human capital practices with its overarching business strategy and goals (Sahoo et al., 2011). Key drivers in achieving this include developing a competitive advantage through strategic HR practices that link employee objectives with organizational goals (Barney et al., 1998; Storey et al., 2019), promoting person-environment fit by ensuring congruence between employees and their work environment (Werbel & DeMarie, 2005), measuring and aligning intangible assets like human capital and organizational culture using tools like the Balanced Scorecard and strategy maps (Kaplan & Norton, 2004), integrating strategic HR with knowledge management processes to drive innovation (Trivedi & Srivastava, 2021), aligning business processes by understanding their relationship to strategies (Morrison et al., 2012), leveraging strategy maps to manage intangible assets in line with strategy (Kaplan & Norton, 2004), and engaging in iterative processes of dialog, benchmarking, and measurement to continually refine HR-strategy alignment (Anderson, 2009). Ultimately, properly aligning HR strategies creates mutual benefits for employees and employers, drives business excellence, and is crucial for organizational success as human resources play a vital strategic partnership role (Barney et al., 1998).

Engineering asset management plays a pivotal strategic role in organizations by establishing connections between asset-related activities and strategy development, positively impacting cost, productivity, quality, and overall business outcomes (El-Akruti et al., 2013). It improves business performance by linking key asset management processes, asset performance indicators, and key business performance indicators (Lima & Galleli, 2021). Simplified asset management approaches are crucial for organizational growth, reducing operating costs, minimizing maintenance needs, and effectively managing capital while involving employees throughout the process (Kumar & Patnaikuni, 2012). Identifying core functions of asset management processes through methods like manual text mining and taxonomy development aids in understanding commonalities and variation points (Frolov et al., 2010). Analyzing complex asset management systems from time and space perspectives ensures overall control (Jia-xu et al., 2021). The systematic implementation of asset management systems using methodologies like Agile/Scrum has improved asset management practices (Sari & Elentukh, 2018). Focusing on key areas such as strategic planning, operations, maintenance, and evidence assessments leads to financial success and sustainability (Kangesu, 2012). Organizational structure significantly impacts asset management performance, with hierarchical structures reducing investment proximity and increasing managerial herding, lowering portfolio concentration and performance (Massa et al., 2008). Optimized cross-asset management procedures can save resources and minimize negative socioeconomic, technical, and environmental impacts (Deix et al., 2012). Effective asset management process modeling requires intuitive representation, fast implementation, sound evaluation, and system integration (Sun et al., 2012).

The detailed analysis of the strategic role of engineering asset management highlights several key factors for successful implementation, as evidenced by the points outlined in Table 1 of the ISO 55000 asset management series. While the benefits of strategic asset management are clearly established, such as improved organizational performance, cost reduction, and process optimization (El-Akruti et al., 2013; Lima et al., 2020; Kumar & Patnaikuni, 2012), the ISO 55000 standard underscores the crucial importance of integrating human resources and organizational aspects to create an enabling environment for excellence in asset management. The factors listed in Table 1, including procurement and supply chain management, asset management leadership, organizational structure, organizational culture, and competency management, play a vital role in aligning asset management activities with organizational objectives (Jackson, 2013; Grubišić,

2009). This holistic approach reflects the findings from the scientific literature, which emphasize the need for strategic integration of human, organizational, and technical factors for effective and sustainable asset management (Alabdulkarim et al., 2015).

Table 1. ISO 55000 HR and organization Subject Group

NO	SUBJECT	DESCRIPTION
1	Procurement and Supply Chain Management	The process through which a business ensures that all asset management activities that are outsourced align with its asset management objectives and that the results of these activities are monitored about those objectives.
2	Asset Management Leadership	Organizational leadership is necessary to support a whole-life asset management approach to achieve organizational goals and organizational asset management.
3	Organizational Structure	An effective organizational structure with a wide range of functions can help achieve asset and organizational management objectives.
4	Organizational Culture	An innovative corporate culture can help achieve asset management and organizational goals.
5	Competency Management	Companies use strategies, including competence management, to systematically generate and maintain the pool of capable and motivated workers needed to meet organizational and asset management objectives.

While the previous discussion highlights the need for a systematic and structured approach to integrate critical factors such as asset management leadership, organizational structure, organizational culture, and competency management to achieve asset management excellence, a research gap remains in identifying and prioritizing the most influential strategic factors within specific organizational contexts, such as vocational education institutions. Although ISO 55000 provides a comprehensive framework, there is a need to address this gap. The application of the Analytical Hierarchy Process (AHP), a proven multi-criteria decision-making technique, can offer an effective solution. AHP has demonstrated its effectiveness in prioritizing and optimizing asset management strategies across various industries (Tran et al., 2003; Dehghanian et al., 2012; Maletič et al., 2021). By employing AHP, this study can identify the most critical strategic factors and prioritize them in the context of asset management in vocational education institutions. This approach will facilitate more structured and informed decision making and contribute to the advancement of knowledge in the field of asset management within the vocational education sector.

Analytic Hierarchy Process

AHP, a multicriteria decision-making method that breaks down complicated issues into a multilevel hierarchical framework of objectives, criteria, and alternatives, is helpful in the representation of choice operations (Sharma & Pratap, 2013). Pairwise comparisons are used to determine the relative relevance of variables at each level of the hierarchy and evaluate options at the bottom to determine which option is best (Janeš et al., 2018). When subjectivity is present, using AHP in decision making might be beneficial. When choosing criteria, subcriteria can be arranged hierarchically and applied (Tuzmen & Sipahi, 2011). Within a multilayer hierarchical framework, AHP establishes relative priorities on an absolute scale of pairwise comparisons that are discontinuous and continuous (Saaty & Vargas, 1987). Using a comparison scale (see Table 2) created by (Saaty & Vargas, 2001), a number is assigned to represent the relative importance of each criterion in the prioritizing process. The methods for figuring out the significant values are provided by the pairwise comparison matrix of these attributes (Sharma & Pratap, 2013).

Table 2. Pairwise Comparison Scale

Intensity of Importance	Explanation
1	Two criterions contribute equally to the objective
3	Experience and judgement slightly favor one over another
5	Experience and judgement strongly favor one over another
7	Criterion is strongly favored and its dominance is demonstrated in practice
9	Importance of one over another affirmed on the highest possible order
2, 4, 6, 8	Used to represent compromise between the priorities listed above

Source: Saaty (1996) and Yuksel and Dagdeviren (2007)

Three key ideas form the foundation of the Analytic Hierarchy Process (AHP) technique: model structure, comparative evaluation of criteria and/or alternatives, and priority synthesis. According to various studies (Arslan & Turan, 2009; Kajanus et al., 2004; Kangas et al., 2001; Kurttila et al., 2000; Lee & Walsh, 2011), AHP has been frequently employed in the literature to handle various decision-making difficulties.

The choice problem is hierarchically arranged in the first stage (Dağdeviren et al., 2009). An intricate multicriteria decision-making problem is first broken down by AHP into a hierarchy of connected decision elements (criteria, decision alternatives). Options, selection criteria, and objectives are arranged in a family tree-like hierarchy of AHP (Albayrak & Erensal, 2004).

Comparing alternatives and/or criteria is the second phase. Finding the relative significance of the criteria is the first step in the prioritization process, which starts after the problem is outlined and the hierarchy is established. Using the standards established at a higher level as a reference, the criteria at each level are evaluated in pairs based on their relative influence. A conventional nine-level comparison scale serves as the foundation for repeated pairwise comparisons in AHP (Albayrak & Erensal, 2004).

Let us assume for the time being that the collection of criteria is C = {Cj | j = 1, 2,... n}. The results of pairwise comparisons on n criteria are represented by each component aij (i, j = 1, 2,..., n) of a (n x n) assessment matrix A, which is the quotient of the criteria weights. Equation (1) can be used to express this pairwise comparison as a square matrix and a reciprocal matrix.

$$A = (a_{ij})_{nxn} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ a_{n1} & a_{n2} & . & a_{nn} \end{bmatrix} \quad (1)$$

The final steps involve determining the relative weight of each matrix and normalizing it. The right eigenvector (w), which determines the relative weight in the following way, is linked to the biggest eigenvalue (λ max):

$$A_w = \lambda_{max}.w \quad (2)$$

Assuming full consistency in the pairwise comparisons, Matrix A has rank 1 and λmax=n. In this instance, one of A's rows or columns can be normalized to obtain weights (Albayrak & Erensal, 2004; Borajee & Yakchali, 2011; Wang & Yang, 2007). It should be noted that there is a relationship between the consistency of the pairwise comparison ratings and the quality of the AHP output.

