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ENERGY MANAGEMENT SYSTEM IMPLEMENTATION STRATEGY IN THE CONCENTRATING DIVISION OF PT FREEPORT INDONESIA BASED ON ISO 50001:2018

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Abstract: This study aims to 1) analyze the current level of energy management system implementation by the PTFI Concentrating Division, 2) analyze the comparison of the Concentrating Division's energy management system with the ISO 50001:2018 standard, 3) formulate a strategy for implementing an energy management system according to the ISO 50001 standard. :2018 at the PT Freeport Indonesia Concentrating Division processing plant. The method in this study uses gap analysis (gap and IPA) and analytical hierarchy process (AHP). The implementation strategy is formulated based on the results of a comparison of the performance level of the energy management system with the 7 clauses of ISO 50001:2018 and their level of importance. The results obtained are 7 clauses that do not meet the standards and 3 clauses of which have a high level of importance but low performance levels to be handled with four different strategies: 1) conducting internal audits and external energy audits, 2) energy management system training, 3) carrying out activities energy efficiency-oriented production, 4) using automation systems and technology on equipment.

Keywords: AHP, concentrate processing plant, energy management system, gap analysis, ISO 50001:2018

Abstrak: *Penelitian ini bertujuan untuk 1) menganalisis tingkat penerapan sistem manajemen energi yang sudah dilakukan oleh Divisi Concentrating PTFI saat ini, 2) menganalisis perbandingan sistem manajemen energi Divisi Concentrating dengan standar ISO 50001:2018, 3) merumuskan strategi implementasi sistem manajemen energi sesuai standar ISO 50001:2018 pada pabrik pengolahan Divisi Concentrating PT Freeport Indonesia. Metode pada penelitian ini menggunakan analisis kesenjangan (gap dan IPA) dan proses hierarki analitik (AHP). Strategi implementasi dirumuskan berdasarkan hasil perbandingan dari tingkat kinerja sistem manajemen energi dengan 7 klausul ISO 50001:2018 dan dengan tingkat kepentingannya. Hasil yang diperoleh terdapat 7 klausul yang belum memenuhi standar dan 3 klausul diantaranya memiliki tingkat kepentingan tinggi namun tingkat kinerja rendah untuk ditangani dengan empat macam strategi: 1) melakukan audit internal dan audit eksternal energi, 2) pelatihan sistem manajemen energi, 3) melakukan aktivitas produksi yang berorientasi pada efisiensi energi, 4) menggunakan sistem otomasi dan teknologi pada peralatan.*

Kata kunci: *AHP, analisis kesenjangan, ISO 50001:2018, pabrik pengolahan konsentrat, sistem manajemen energi*

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INTRODUCTION

One of the basic human needs is energy, humans need energy to support all their activities. Energy is a strategic commodity because the entire system and dynamics of human and state life depend on energy as the lifeblood of all sectors (KESDM 2016). This is what results in the world's energy consumption always increasing every year along with the development of human civilization (Figure 1), so that energy must be managed and utilized properly and efficiently.

The Indonesian government plays a role in regulating energy utilization through *PP No.70 Tahun 2009* concerning Energy Conservation and *Permen ESDM No.14 Tahun 2012* concerning Energy Management, where in this regulation it is emphasized that all energy source users and energy users who use energy greater than or equal to 6,000 tons of oil equivalent (TOE) are required to carry out energy management.

Energy management is an integrated activity to control energy consumption in order to achieve effective and efficient energy utilization to produce maximum output through structured and economical technical actions to minimize energy utilization including energy for the production process and minimize the consumption of raw materials and supporting materials (Permen ESDM No.14 2012). Energy management includes planning and operating energy-related consumption and production units to actively manage energy use saving efforts and reducing energy costs. The objectives of energy management are resource saving, climate protection, and cost savings. According to *Verein Deutscher Ingenieure,* energy management as a proactive activity, organized and systematic procurement of goods, conversion, distribution and use of energy that meets needs by considering environmental and economic goals (VDI 2007).

Energy Management System (EnMS) is a method of continuously improving energy efficiency by integrating energy efficiency activities in an existing management system so that it can consider cost factors, environment, business availability and several other things related to energy savings (ESDM East Kalimantan 2019). Models of energy management systems, such as a continuous improvement framework that incorporates energy management into daily organizational practices can be illustrated in Figure 2.