Consistency is determined by the relationship between A's entries (aij x ajk = aik), according to (Dağdeviren et al., 2009). The following formula (Saaty & Vargas, 1987) can be used to determine the Consistency Index (CI):

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (3)$$

To determine whether the evaluation is sufficiently consistent, we can utilize the final consistency ratio (CR). Equation (4) can be used to calculate the CR or the ratio of the CI to the random index (RI).

$$CR = \frac{CI}{RI} \quad (4)$$

The acknowledged upper bound for CR is 0.1. To improve consistency, the review procedure should be repeated if the final consistency ratio is higher than this threshold (Borajee & Yakchali, 2011).

Table 3. Random Index

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

RESEARCH METHOD

Figure 1 illustrates a conceptual literature map that integrates the ISO 55000 HR and organizational topic group, proposed to guide the development of the Public Service Agency (BLU) asset management strategy (Bankins et al., 2017). This framework is also contextualized within the scope of the Management of Public Service Agency (BLU) Regulation Number: 202/PMK.05/2022 of 2022, issued by the Ministry of Finance.

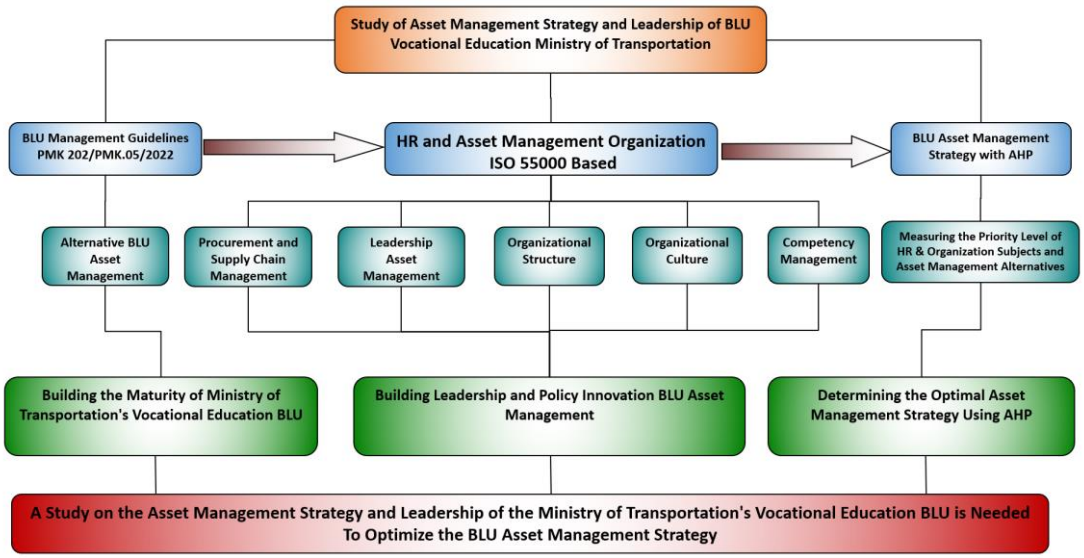

Figure 1. Literature Map

The literature review was conducted using a systematic approach to ensure comprehensive coverage. Scholarly databases including Web of Science, Scopus, and Google Scholar were searched using a combination of relevant keywords such as "asset management," "ISO 55000," "human resources," "organizational structure," "competency management," "public service agencies," and "vocational education." The search included peer-reviewed journal articles, conference proceedings, books, and authoritative reports from reputable organizations. The literature review aimed to synthesize theoretical insights from the ISO 55000 standards with practical regulatory requirements, facilitating a comprehensive approach to asset management within BLUs (Demircioglu, 2018). This integration ensures that asset management practices are not only aligned with international standards but also compliant with national regulations, thereby enhancing the effectiveness and efficiency of asset management in public service agencies (Demircioglu & Audretsch, 2017).

The specifics of the BLU asset management regulations are contained in Minister of Finance Regulation Number: 202/PMK.05/2022 of 2022 on BLU Management Regulations. Until now, the Ministry of Transportation's vocational education BLU has not widely adopted the asset management strategies of using assets against BLU assets, using assets against other party assets, management cooperation with BLU and/or other parties, and building BLU business units (Dhliwayo, 2017). Developing an ISO 55000-based strategy is required as part of the proposal to strengthen BLU asset management (Demircioglu & Chowdhury, 2021). The strategy will focus on the BLU HR and organization subject group and will analyze five (five) subjects: procurement and supply chain management, asset management leadership, organization structure, organization culture, and competency management (Esmer & Dayi, 2017). This study focuses on the ways in which BLU's asset management strategy is influenced by leadership and innovative policy (Frangopol et al., 2017). Table 3 indicates that there are only two (two) strategic objectives, with the best asset management strategy being one of them, as seen from the perspectives of HR and the BLU organization (Girsang et al., 2015). In this situation, the primary objective of the entire asset management process must be optimal asset management. To comply with the ISO 55000 viewpoint and PMK 202/PMK.05/2022 of 2022 on BLU Management Guidelines, it must be backed by additional strategic objectives. Therefore, in addition to the BLU Management Guidelines specified in the Minister of Finance's Regulation No. 202/PMK.05/2022 of 2022, it must be bolstered by additional strategic goals that take into account the viewpoints of organizations and human resources. The topics from the specifications for optimizing BLU asset management procedures are compiled into the strategic objectives given in the HR and organizational viewpoints and BLU management guidelines (Hopland & Kvamsdal, 2016). This viewpoint applies to BLU parties within and outside the organization, which could include the public and private sectors, other BLUs, and the local community (Huang et al., 2014). According to this viewpoint, to maximize BLU's asset management approach, several conditions must be satisfied (Ronald et al., 2017).

Table 4. BLU Asset Management Strategy Map

No	Subject Group	Subject	Strategic Objectives
1	Human resources and the BLU structure	1. Procurement and Supply Chain Management 2. Asset Management Leadership 3. Organizational Structure 4. Organizational Culture 5. Competency Management	Competent human resources and an effective, feature-rich BLU

No	Subject Group	Subject	Strategic Objectives
2	Alternative Asset Management	1. Asset Utilization against BLU Assets 2. Asset Utilization against other party's assets 3. KSM at BLU and/or other parties 4. Business Unit Development	Best Practices for BLU Asset Management

Figure 2 outlines a three-phase research framework designed to determine the optimal asset management strategy for Vocational Public Service Agencies (BLUs). Phase I involves constructing the Analytical Hierarchy Process (AHP) structure by integrating the characteristics of the Vocational BLU, literature review insights, and relevant organizational indicators. In Phase II, qualitative data were collected through structured interviews with key personnel responsible for asset management within the Vocational BLU. The informants, specifically Echelon III and IV officials in charge of assets and the Head of the Business Development Division, were selected based on their direct involvement and decision-making roles in asset management activities. The criteria for selection prioritized those with hands-on experience, comprehensive knowledge of asset management processes, and decision-making authority within the organization. During the interviews, the authors employed open-ended questions to gather in-depth insights into current asset management practices, challenges faced, and potential areas for improvement. The questions aimed to understand the informants' perspectives on factors influencing effective asset management, such as leadership, organizational structure, culture, and competency management.

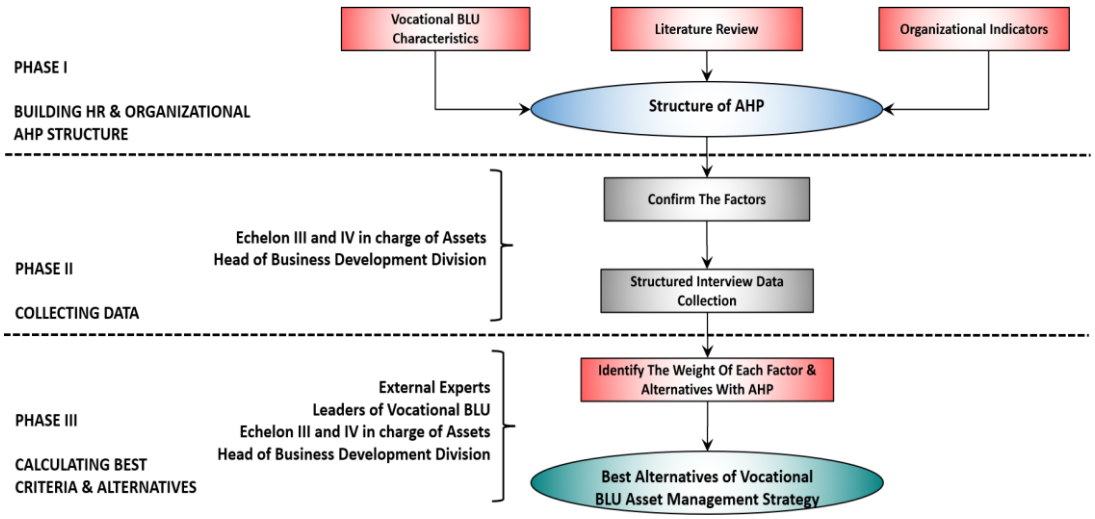

Figure 2. Phase of Proposed Methodology (Modified from Wang and Yang (2007))

In Phase III, the calculation of the best criteria and alternatives through the AHP process involved external experts, Vocational BLU leaders, Echelon III and IV officials in charge of assets, and the Head of the Business Development Division. These stakeholders collaborated to identify the weights of various factors and alternatives. The framework culminates in the identification of the best alternative for the implementation of the vocational BLU asset management strategy. This comprehensive approach integrates inputs from both internal and external stakeholders, ensuring

alignment with organizational objectives while enabling an objective and systematic prioritization of factors influencing effective asset management through the AHP methodology.

The research primarily focuses on leadership in asset management and policy innovation, specifically targeting the HR and organizational issue group within Public Service Agencies (BLU) (Hvidman & Andersen, 2014). Its main objective is to devise an optimal asset management plan for BLUs, with a keen emphasis on strategies that enhance asset management practices (Jing & Osborne, 2017). The study will concentrate on vocational education BLUs under the Ministry of Transportation, including the Banten Shipping Polytechnic (POLTEKPEL), the Indonesian Aviation Polytechnic of Curug (PPIC) in Tangerang, the Indonesian Land Transportation Polytechnic (PTDI) in Bekasi, the Curug Aviation Education and Training Center (BP3C) in Tangerang, the Jakarta College of Shipping Science (STIP), and the Jakarta Center for Refresher and Improvement of Shipping Science Training (BP3IP). These institutions serve as primary examples for illustrating asset management strategies, each with strategic objectives tailored to their specific subject groups (Kaplan & Norton, 2004).

To validate the strategic factors for enhancing asset management in vocational education PSAs, the interview findings were systematically analyzed and incorporated into a structured framework. Upon completing the analysis, a matrix was constructed to highlight key components of the BLUs' asset management plan, integrating the interview findings into this framework (Kaplan & Norton, 2001). This effort was further strengthened by the collective insights of seven asset management experts who contributed their knowledge to evaluate factors that influence the optimization of the BLU asset management system (Kim, 2010). Utilizing the Analytic Hierarchy Process (AHP) technique, a matrix was developed to systematically assess these factors (Greenberg & Nunamaker, 1994). Figure 3 presents the AHP hierarchy structure, illustrating the methodical approach taken to optimize BLU's asset management strategy based on the interview findings and expert inputs. This facilitated a structured and strategic enhancement of asset management within these vocational education institutions (Bentes et al., 2012).

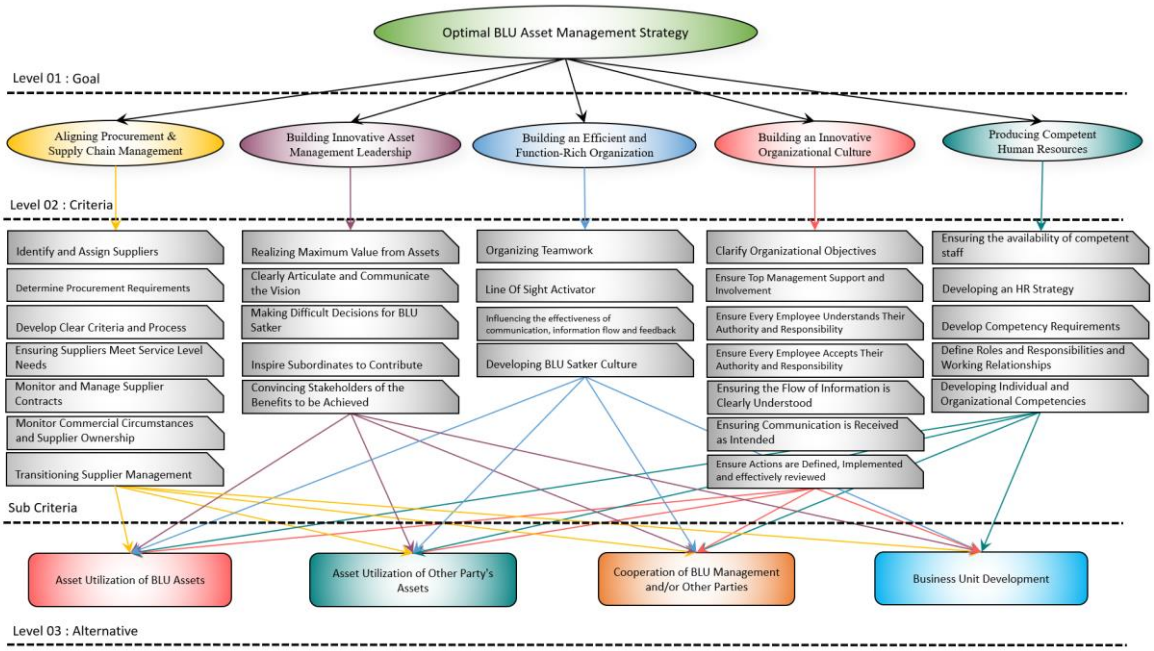

Figure 3. AHP Hierarchy Structure of the Optimization of the BLU Asset Management Strategy

Second, Saaty and Vargas (1987) comparison scale was used to pairwise compare the ISO 55000 subject groupings of HR and organizations. Table 4 displays the matrix priority weight results. Every combination of characteristics was considered while comparing the criteria. The entire comparison matrix was developed by the BLU asset management expert group (Ministry of Finance Republic of Indonesia, 2022). They assessed each criterion's relative value and created a comparison matrix using their professional experience. To decide which alternative BLU to choose, they performed a pairwise comparison of the comparison matrix and hierarchy process with the choice matrix for the BLU asset management strategy.

FINDINGS AND DISCUSSION

Table 5 presents the priority weights of the main criteria for human resources and organization. Asset Management Leadership is the most crucial factor with a degree of importance of 0.40, confirming its central role in encouraging the success of asset management in the Public Service Agency (BLU) for vocational education. Organizational Culture ranks second with a weight of 0.23, emphasizing the importance of fostering an innovative and asset management-oriented corporate culture. Competency Management with a weight of 0.17 underlines the need for strategies to develop and maintain competent and motivated human resources. Meanwhile, Procurement and Supply Chain Management and Organizational Structure both have a weight of 0.10, highlighting the need to ensure alignment between outsourced asset management activities and organizational goals and structures that support the achievement of overall asset management and organizational goals.

Table 5. Priority Weight of the Main Criteria HR and Organization

DESCRIPTION	POLTEKPEL	PPIC	PTDI	BP3C	STIP	BP3IP	IMPORTANCE DEGREES
Procurement and supply chain management	0,20	0,11	0,07	0,08	0,06	0,07	0,10
Asset management leadership	0,45	0,49	0,17	0,11	0,67	0,51	0,40
Organizational structure	0,14	0,14	0,07	0,13	0,07	0,06	0,10
Organizational culture	0,15	0,19	0,39	0,31	0,13	0,19	0,23
Competency Management	0,06	0,07	0,29	0,37	0,08	0,18	0,17
CR = 0,077							

Table 6 presents the priority weight matrix for the Procurement and Supply Chain Management criteria. It can be seen that business unit development is an alternative strategy with the highest importance weight, namely 0.56. These findings underline the need for vocational education BLUs to explore and exploit potential outside their main services to increase performance and income. Furthermore, the use of BLU's own assets and management collaboration with BLU/other parties also play an important role with weights of 0.17 and 0.18, respectively. This emphasizes the importance of optimizing the use of internal assets and collaborating with external parties to effectively manage assets. Meanwhile, the use of assets belonging to other parties has the lowest weight, namely 0.08, indicating a lower priority compared with other factors in the context of asset procurement and supply chain management in vocational education BLU.