Ali *et al.* (2015) states that by implementing an Energy Management System, organization has consciously monitored the energy aspects in business processes that will provide improved energy performance, reduce costs associated with energy consumption, limit exposure to highly variable energy prices, help save operational costs, improve supply chain relationships, and the ability to meet government standards and international targets in efficient energy management. According to Dasril and Lukman (2020), the implementation of an energy management system in companies can reduce the use of electrical energy and reduce production costs.

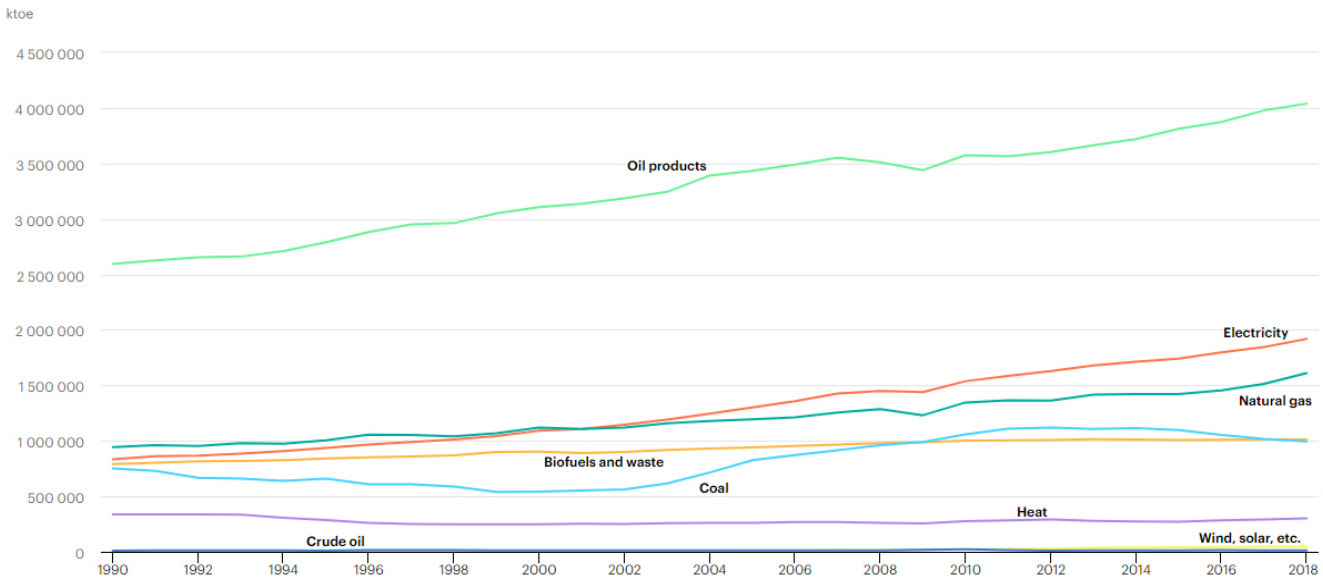

Figure 1. Total world energy consumption by type of energy (International Energy Agency (IEA), 2020)