Table 6. Procurement and Supply Chain Management Priority Weight Matrix

DESCRIPTION	POLTEKPEL	PPIC	PTDI	BP3C	STIP	BP3IP	IMPORTANCE DEGREES
Utilization against BLU assets	0,12	0,13	0,13	0,18	0,23	0,21	0,17
Utilization against other parties' assets	0,08	0,10	0,06	0,08	0,08	0,10	0,08
Management Cooperation with BLU/other parties	0,19	0,24	0,17	0,16	0,15	0,19	0,18
Business unit development	0,60	0,52	0,64	0,58	0,55	0,50	0,56
CR = 0,053							

The Asset Management Leadership Priority Weight Matrix outlines the relative importance of various strategic initiatives within an organization's asset management framework. In this matrix, business unit development is assigned the highest importance degree at 0.52, indicating a strong strategic focus on expanding and enhancing the organization's operational units, which is crucial for driving growth and improving efficiency. Both "Utilization against BLU assets" and "Management Cooperation with BLU/other parties" receive an equal importance degree of 0.19. This highlights the significance of efficiently leveraging the organization's own assets as well as collaborating effectively with other parties, suggesting a balanced approach to internal asset utilization and external collaboration. "Utilization against other parties' assets" is given a lower priority with an importance degree of 0.10, reflecting a lesser emphasis on relying on external assets for achieving organizational objectives. A consistency ratio (CR) of 0.032 indicates a high level of reliability in the decision-making data, ensuring that the priorities set are both statistically consistent and aligned with the organization's strategic vision. This structured prioritization aids in focusing efforts and resources on the most impactful areas of asset management to optimize overall organizational performance.

Table 7. Asset Management Leadership Priority Weight Matrix

DESCRIPTION	POLTEKPEL	PPIC	PTDI	BP3C	STIP	BP3IP	IMPORTANCE DEGREES
Utilization against BLU assets	0,15	0,13	0,19	0,24	0,19	0,21	0,19
Utilization against other parties' assets	0,08	0,11	0,14	0,09	0,09	0,10	0,10
Management Cooperation with BLU/other parties	0,24	0,25	0,13	0,17	0,18	0,19	0,19
Business unit development	0,53	0,50	0,53	0,50	0,55	0,50	0,52
CR = 0,032							

Table 8 presents the priority weight matrix for the Organizational Structure criteria. It can be observed that business unit development is again the strategic alternative with the highest importance weight, namely 0.55. These findings emphasize the importance for vocational education BLU to expand its business scope beyond its main services to increase organizational performance and income. Furthermore, the use of BLU's own assets and management collaboration with BLU/other parties also play an important role with weights of 0.17 and 0.18, respectively. This

emphasizes the need for an organizational structure that supports the optimal use of internal assets and facilitates collaboration with external parties in effectively managing assets. Meanwhile, the use of assets belonging to other parties has the lowest weight, namely 0.09, indicating a lower priority compared with other factors in the context of the organizational structure that supports asset management in vocational education BLUs.

Table 8. Organizational Structure Priority Weight Matrix

DESCRIPTION	POLTEKPEL	PPIC	PTDI	BP3C	STIP	BP3IP	IMPORTANCE DEGREES
Utilization against BLU assets	0,12	0,13	0,20	0,18	0,23	0,19	0,17
Utilization against other parties' assets	0,08	0,10	0,08	0,08	0,08	0,12	0,09
Management Cooperation with BLU/other parties	0,19	0,24	0,18	0,16	0,15	0,16	0,18
Business unit development	0,60	0,52	0,54	0,58	0,55	0,53	0,55
CR = 0,047							

Table 9 presents the priority weight matrix for the Organizational Culture criteria. It can be seen that business unit development is an alternative strategy with the highest importance weight, namely 0.56. These findings reinforce the importance of the vocational education Public Service Agency (BLU) expanding its business scope beyond main services to increase organizational performance and income, where an organizational culture that supports innovation and business diversification is a key driver. Furthermore, the use of BLU's own assets and management collaboration with BLU/other parties have the same importance weight, namely 0.18, indicating that organizational culture must encourage optimal use of internal assets and facilitate collaboration with external parties in effectively managing assets. Meanwhile, the use of assets belonging to other parties has the lowest weight of 0.08, indicating a lower priority but still needs to be considered so that the organizational culture is open to partnerships and optimal use of external resources in the context of vocational education BLU asset management.

Table 9. Organizational Culture Priority Weight Matrix

DESCRIPTION	POLTEKPEL	PPIC	PTDI	BP3C	STIP	BP3IP	IMPORTANCE DEGREES
Utilization against BLU assets	0,13	0,13	0,18	0,18	0,24	0,22	0,18
Utilization against other parties' assets	0,08	0,10	0,06	0,08	0,08	0,10	0,08
Management Cooperation with BLU/other parties	0,21	0,22	0,19	0,16	0,15	0,16	0,18
Business unit development	0,58	0,54	0,57	0,58	0,53	0,52	0,56
CR = 0,048							

The analysis across Tables 5 to Table 10 offers a detailed examination of priority weights assigned to main criteria and specific sub-criteria within the HR and Organization domains for several vocational education Public Service Agencies (BLUs), highlighting the nuanced priorities

across institutions such as POLTEKPEL, PPIC, PTDI, BP3C, STIP, and BP3IP. A standout observation is the paramount importance of Asset Management Leadership, particularly emphasized by STIP and PPIC, underscoring leadership's crucial role in steering asset management practices. This sentiment is echoed in asset management literature emphasizing leadership's influence on organizational asset management culture and processes (El Syam, 2017; Gazi, 2020; Rafiki, 2020). Furthermore, Organizational Culture and Competency Management emerge as significant, especially in PTDI and BP3C, indicating the recognized need for a supportive cultural framework and skilled personnel to achieve asset management excellence, aligning with literature that highlights these factors as essential for the successful implementation of asset management strategies (Saunders et al., 2008).

Table 10. Competency Management Priority Weight Matrix

DESCRIPTION	POLTEKPEL	PPIC	PTDI	BP3C	STIP	BP3IP	IMPORTANCE DEGREES
Utilization against BLU assets	0,13	0,15	0,14	0,16	0,22	0,19	0,17
Utilization against other parties' assets	0,08	0,09	0,06	0,13	0,07	0,09	0,09
Management Cooperation with BLU/other parties	0,21	0,24	0,18	0,13	0,14	0,18	0,18
Business unit development	0,58	0,52	0,63	0,57	0,56	0,55	0,57
CR = 0,044							

The sub-criteria analysis reveals a consistent emphasis on Business Unit Development across various criteria, indicating a strategic focus on enhancing business units for improved asset management, particularly noted in PTDI and POLTEKPEL for Procurement and Supply Chain Management, and across all institutions for Asset Management Leadership (Höjer & Mjörnell, 2018). This focus suggests a collective agreement on the value of developing business units as a means of optimizing asset management capabilities. Additionally, Utilization against BLU Assets and Management Cooperation with BLU/Other Parties are identified as critical in Competency Management, suggesting an emphasis on leveraging assets effectively and fostering collaborative management practices (Moshkovich & Mechitov, 2017).

The consistency ratios (CR) reported in each table validate the reliability of these assessments, demonstrating a coherent and reliable decision-making process within the AHP framework (Grussing & Liu, 2014). The prioritization of business unit development across multiple facets of asset management reflects a strategic alignment with the literature advocating for structured approaches to enhance organizational asset management capabilities (Lee, 2017). This comprehensive analysis underscores the multifaceted nature of asset management in vocational education BLUs, highlighting the importance of leadership, culture, and competency in driving asset management strategy and execution (Lapuente & Suzuki, 2021).

Table 11 showcases the prioritization of alternative asset management strategies using the AHP, presenting a clear preference hierarchy among the strategies (Leyden, 2016). The eigenvector criteria multiplied by the alternatives indicate the relative degree of importance, culminating in a distinct prioritization: Business Unit Development (51%) emerges as the most significant strategy, underscoring its central role in enhancing asset management practices. This is followed by Management Cooperation Between BLU/Other Parties (23%), highlighting the importance of collaborative efforts in asset management. Utilization Against BLU Assets and Utilization Against

Other Parties' Assets receive lower prioritization, at 17% and 9%, respectively, suggesting that while important, these strategies play a secondary role in business development and cooperative management in the context of optimizing asset management (Ishizaka & Nemery, 2013).