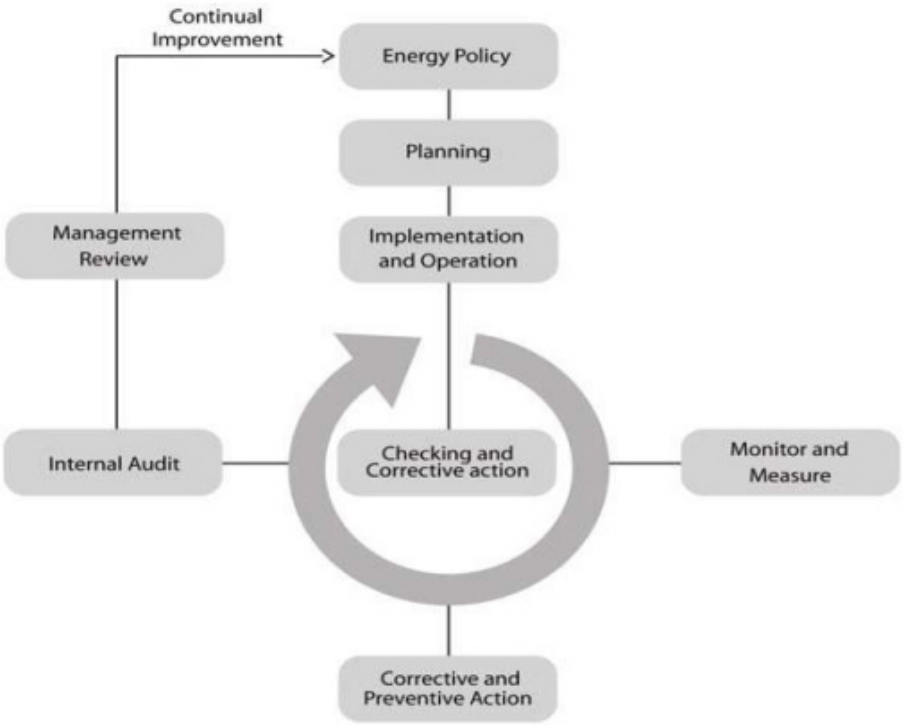

Figure 2. Energy management system model (EnMS ISO 50001:2011)

ISO 50001 is one of the international standards used to manage energy performance including energy efficiency and consumption using the Management System model with a Plan, Do, Check, Action (PDCA) cycle approach for continuous improvement. This energy management standard aims to help organizations optimize energy consumption systematically and consider the role of management in supporting energy projects, including energy in organizational policies, monitoring energy consumption and controlling increased energy use (Mkhaimer *et al*. 2017) . The benefit of implementing ISO 50001 is that it helps to improve energy performance and reduce energy consumption costs by obtaining commitment and support from management in complying with laws and other requirements (Howel 2014). Clause of ISO 50001:2018 consists of: 1) Scope, 2) Normative references, 3) Terms and definitions, 4) Context of the organization, 5) Leadership, 6) Planning, 7) Support, 8) Operation, 9) Performance evaluation, 10) Improvement.

Lestari *et al.* (2018) stated that the implementation of an energy management system in companies that have ISO 50001 certification is much better than those that do not have one. According to Zimon *et al.* (2020), ISO 50001 contributes to the largest cost reduction and meets the external requirements of stakeholders, which will be a consideration for consumers and external stakeholders when making decisions in purchasing products.

PT Freeport Indonesia (PTFI) is an affiliated mineral mining company of Freeport-McMoRan (FCX) and Mining Industry Indonesia (MIND ID) operating in Papua-Indonesia province in managing the copper and gold mining industry (PTFI 2018). PTFI as an energy user, on average requires more than 6000 TOE of energy per year (Figure 3) to support all its activities.

The Concentrating (Mill) Division is one of PTFI's operating divisions that uses the largest electrical energy of approximately 110,000 TOE of all energy generated by PTFI's plants to run concentrate processing plants that operate for 24 hours every day non-stop. This condition prompted the Concentrating Division to start making efficient use of energy and start conducting energy audits to assess the performance of existing energy and opportunities for energy efficiency. This is also a form of the company's compliance with Indonesian Government Regulations and the company's values, namely Safety, Integrity, Commitment, Respect, Excellent (SINCERE). However, until now the implementation of the energy management system has not been carried out according to ISO 50001 standards, so the Concentrating Division took the initiative to become a pioneer in PTFI in the energy management system implementation plan which refers to the ISO 50001: 2018 standard.

Figure 3. Energy mapping at PTFI

The objectives of this study are: 1) analyzing the level of application of the energy management system that has been carried out by PTFI's Current Concentrating Division, 2) analyzing the comparison of the Concentrating Division's energy management system with the ISO 50001:2018 standard, 3) formulating an energy management system implementation strategy according to ISO 50001:2018 standards at the PT Freeport Indonesia Concentrating Division processing plant.

METHODS

The research was conducted at PTFI's concentrate processing plant Concentrating Division, located in the Mile 74 area, Tembagapura, Papua, Indonesia from June to September 2021. This study used primary data obtained from interviews with experts related to energy management systems in the Concentrating Division, and secondary data obtained from audit reports, PTFI internal data and internal data of the Concentrating Division.

The data used in this study were collected through the following data collection techniques: 1) conducting in-depth interviews and filling out questionnaires in accordance with the research objectives with experts and related parties to the Energy Management System in PTFI's Concentrating Division, 2) conducting a literature study with an understanding of the literature from various sources, audit reports, ptfi internal data and the Concentrating Division, 3) the entire process of collecting questionnaire and interview data in this study was sourced from the same respondents or experts.

The determination of respondents was carried out intentionally (purposive sampling) as many as six respondents who were considered experts or experts in the Energy Management System in PTFI's Concentrating Division, namely: Senior Operations Manager as Energy Manager, Senior Maintenance Manager as Deputy Manager Energy, Mill Electrical Manager as Energy Technical Manager, Resource Management Manager, Section Head Mill Environmental and Section Head Mill Electrical as the energy management team in the Concentrating Division.

The data processing and analysis technique carried out in this research is to analyze the level of application of the Energy Management System in the Current Concentrating Division with several stages of the analysis process:

1. Analyze the level of application of EnMS in PTFI's Concentrating Division currently using primary data from the results of in-depth interviews with experts as well as secondary data in the form of audit reports, PTFI internal data and internal data of the Concentrating Division.
2. The results of the first Questionnaire as primary data with assessment using a Likert scale of 1-5. The first assessment was analyzed using gap analysis to compare the current performance level of the EnMS with each clause in ISO 50001:2018. According to Kim and Yingru (2018), analysis of gaps is a tool or process for identifying where the gaps are and what are the differences between the current organizational situation and the situation it should be. Table 1 shows the percentage range values for gap analysis. While the second assessment was analyzed using importance performance analysis (IPA) to compare the performance level of EnMS with its level of importance, the priority is a high level of importance with low performance in quadrant 1 (Figure 4)
3. Qualified factors from gap analysis and IPA will be used in the compilation of the AHP hierarchy. Meanwhile, actors, objectives and alternative strategies will be determined with experts through in-depth interviews to structure a complete hierarchy. Furthermore, the second questionnaire is arranged based on the results of the preparation of the hierarchy.

Table 1. Percentage ranges for gap analysis

Percentage	Information
96-100%	The company has fulfilled and run the clauses of the energy management system according to ISO 50001:2018 completeness standards and is run consistently.
90-95%	The requirements and procedures on the clause of the company's energy management system to implement ISO 50001:2018 have been met but not implemented consistently.
76-89%	Some of the requirements on the clauses of the ISO 50001:2018 energy management system have been implemented but not all of them.
51-75%	It is still necessary to make improvements to the clauses of the company's energy management system to prepare for ISO 50001: 2018, because there are requirements that have not been implemented, and there are requirements that are carried out but not documented.
0-50%	The non-implementation of the clausula application of the energy management system in the company according to the conditions specified by ISO 50001: 2018. It is still in urgent need of improvement and training for the implementation of the ISO 50001:2018 energy management system.

Source: Nasikin & Rahardjo (2019)

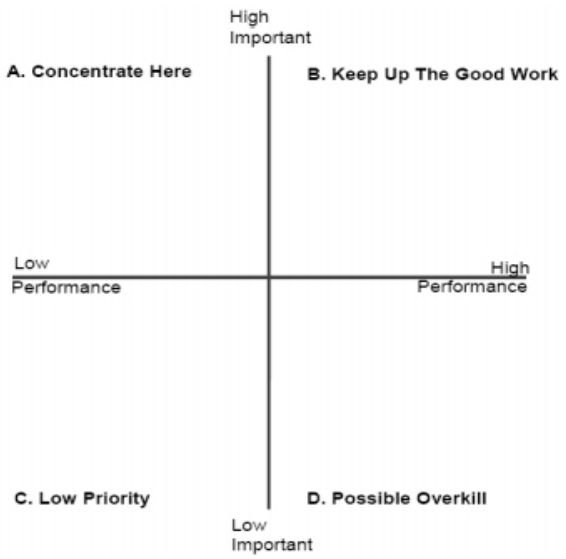

Figure 4. IPA Matrix (Martilla, 1977)

4. The second questionnaire as primary data with assessment using a paired comparison scale (Table 2) filled in by experts will be analyzed using an analysis hierarchy process (AHP) to see the level of importance of each element in the hierarchical process. The expert who is the reference in filling out the questionnaire will be measured for consistency using ratio consistency, where the consistency ratio should not be more or equal to 0.1 (10%). All of this questionnaire data processing process will be processed using Expert Choice software.

The AHP results are an alternative strategy that is an important priority will be recommended as a strategy in the implementation of an Energy Management System based on ISO 50001:2018.