Table 11. Prioritization Level of Alternative Asset Management Strategies with AHP

Alternative Strategies	**Eigenvector Criteria Alternative**					**Importance Degrees**
Utilization against BLU assets	0,0163	0,0743	0,0176	0,0405	0,0290	0,17 (17%)
Utilization against other parties' assets	0,0081	0,0406	0,0092	0,0189	0,0149	0,09 (9%)
Management Cooperation with BLU/other parties	0,0179	0,0771	0,0723	0,0410	0,0314	0,23 (23%)
Business unit development	0,0548	0,2080	0,0563	0,1261	0,0996	0,51(51%)

Building upon the findings from Table 11, Table 12 further breaks down the AHP results based on organization, examining criteria weights and alternative weights across various organizations such as PTDI, STIP, POLTEKPEL, BP3IP, PPIC, and BP3C. Notably, Leadership is highly valued in STIP (67%), indicating a strong emphasis on leadership within their asset management framework. Conversely, Organizational Culture is most emphasized in PTDI (39%) and BP3C (37%), indicating the significance of cultural factors in asset management strategies in these organizations. Competency Management also varies, with PTDI (29%) and BP3C (37%) placing substantial emphasis on this aspect, reflecting the importance of skills and knowledge in asset management. The consistency indexes (CI) and consistency ratios (CR) across organizations underscore the robustness and reliability of the AHP analysis, ensuring that the decision-making process is both coherent and credible.

Table 12. AHP Results Based on Organization

DESCRIPTION	**ORGANIZATION**					
	PTDI	**STIP**	**POLTEKPEL**	**BP3IP**	**PPIC**	**BP3C**
1. Criteria Weight						
a. Procurement management	0,07	0,06	0,20	0,07	0,11	0,08
b. Leadership	0,17	0,67	0,45	0,51	0,49	0,11
c. Organization Structure	0,07	0,07	0,14	0,06	0,14	0,13
d. Organizational Culture	0,39	0,13	0,15	0,19	0,19	0,31
e. Competency Management	0,29	0,08	0,06	0,18	0,07	0,37
2. λ Max	5,36	5,13	5,43	5,30	5,43	5,41
3. CI (consistency index)	0,091	0,032	0,106	0,076	0,109	0,103
4. CR (consistency ratio)	0,081	0,029	0,095	0,067	0,097	0,092
5. Alternative Weight						
a. Utilization against BLU assets	0,13	0,14	0,17	0,19	0,22	0,20
b. Utilization against other parties' assets	0,08	0,10	0,08	0,09	0,08	0,10
c. Management Cooperation Between BLU/other parties	0,21	0,24	0,17	0,15	0,15	0,18
d. Business unit development	0,58	0,52	0,58	0,56	0,55	0,52

To visually summarize the findings from Table 11, Figure 4 illustrates the overall level of importance of alternative asset management strategies derived through AHP. It reinforces the paramount importance of Business Unit Development as a strategy, visually depicting its

dominance over other strategies in the asset management landscape. This aligns with the results presented in Table 11, further emphasizing the central role of business unit development in enhancing asset management practices.

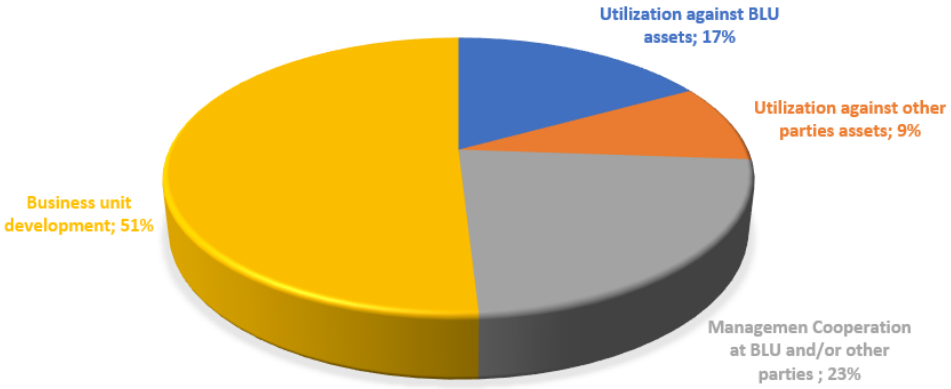

Figure 4. Importance of Alternative Asset Management Strategies with AHP

This comprehensive analysis not only highlights the varied strategic focuses across different organizations and aligns with the literature on asset management, emphasizing the critical role of leadership, culture, and competency in developing effective asset management strategies. The results underscore the strategic value of developing business units and fostering cooperative management as essential components of a successful asset management strategy.

The analysis of alternative asset management strategies within Public Service Agencies (BLUs) in Indonesia, focusing on business unit development and cooperation between BLUs and other parties, can be enriched by considering the strategic asset management practices from the social rented sector in the Netherlands and England, as well as the comparison of municipal property asset management between the UK and Russia (Newnham et al., 2018). The study by Gruis (2005) on housing associations in England and the Netherlands reveals a wide variety of strategic asset management practices, where some approaches can serve as models for BLUs in optimizing their asset management. These approaches include strategic focus, organizational will, portfolio intelligence, and an entrepreneurial culture, which are also emphasized in a study by Phelps (2011) that compared municipal asset management in the UK and Russia.

In an international context, the success of asset managers in global markets, as described by Walter (1999), requires global money management expertise, mastery of diverse markets, and a positive culture with cohesive senior management and motivated staff. This is relevant to the findings in the BLU asset management strategy analysis, where leadership and business unit development are emphasized as key elements. Furthermore, research by Zuashkiani et al. (2011) on asset management curriculum indicates that asset management education programs in North America, Europe, and Australia need improvement in subject coverage and alignment with industrial needs, underscoring the importance of enhancing asset management competencies, which is also a focus in BLU asset management strategies.

The BLU's asset management strategy focuses on Business Unit Development and Management Cooperation, mirroring global trends in enhancing efficiency and innovation in asset management. This approach aligns with the research by Khuntia et al. (2016), which explored asset management in the electric power industry using smart meters and data-mining techniques, indicating the importance of technological innovation in asset management. This affirms that BLUs

in Indonesia can adopt similar approaches to enhance their asset management, leveraging technology, innovation, and strategic cooperation across sectors (Kousky & Kunreuther, 2018).

In conclusion, strategic asset management within BLUs in Indonesia, with an emphasis on business unit development and management cooperation, not only aligns with the ISO 55000 standards and national regulations but can also be enriched and strengthened through benchmarking and adaptation from international best practices in asset management (Windrum & Koch, 2008). By learning from housing associations in England and the Netherlands, as well as municipal asset management in the UK and Russia, BLUs can identify and implement effective asset management strategies to achieve efficiency, sustainability, and innovation in public services (Scott et al., 2018).

CONCLUSIONS

Based on the comprehensive analysis presented in the research, it can be concluded that the development of an effective asset management strategy for Public Service Agencies (BLUs) in Indonesia, particularly in the vocational education sector, requires a multifaceted approach that integrates the ISO 55000 standards, national regulations, and best practices from international contexts. The Analytical Hierarchy Process (AHP) results highlight the paramount importance of Business Unit Development as a strategic priority, followed by Management Cooperation Between BLU/Other Parties, Utilization Against BLU Assets, and Utilization Against Other Parties' Assets. This prioritization underscores the need for BLUs to focus on expanding and enhancing their operational units to drive growth, efficiency, and innovation in asset management. The analysis also reveals the critical role of leadership, organizational culture, and competency management in shaping successful asset management strategies within BLUs. The varying emphasis on these factors across different organizations, such as PTDI, STIP, POLTEKPEL, BP3IP, PPIC, and BP3C, indicates the need for tailored approaches that align with each institution’s unique context and strategic objectives.

In conclusion, the development of a robust asset management strategy for BLUs in Indonesia requires a holistic approach that combines the prioritization of Business Unit Development and Management Cooperation, a strong emphasis on leadership, culture, and competency. To operationalize these findings, BLUs should prioritize the development and expansion of their business units through strategic planning, resource allocation, and the adoption of innovative business models. Leadership development programs should be implemented to cultivate strong asset management leadership, focusing on enhancing decision-making skills, strategic thinking, and the ability to foster a culture of innovation and collaboration. BLUs should invest in competency management initiatives, such as training programs and knowledge-sharing platforms, to ensure that their workforce possesses the necessary skills and knowledge to effectively manage assets. Organizational culture should be actively shaped to support asset management excellence by promoting values such as innovation, collaboration, and continuous improvement, as well as establishing clear performance metrics and incentives. Furthermore, technology adoption and data-driven decision making should be prioritized to enhance asset management efficiency and effectiveness, including the implementation of asset management information systems, predictive maintenance techniques, and data analytics. By implementing these practical implications, BLUs in Indonesia can drive tangible improvements in their asset management practices, ultimately leading to enhanced public service delivery and organizational success.

LIMITATION & FURTHER RESEARCH

Based on the analysis and findings of this study on strategic asset management practices within Public Service Agencies (BLUs) in Indonesia, several recommendations and avenues for

future research can be proposed. First, there is a clear need for BLUs to further integrate and align their asset management strategies with the ISO 55000 standards to ensure that global best practices are adopted. This alignment not only enhances operational efficiency but also ensures compliance with international and national regulatory frameworks. BLUs should prioritize the development of business units and foster management cooperation both within the organization and with external partners to optimize asset utilization and management. Implementing technology-driven solutions, such as smart meters and data analytics, could significantly improve asset management practices by offering real-time insights and facilitating more informed decision making.

For future research, a comparative study of asset management practices between BLUs in Indonesia and their counterparts in other countries could provide deeper insights into the effectiveness of different asset management strategies. Investigating the impact of organizational culture and leadership on the successful implementation of asset management practices offers another promising research direction. Additionally, exploring the potential of emerging technologies, such as the Internet of Things (IoT) and artificial intelligence (AI), in transforming asset management practices within public service agencies could unveil new opportunities for innovation and efficiency improvements. Finally, assessing the long-term financial and operational impacts of adopting ISO 55000 standards in BLUs could provide valuable evidence to support the case for widespread adoption of these practices.

REFERENCES

Alabdulkarim, A. A., Ball, P., & Tiwari, A. (2015). Assessing asset monitoring levels for maintenance operations: A simulation approach. *Journal of Manufacturing Technology Management*, *26*(5). https://doi.org/10.1108/JMTM-01-2013-0003

Albayrak, E., & Erensal, Y. C. (2004). Using analytic hierarchy process (AHP) to improve human performance: An application of multiple criteria decision making problem. *Journal of Intelligent Manufacturing*, *15*(4). https://doi.org/10.1023/B:JIMS.0000034112.00652.4c

Ali, A. S., Chua, S. J. L., & Lim, M. E. L. (2015). The effect of physical environment comfort on employees' performance in office buildings: A case study of three public universities in Malaysia. *Structural Survey*, *33*(4–5). https://doi.org/10.1108/SS-02-2015-0012

Alsyouf, I., Alsuwaidi, M., Hamdan, S., & Shamsuzzaman, M. (2021). Impact of ISO 55000 on organisational performance: evidence from certified UAE firms. *Total Quality Management & Business Excellence*, *32*(1-2), 134-152. https://doi.org/10.1080/14783363.2018.1537750

Anderson, V. (2009). Desperately seeking alignment: reflections of senior line managers and HRD executives. *Human Resource Development International*, *12*(3), 263-277. https://doi.org/10.1080/13678860902982009

Arslan, O., & Turan, O. (2009). Analytical investigation of marine casualties at the Strait of Istanbul with SWOT-AHP method. *Maritime Policy and Management*, *36*(2). https://doi.org/10.1080/03088830902868081

Arundel, A., Casali, L., & Hollanders, H. (2015). How European public sector agencies innovate: The use of bottom-up, policy-dependent and knowledge-scanning innovation methods. *Research Policy*, *44*(7). https://doi.org/10.1016/j.respol.2015.04.007

Badan Pemeriksa Keuangan (BPK) Republic of Indonesia (2017). (2017). *Audit report of the BPK RI 2017*.

Badan Pemeriksa Keuangan (BPK) Republic of Indonesia. (2021). *Audit report of the BPK RI 2021*.

Bankins, S., Denness, B., Kriz, A., & Molloy, C. (2017). Innovation Agents in the Public Sector: Applying Champion and Promotor Theory to Explore Innovation in the Australian Public Service. *Australian Journal of Public Administration*, *76*(1). https://doi.org/10.1111/1467-

8500.12198

Barney, J. B., Bunderson, J. S., Foreman, P., Gustafson, L. T., Huff, A. S., Martins, L. L., ... & Stimpert, J. L. (1998). A strategy conversation on the topic of organization identity. *Identity in organizations: Building theory through conversations*, 99-168.

Bentes, A. V., Carneiro, J., da Silva, J. F., & Kimura, H. (2012). Multidimensional assessment of organizational performance: Integrating BSC and AHP. *Journal of Business Research*, *65*(12). https://doi.org/10.1016/j.jbusres.2011.10.039

Borajee, M., & Yakchali, S. H. (2011). Using the AHP-ELECTRE III integrated method in a competitive profile matrix. *International Conference on Financial Management and Economics*.

Boyne, G. A. (2002). Public and private management: What's the difference? *Journal of Management Studies*, *39*(1). https://doi.org/10.1111/1467-6486.00284

Campbell, J., Jardine, A. K. S., & McGlynn, J. (2010). Asset management excellence: optimizing equipment life-cycle decisions. In *Dekker Mechanical Engineering*. https://doi.org/10.1016/S0952-1976(00)00012-9

Chlivickas, E. (2014). International Cooperation and Innovations for Developing Human Resources System. *Procedia - Social and Behavioral Sciences*, *110*. https://doi.org/10.1016/j.sbspro.2013.12.871

Creswell, J. W. (2003). Research design Qualitative quantitative and mixed methods approaches. *Research Design Qualitative Quantitative and Mixed Methods Approaches*. https://doi.org/10.3109/08941939.2012.723954

Currie, G., Humphreys, M., Ucbasaran, D., & Mcmanus, S. (2008). Entrepreneurial leadership in the English public sector: Paradox or possibility? *Public Administration*, *86*(4). https://doi.org/10.1111/j.1467-9299.2008.00736.x

Dağdeviren, M., Yavuz, S., & Kilinç, N. (2009). Weapon selection using the AHP and TOPSIS methods under fuzzy environment. *Expert Systems with Applications*, *36*(4). https://doi.org/10.1016/j.eswa.2008.10.016

Dehghanian, P., Fotuhi-Firuzabad, M., Bagheri-Shouraki, S., & Kazemi, A. A. R. (2011). Critical component identification in reliability centered asset management of power distribution systems via fuzzy AHP. *IEEE Systems Journal*, *6*(4), 593-602. https://doi.org/10.1109/JSYST.2011.2177134

Deix, S., Alten, K., & Weninger-Vycudil, A. (2012). Procedures for cross asset management optimisation. *Procedia-Social and Behavioral Sciences*, *48*, 2022-2028. https://doi.org/10.1016/j.sbspro.2012.06.1175

Demircioglu, M. A. (2018). The Effects of Empowerment Practices on Perceived Barriers to Innovation: Evidence from Public Organizations. *International Journal of Public Administration*, *41*(15). https://doi.org/10.1080/01900692.2017.1387143

Demircioglu, M. A., & Audretsch, D. B. (2017). Conditions for innovation in public sector organizations. *Research Policy*, *46*(9). https://doi.org/10.1016/j.respol.2017.08.004

Demircioglu, M. A., & Audretsch, D. B. (2020). Conditions for complex innovations: evidence from public organizations. *Journal of Technology Transfer*, *45*(3). https://doi.org/10.1007/s10961-018-9701-5

Demircioglu, M. A., & Chowdhury, F. (2021). Entrepreneurship in public organizations: the role of leadership behavior. *Small Business Economics*, *57*(3). https://doi.org/10.1007/s11187-020-00328-w

Dhliwayo, S. (2017). Defining public-sector entrepreneurship: A conceptual operational construct. *International Journal of Entrepreneurship and Innovation*, *18*(3). https://doi.org/10.1177/1465750317709708

El Syam, R. S. (2017). Prophetic Leadership: The Leadership Model of Prophet Muhammad in Political Relation of Social – Ummah. *Jurnal Pendidikan Islam*, *6*(2). https://doi.org/10.14421/jpi.2017.62.371-396

El-Akruti, K., Dwight, R., & Zhang, T. (2013). The strategic role of engineering asset management. *International Journal of Production Economics*, *146*(1), 227-239. https://doi.org/10.1016/j.ijpe.2013.07.002

Esmer, Y., & Dayi, F. (2017). Entrepreneurial Leadership: A Theoretical Framework. *Mehmet Akif Ersoy Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *4*(2). https://doi.org/10.30798/makuiibf.332570

Fouladgar, M. M., Yazdani-Chamzini, A., Lashgari, A., Zavadskas, E. K., & Turskis, Z. (2012). Maintenance strategy selection using AHP and COPRAS under fuzzy environment. *International journal of strategic property management*, *16*(1), 85-104. https://doi.org/10.3846/1648715X.2012.666657

Frangopol, D. M., Dong, Y., & Sabatino, S. (2017). Bridge life-cycle performance and cost: analysis, prediction, optimisation and decision-making. *Structure and Infrastructure Engineering*, *13*(10). https://doi.org/10.1080/15732479.2016.1267772

Frolov, V., Ma, L., Sun, Y., & Bandara, W. (2010). Identifying Core Functions of Asset Management. In *Engineering Asset Management Review* (Vol. 1, pp. 19–30). https://doi.org/10.1007/978-1-84996-178-3_2

Gazi, M. A. I. (2020). Islamic perspective of leadership in management; foundation, traits and principles. *International Journal of Management and Accounting*, *2*(1), 1-9. https://doi.org/10.34104/ijma.020.0109

Girsang, A. S., Tsai, C. W., & Yang, C. S. (2015). Ant algorithm for modifying an inconsistent pairwise weighting matrix in an analytic hierarchy process. *Neural Computing and Applications*, *26*(2). https://doi.org/10.1007/s00521-014-1630-0

Greenberg, R. R., & Nunamaker, T. R. (1994). Integrating the analytic hierarchy process (AHP) into the multiobjective budgeting models of public sector organizations. *Socio-Economic Planning Sciences*, *28*(3). https://doi.org/10.1016/0038-0121(94)90005-1

Grubišić, M. (2009). Towards Efficient Public Sector Asset Management. *Financial Theory & Practice*, *33*(June 2007).