The framework for formulating an energy management system implementation strategy based on ISO 50001: 2018 in this study can be seen in Figure 5. The energy management system of PTFI's Concentrating Division is implemented based on *PP No.70 Tahun 2009* concerning energy conservation, *Permen No.14 Tahun 2012* concerning energy management and the values of PTFI (SINCERE). Gap analysis is used to compare the current performance level of the EnMS with the ideal conditions of ISO 50001:2018 and the IPA method to compare the current level of performance with the level of importance of any clause on ISO 50001:2018. The gap result for each clause is below 100% and entered in the first quadrant of the IPA is considered to have not met the standards so it will be used as a factor in the preparation of the hierarchy. The hierarchy of actor levels, objectives and alternative strategies is determined through discussions with relevant experts. The priority strategy of implementing ISO 50001:2018 will be obtained from the results of AHP processing.

RESULTS

PTFI began the initiative to implement the first Energy Management System (EnMS) on March 6, 2018 in accordance with the mandate of the Government of Indonesia by issuing an interoffice memorandum (IOM) from PTFI's top management on energy management (PTFI 2018), which established an energy management team to manage energy and implement EnMS at PTFI. The Concentrating Division as PTFI's largest user of electrical energy also established an energy working team based on the IOM, consisting of three members under the supervision of PTFI's energy management team. The energy work team carried out energy mapping

by dividing into three systems, namely: Concentrator#1 – Concentrator#2 (C#1 – C#2), Concentrator#3 (C#3), and Concentrator#4 (C#4). The first energy audit was conducted at the end of 2020 by the energy work team in collaboration with PT Sucofindo as an external party in the three systems to determine energy performance and comply with Indonesian government regulations on energy use at PTFI (PTFI 2020).

The level of application of the energy management system in the Concentrating Division until now is still around 50% when compared to the international standard of energy management system ISO 50001: 2018. According to experts who manage the energy management system in the Concentrating Division, currently the energy management carried out does not refer to the international standard ISO 50001: 2018 and is still limited to compliance with Indonesian government regulations.

Gap and science analysis was used to compare the performance level of the Concentrating Division EnMS with the ISO 50001:2018 standard and its importance level, using the results of the questionnaire assessment of six respondents. Hasil gap analysis in Figure 6 shows that the claustrophobic factorul organizational context, leadership, planning, operations, performance evaluation and improvement is in the gap range of 51-75% which means that improvements need to be made because there are still many requirements of ISO 50001: 2018 that have not been met, while the clauseu l supporters enter in the range of 0-50% which means that the implementation of ISO 50001:2018 has not been carriedout there. This result shows that the factors of each clauseul have not met the ideal conditions of ISO 50001: 2018 so it is necessary to improve and improve the performance of the EnMS in the Concentrating Division.

Table 2. Pairwise comparison scale

Importance	Definitions
1	Equal importance over others
3	Moderate importance compared to others
5	Abolition of importance over others
7	More importance than others
9	Extremes/ absolute importance compared to others
2,4,6,8	Value between two adjacent assessments
Inverse	If the i element has one value above when compared to the j element, then j has its inverse value compared to the element i

Source: Saaty (2001)

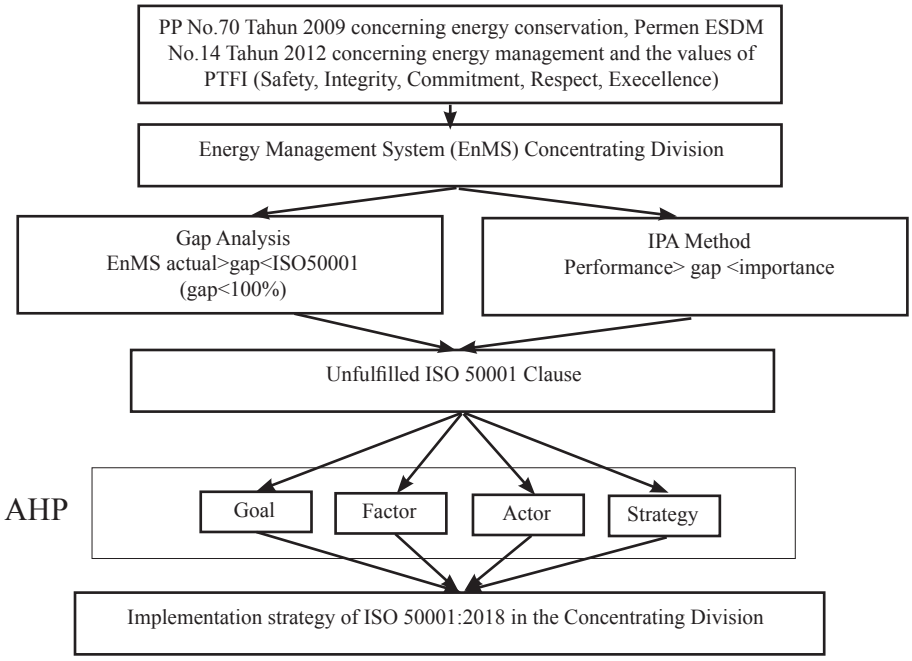

Figure 5. The research framework

The IPA analysis produces an IPA diagram as shown in Figure 7, where each clause is spread into only three quadrants. The organizational, leadership and planning context clauses fall into quadrant one (concentrate here) which has a high level of importance but a low level of performance, so it requires attention in improving its performance. These three clauses will be taken to be factors in the next analysis. The supporting factor does not fall into quadrant one because the importance is low so it becomes a low priority in quadrant four.

The strategy for implementing the energy management system in the Concentrating Division of PT Freeport Indonesia based on ISO50001:2018 was formulated using the AHP method. The preparation of the hierarchy was determined based on the opinions of six respondents as experts responsible for the management of EnMS in the Concentrating Division of PT Freeport Indonesia. The initial foundation in designing the AHP hierarchy at the factor level is determined from the results of gap analysis and science analysis, namely organizational context, leadership, planning, support, operations, performance evaluation and improvement. Based on the hierarchy of decisions, the determination of components consists of five levels (levels), namely: 1) Focus (main objectives of the EnMS implementation strategy), 2) Factors (organizational context, leadership, planning, support, operations, performance evaluation, improvement, 3) Actors (division heads, energy managers, energy management teams, heads of departments), 4) Objectives (identifying energy consumption and significant energy use, planning the management of energy performance and its changes, increase the use of energy efficiency technologies in equipment), and 5) Alternative strategies (conducting internal audits and external audits of energy, training EnMS, conducting production activities oriented towards energy efficiency, using automation systems and technologies on equipment). The results of the AHP analysis can be seen in Figure 8, with the consistency test resulting from the expert choice software showing a Consistency Ratio (CR) value of 0.02 < 0.1, which means the data is consistent.