Gruis, V. (2005). Financial and social returns in housing asset management: Theory and Dutch housing associations' practice. *Urban Studies*, *42*(10). https://doi.org/10.1080/00420980500231696

Grussing, M. N., & Liu, L. Y. (2014). Knowledge-Based Optimization of Building Maintenance, Repair, and Renovation Activities to Improve Facility Life Cycle Investments. *Journal of Performance of Constructed Facilities*, *28*(3). https://doi.org/10.1061/(asce)cf.1943-5509.0000449

Gupta, V., Chauhan, D. S., & Dutta, K. (2015). Exploring reprioritization through systematic literature surveys and case studies. *SpringerPlus*, *4*(1), 539. https://doi.org/10.1186/s40064-015-1320-0

Hegazy, T., Elhakeem, A., Singh Ahluwalia, S., & Attalla, M. (2012). MOST-FIT: Support techniques for inspection and life cycle optimization in building asset management. *Computer-Aided Civil and Infrastructure Engineering*, *27*(2). https://doi.org/10.1111/j.1467-8667.2011.00729.x

Höjer, M., & Mjörnell, K. (2018). Measures and steps for more efficient use of buildings. *Sustainability (Switzerland)*, *10*(6). https://doi.org/10.3390/su10061949

Hopland, A. O., & Kvamsdal, S. F. (2016). Optimal maintenance scheduling for local public purpose buildings. *Property Management*, *34*(2). https://doi.org/10.1108/PM-01-2015-0002

Howarth, A. (2006). *Improving asset management in government departments, A report on improving*

the capability and capacity of managing property assets in central civil government for the office of government commerce.

Huang, J., Lv, H., Gao, T., Feng, W., Chen, Y., & Zhou, T. (2014). Thermal properties optimization of envelope in energy-saving renovation of existing public buildings. *Energy and Buildings*, *75*. https://doi.org/10.1016/j.enbuild.2014.02.040

Hvidman, U., & Andersen, S. C. (2014). Impact of performance management in public and private organizations. *Journal of Public Administration Research and Theory*, *24*(1). https://doi.org/10.1093/jopart/mut019

Ihemegbulem, I., & Baglee, D. (2016). Assessing The Effectiveness of ISO 55000 Standard in Small to Medium Sized Enterprises (SMEs). *AMRC 2016: Propelling Growth in Africa through Maintenance & Reliability*, *1*.

Ishizaka, A., & Nemery, P. (2013). Multi-Criteria Decision Analysis: Methods and Software. In *Multi-Criteria Decision Analysis: Methods and Software*. https://doi.org/10.1002/9781118644898

Jackson, L. A. (2013). Towards an understanding of lodging asset management and its components. *FIU Hospitality Review*, *30*(1).

Janeš, A., Kadoić, N., & Redep, N. B. (2018). Differences in prioritization of the BSC's strategic goals using AHP and ANP methods. *Journal of Information and Organizational Sciences*, *42*(2). https://doi.org/10.31341/jios.42.2.3

Jia-xu, C. H. E. N. G., Guan-ran, W. A. N. G., & Wei-xuan, M. E. N. G. (2021, January). Analysis of Key Processes and Dimensions Based on Complex Assets management Systems. In *2021 2nd International Conference on Urban Engineering and Management Science (ICUEMS)* (pp. 310-313). IEEE. https://doi.org/10.1109/ICUEMS52408.2021.00074

Jing, Y., & Osborne, S. P. (2017). Public Service Innovations in China: An Introduction. In *Governing China in the 21st Century*. https://doi.org/10.1007/978-981-10-1762-9_1

Kajanus, M., Kangas, J., & Kurttila, M. (2004). The use of value focused thinking and the A'WOT hybrid method in tourism management. *Tourism Management*, *25*(4). https://doi.org/10.1016/S0261-5177(03)00120-1

Kangas, J., Pesonen, M., Kurttila, M., & Kajanus, M. (2001). *A'wot: Integrating the AHP with Swot Analysis*. https://doi.org/10.13033/isahp.y2001.012

Kangesu, V. (2012). *Asset Management Key Areas for Financial Success* (pp. 441–458). https://doi.org/10.1007/978-0-85729-493-7_34

Kaplan, R. S., & Norton, D. P. (2001). Transforming the balanced scorecard from performance measurement to strategic management: Part I. In *Accounting Horizons* (Vol. 15, Issue 1). https://doi.org/10.2308/acch.2001.15.1.87

Kaplan, R. S., & Norton, D. P. (2004). The strategy map: guide to aligning intangible assets. *Strategy & Leadership*, *32*(5). https://doi.org/10.1108/10878570410699825

Khuntia, S. R., Rueda, J. L., Bouwman, S., & van der Meijden, M. A. M. M. (2016). A literature survey on asset management in electrical power [transmission and distribution] system. *International Transactions on Electrical Energy Systems*, *26*(10). https://doi.org/10.1002/etep.2193

Kim, Y. (2010). Stimulating entrepreneurial practices in the public sector: The roles of organizational characteristics. *Administration and Society*, *42*(7). https://doi.org/10.1177/0095399710377432

Kousky, C., & Kunreuther, H. (2018). Risk Management Roles of the Public and Private Sector. *Risk Management and Insurance Review*, *21*(1). https://doi.org/10.1111/rmir.12096

Kriege, L., & Vlok, P. J. (2015). Human resources within ISO 55000—The hidden backbone to the asset management system. In *9th WCEAM Research Papers: Volume 1 Proceedings of 2014*

World Congress on Engineering Asset Management (pp. 435-446). Springer International Publishing. https://doi.org/10.1007/978-3-319-15536-4_34

Kumar, D., & Patnaikuni, I. (2012). Why simplified asset management is vital for organizational growth. *International Journal of Construction Engineering and Management*, *1*(3), 14-19. https://doi.org/10.5923/j.ijcem.20120103.01

Kurttila, M., Pesonen, M., Kangas, J., & Kajanus, M. (2000). Utilizing the analytic hierarchy process (AHP) in SWOT analysis - A hybrid method and its application to a forest-certification case. *Forest Policy and Economics*, *1*(1). https://doi.org/10.1016/s1389-9341(99)00004-0

Lapuente, V., & Suzuki, K. (2021). The prudent entrepreneurs: women and public sector innovation. *Journal of European Public Policy*, *28*(9). https://doi.org/10.1080/13501763.2020.1770316

Laue, M., Brown, K., Scherrer, P., & Keast, R. (2014). Integrated strategic asset management: Frameworks and dimensions. *Topics in Safety, Risk, Reliability and Quality*, *24*. https://doi.org/10.1007/978-3-319-02493-6_6

Lee, M. J. (2017). Open Strategies for Innovation in the Public Sector: Challenges and Opportunities. *Thesis*.