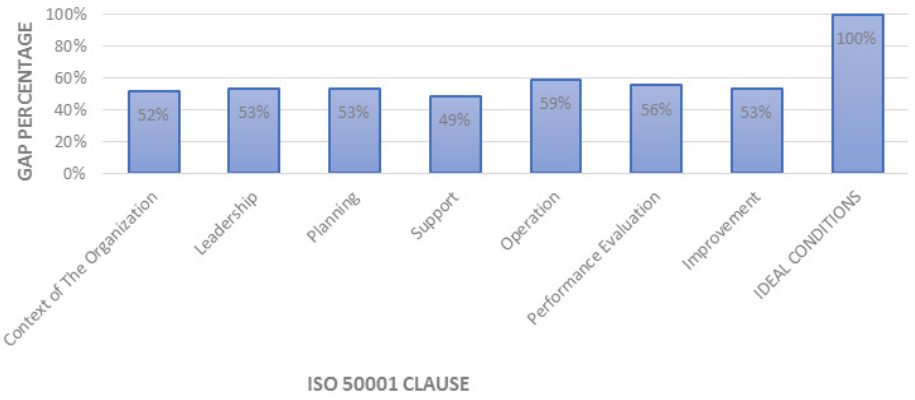

Figure 6. Gap analysis of concentrating division energy management system

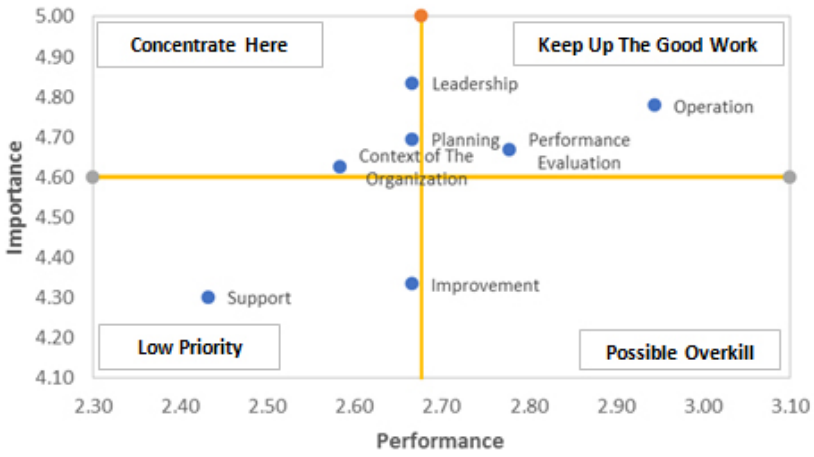

Figure 7. IPA diagram of energy management system in concentrating division

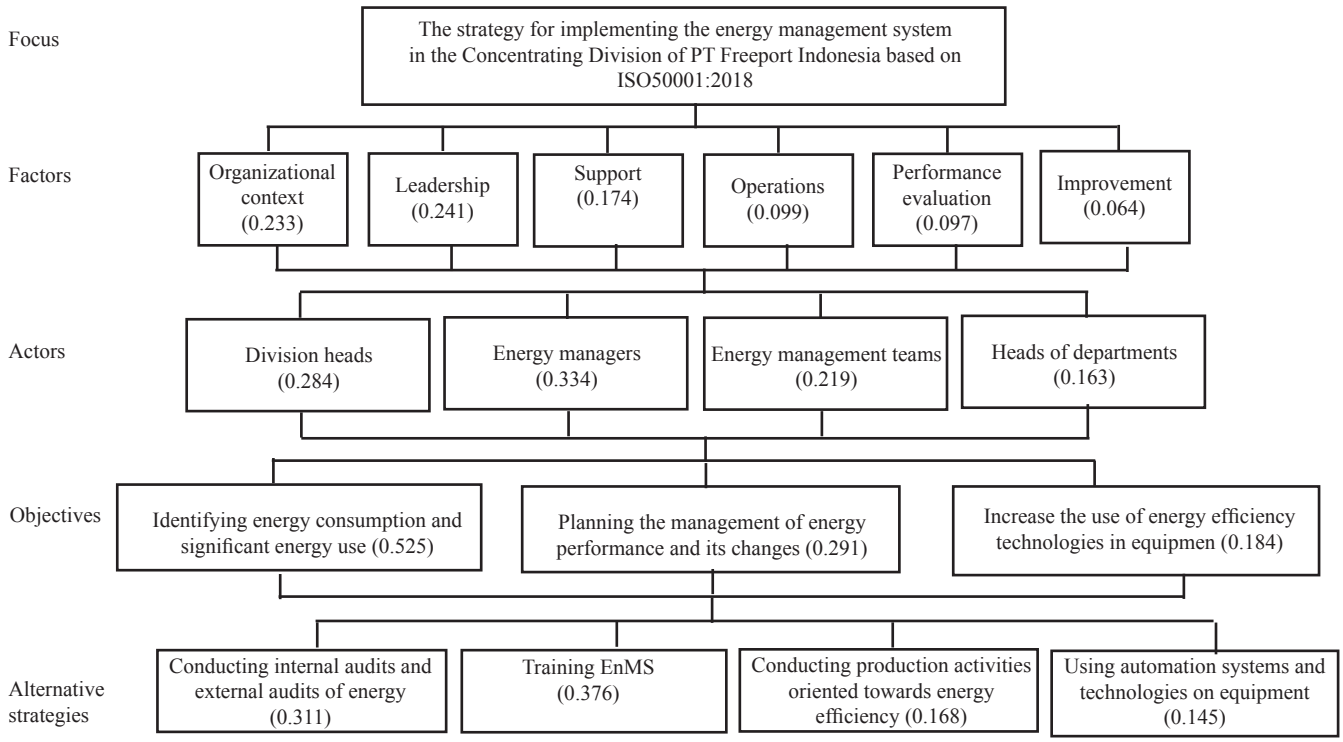

Figure 8. Results of AHP processing of EnMS strategy priorities concentrating division

Managerial Implications

Alternative strategies are produced through analysis with the AHP method as a reference in the formulation of strategies that can be carried out by the head of the concentrating division, energy manager, energy management team and head of department to implement the energy management system in PTFI's Concentrating Division based on ISO 50001:2018. The managerial implications of the results of this study are:

1. Energy management system training: the energy management team cooperates with internal and external parties in the implementation of EnMS training. According to the research of Julianry et al. (2017) and Nurhayati et al. (2021) states that training is proven to be effective and able to improve employee performance so that they can work properly and optimally.
2. Conducting internal audits and external energy audits: the energy management team conducts internal energy audits and external audits are carried out together with external parties in this case the ESDM work team or competent private parties. This is in line with previous research from Saini et al. (2014) and Kresnadi et al. (2020) which states that by knowing the magnitude of the intensity value of energy consumption obtained from the audit results, energy waste can be prevented without reducing the value of safety and comfort in energy use. According to Mulyani et al. (2018), periodic energy audits are needed to improve existing energy performance.
3. Carrying out production activities oriented towards energy efficiency: the energy management team collaborates with the operation team, metallurgical team, and automation team to test samples from each stage of production activity in the metallurgical laboratory before being applied to the production process in the factory. According to the research of Wirtza et al. (2020) states that process simulation in plant adaptation planning by analyzing process time, energy consumption and process stability can optimize equipment work and energy use more efficiently.
4. Using automation and technology systems on equipment: the equipment in the processing plant mostly already uses automation and technology systems, but it needs to be upgraded again for some equipment that is outdated in technology or that has not used it at all. The energy management team collaborates with the maintenance team (electrical / instrument / mechanical) and the automation team to map equipment that is outdated in technology or that has not used an automation system, such as the use of variable speed drives (VSD) in electric motors, the use of digital and analog sensors in electrical equipment, instruments and mechanics so that efficiency in the use of equipment can run well and make an impact also in energy performance. The

research of Kostić *et al*. (2020) states that knowing the characteristics of the motor drive and the control structure affects the power grid and the potential for energy savings.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The energy management system in the Concentrating Division has been implemented since 2018 since PTFI's top management issued an IOM on energy management and established PTFI's energy management team. However, the first audit with external parties was only carried out at the end of 2020, so that the average level of application of the energy management system in the Concentrating Division is still around 50% of the ISO 50001: 2018 energy management system standard and the implementation carried out is still limited to compliance with government regulations. Indonesian.

The results of the comparative analysis of the Concentrating Division's energy management system with the ISO 50001: 2018 standard using gap analysis methods and science show that there is still a gap of 49% to 59% of each existing clause. The context of organization, leadership, planning, operation, performance evaluation and improvement is a clause that still needs to be improved because there are iso 50001:2018 requirements that have not been met, while the supporting clauses have not been applied according to the conditions specified by ISO 50001:2018. Organizational context clauses, leadership and planning are of primary concern because they have a high level of importance, but a low level of performance. Seeing such conditions, it is necessary to improve and improve the performance of the energy management system in the Concentrating Division to meet iso 50001: 2018 standards.

The strategy of implementing energy management system in accordance with ISO 50001: 2018 standards at the processing plant of the Concentrating Division of PT Freeport Indonesia was formulated based on the results of the analysis using the AHP method. The results of the AHP analysis show that the main factor influencing the implementation of the energy management system in PTFI's Concentrating Division based on ISO 50001:2018 is leadership, where energy managers are the actors who have the most influence with the main objective of identifying significant energy consumption and energy use. Some alternative strategies in the implementation of energy management systems based on ISO 50001:2018 are energy management system training as the priority strategy, and the next priority strategy is to conduct internal audits and external audits of energy, carry out production activities oriented towards energy efficiency, use automation systems and technologies on equipment.

Recommendations

Based on the results of research on the strategy of implementing an energy management system in the Concentrating Division based on ISO 50001: 2018, several suggestions can be recommended as follows:

1. The program for implementing the Energy Management System of the Concentrating Division based on ISO 50001: 2018 needs to be well prepared by the energy management team and socialized to every employee of the Concentrating Division.
2. Energy management system training based on ISO 50001: 2018 must be carried out to complement the competencies and certificates for employees in managing energy.
3. Further research needs to be carried out on the implementation of EnMS in other divisions at PTFI to obtain results with a wider scope so that the application of EnMS at the company level can also be implemented.

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