Lee, S., & Walsh, P. (2011). SWOT and AHP hybrid model for sport marketing outsourcing using a case of intercollegiate sport. *Sport Management Review*, *14*(4). https://doi.org/10.1016/j.smr.2010.12.003

Leyden, D. P. (2016). Public-sector entrepreneurship and the creation of a sustainable innovative economy. *Small Business Economics*, *46*(4). https://doi.org/10.1007/s11187-016-9706-0

Lima, L., & Galleli, B. (2021). Human resources management and corporate governance: Integration perspectives and future directions. *European Management Journal*, *39*(6), 731-744. https://doi.org/10.1016/j.emj.2021.02.004

Ma, Z., Zhou, L., & Sheng, W. (2014, September). Analysis of the new asset management standard ISO 55000 and PAS 55. In *2014 China International Conference on Electricity Distribution (CICED)* (pp. 1668-1674). IEEE. https://doi.org/10.1109/CICED.2014.6991990

Maletič, D., Maletič, M., Al-Najjar, B., & Gomišček, B. (2020). An analysis of physical asset management core practices and their influence on operational performance. *Sustainability*, *12*(21), 9097. https://doi.org/10.3390/su12219097

Márquez, A. C., López, A. J. G., Rosique, A. S., & Márquez, C. P. (2018). On the family of standards UNE-ISO 55000 and How to Effectively Manage Assets. *Advanced Maintenance Modelling for Asset Management: Techniques and Methods for Complex Industrial Systems*, 1-16.

Massa, M., & Rehman, Z. (2008). Information flows within financial conglomerates: Evidence from the banks–mutual funds relation. *Journal of Financial Economics*, *89*(2), 288-306. https://doi.org/10.1016/j.jfineco.2007.10.002

Ministry of Finance Republic of Indonesia. (2022). *BLU Performance Annual Report 2022*.

Minnaar, J. R., Basson, W., & Vlok, P. J. (2013). Quantitative methods required for implementing PAS 55 or the ISO 55000 series for asset management. *South African Journal of Industrial Engineering*, *24*(3), 98-111. https://doi.org/10.7166/24-3-576

Morrison, E. D., Ghose, A. K., Dam, H. K., Hinge, K. G., & Hoesch-Klohe, K. (2012). Strategic alignment of business processes. In *Service-Oriented Computing-ICSOC 2011 Workshops: ICSOC 2011, International Workshops WESOA, NFPSLAM-SOC, and Satellite Events, Paphos, Cyprus, December 5-8, 2011. Revised Selected Papers 9* (pp. 9-21). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-31875-7_3

Moshkovich, H. M., & Mechitov, A. I. (2017). ORCON - A tool for analysis of ordinal consistency in a pairwise comparison matrix. *International Journal of Management and Decision Making*, *16*(1). https://doi.org/10.1504/IJMDM.2017.082511

Newnham, L. (2018). *The relationship between workplace innovation and organizational culture: a case study of a Victorian public sector organization* (Doctoral dissertation, RMIT University).

Ngai, E. W., & Chan, E. W. C. (2005). Evaluation of knowledge management tools using AHP. *Expert systems with applications*, *29*(4), 889-899. https://doi.org/10.1016/j.eswa.2005.06.025

Phelps, A. (2011). Municipal property asset management - a comparative study of UK and Russia. *International Journal of Strategic Property Management*, *15*(4).

Platfoot, R. A. (2014, November). Improving the delivery of asset management across the enterprise. In *Asset Management Conference 2014* (pp. 1-6). IET. https://doi.org/10.1049/cp.2014.1045

Polimac, V., & Polimac, J. (2016). Holistic approach to asset management with new ISO 55000. https://doi.org/10.1049/cp.2016.1011

Rafiki, A. (2020). Islamic Leadership: Comparisons and Qualities. In *Digital Leadership - A New Leadership Style for the 21st Century*. https://doi.org/10.5772/intechopen.90151

Ronald, A. M., Simanjuntak, & Munizar R. (2017). Preliminary Study of Optimization Model of Local Government Infrastructure Asset Management to Improving the Sustainable Development Performance. *International Journal of Scientific and Research Publications*, *7*(12).

Saaty, T. L. (1996). Decisions with the analytic network process (ANP). *University of Pittsburgh (USA), ISAHP*, *96*.

Saaty, T. L., & Vargas, L. G. (1987). Uncertainty and rank order in the analytic hierarchy process. *European Journal of Operational Research*, *32*(1). https://doi.org/10.1016/0377-2217(87)90275-X

Saaty, T. L., & Vargas, L. G. (2001). *The Seven Pillars of the Analytic Hierarchy Process*. https://doi.org/10.1007/978-1-4615-1665-1_2

Sahoo, C. K., Das, S., & Sundaray, B. K. (2011). Strategic human resource management: Exploring the key drivers. *Employment Relations Record*, *11*(2), 18–32. https://search.informit.org/doi/10.3316/informit.273316664620288

Sari, D. P., & Elentukh, A. (2018, August). Systematic Implementation of ASM (Asset Management System). In *2018 6th International Conference on Cyber and IT Service Management (CITSM)* (pp. 1-5). IEEE. https://doi.org/10.1109/CITSM.2018.8674379

Saunders, M., Bristow, A., & Lewis, P. (2008). Understanding research philosophy and approaches to theory development. In *Research Methods for Business Students (8th edition) Chapter 4*.

Scott, J. T., Link, A. N., & Hayter, C. S. (2018). Public-sector entrepreneurship. *Oxford Review of Economic Policy (2018)*.

Sharma, S., & Pratap, R. (2013). A Case Study of Risks Optimization Using AHP Method. *International Journal of Scientific and Research Publications*, *3*(10).

Storey, J., Ulrich, D., & Wright, P. M. (2019). *Strategic human resource management: A research overview*. Routledge. https://doi.org/10.4324/9780429490217

Sun, Y., Ma, L., Robinson, W., Purser, M., Mathew, A., & Fidge, C. (2012). Renewal decision support for linear assets. In *Engineering Asset Management and Infrastructure Sustainability: Proceedings of the 5th World Congress on Engineering Asset Management (WCEAM 2010)* (pp. 885-899). Springer London. https://doi.org/10.1007/978-0-85729-493-7_68

Tran, T. X. M., Malano, H. M., & Thompson, R. G. (2003). Application of the analytic hierarchy process to prioritise irrigation asset renewals: the case of the La Khe irrigation scheme, Vietnam. *Engineering, Construction and Architectural Management*, *10*(6), 382-390. https://doi.org/10.1108/09699980310509354

Trivedi, K., & Srivastava, K. B. L. (2021). A framework for integrating strategic HR and knowledge management for innovation performance. *Strategic HR Review*, *20*(1), 11-16.

https://doi.org/10.1108/SHR-08-2020-0076

Tuzmen, S., & Sipahi, S. (2011). A multi-criteria factor evaluation model for gas station site selection. *Journal of Global Management*, *2*(1).

Uddin, W., Hudson, W. R., & Haas, R. (2013). Public Infrastructure Asset Management. In *Public Infrastructure Asset Management, Second Edition*.

Van Wart, M. (2014). Dynamics of leadership in public service: Theory and practice. In *Dynamics of Leadership in Public Service: Theory and Practice*. https://doi.org/10.4324/9781315705071

Walter, I. (1999). The Global Asset Management Industry: Competitive Structure and Performance. *Financial Markets, Institutions & Instruments*, *8*(1). https://doi.org/10.1111/1468-0416.00026

Wang, J. J., & Yang, D. L. (2007). Using a hybrid multi-criteria decision aid method for information systems outsourcing. *Computers and Operations Research*, *34*(12). https://doi.org/10.1016/j.cor.2006.01.017

Werbel, J. D., & DeMarie, S. M. (2005). Aligning strategic human resource management and person–environment fit. *Human resource management review*, *15*(4), 247-262. https://doi.org/10.1016/j.hrmr.2005.10.001

White, A. D., Hasbi Hanis, M., Trigunarsyah, B., & Susilawati, C. (2011). The application of public asset management in Indonesian local government: A case study in South Sulawesi province. *Journal of Corporate Real Estate*, *13*(1). https://doi.org/10.1108/14630011111120332

Windrum, P., & Koch, P. (2008). Innovation in public sector services: Entrepreneurship, creativity and management. In *Innovation in Public Sector Services: Entrepreneurship, Creativity and Management*. https://doi.org/10.1080/14719030902860345

Yang, J., & Lee, H. (1997). An AHP decision model for facility location selection. *Facilities*, *15*(9/10), 241-254. https://doi.org/10.1108/02632779710178785

Yüksel, İ., & Dagdeviren, M. (2007). Using the analytic network process (ANP) in a SWOT analysis–A case study for a textile firm. *Information sciences*, *177*(16), 3364-3382. https://doi.org/10.1016/j.ins.2007.01.001

Zuashkiani, A., Rahmandad, H., & Jardine, A. K. S. (2011). Mapping the dynamics of overall equipment effectiveness to enhance asset management practices. *Journal of Quality in Maintenance Engineering*, *17*(1). https://doi.org/10.1108/13552511111116268