

## **Analysis of the Influence of Certified Wastewater Treatment Personnel Competence as an Effort to Meet Industrial Wastewater Quality Standard Requirements in Semarang City**

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### **Abstract**

*This research examines the effect of certified personnel competence in industrial wastewater treatment on the fulfillment of industrial wastewater quality standards in Semarang City, Indonesia. Amid rapid industrial expansion, ensuring environmental sustainability has become increasingly challenging, prompting regulatory requirements for operator certification. The study adopts a quantitative descriptive approach, gathering data from 26 key wastewater treatment operators (POPAL) in major manufacturing sectors through structured questionnaires, interviews, and direct field observation. Findings demonstrate that the majority of industries in Semarang have already appointed certified wastewater treatment personnel, with most respondents possessing a strong educational background and extensive experience. Results indicate that certified operators significantly improve industrial compliance with wastewater quality standards, particularly regarding key parameters such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS). Certified personnel exhibit enhanced ability in identifying risks, operating and maintaining wastewater facilities, and implementing standard procedures, which directly translates into higher rates of regulatory compliance. However, the research also finds that certification alone is not a panacea; certain industries still face challenges due to outdated technology, insufficient management support, or a lack of continuous training. These factors may hinder optimal wastewater treatment, even when certified personnel are present. The study's implications are twofold. Theoretically, it affirms the critical role of human resource competence in effective industrial environmental management. Practically, it encourages policymakers and industry leaders to prioritize ongoing professional development, technological upgrades, and supportive management systems, in addition to certification. Such efforts will further strengthen the effectiveness of certified operators and improve overall environmental compliance. In conclusion, certified personnel competence, when supported by proper institutional and technological resources, is a key driver for successful and sustainable industrial wastewater management in Semarang.*

**Keywords:** *Certified Personnel; Wastewater Treatment; Competency Certification; Compliance; Environmental Management; Sustainable Industry*

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## INTRODUCTION

Industrial development in Indonesia has experienced rapid acceleration in recent years, especially in urban areas such as Semarang City. This growth is instrumental in driving economic progress but simultaneously introduces significant environmental challenges, particularly in managing industrial wastewater ([Greenlab Indonesia, 2024](#); [Putri & Syafira, 2024](#)). Untreated or inadequately treated industrial effluents are known to deteriorate water quality, disrupt aquatic ecosystems, and pose considerable risks to public health ([Hidayat et al., 2021](#); [Luzha et al., 2023](#)). As industrial activities increase in scale and complexity, the effective management of industrial wastewater becomes even more critical.

In recognition of these challenges, the Indonesian government has reinforced environmental regulations, requiring industries to comply with stringent wastewater quality standards (Permen LHK No.

P.80/MENLHK/SETJEN/KUM.1/10/2019; Permen LHK No. 5/2021). Central to compliance is the role of competent personnel who are responsible for the operation and management of wastewater treatment facilities. Accordingly, regulatory authorities have introduced mandatory competency certification programs for wastewater treatment operators (POPAL), designed to ensure that operators possess the technical expertise and professional qualifications needed for effective and sustainable wastewater management ([Arif, Abdullah, & Rangkuti, 2021](#); [Cheng et al., 2019](#)).

However, despite these regulatory initiatives, numerous industries continue to face difficulties in meeting the required

wastewater quality standards. Prior research highlights that certification alone may not guarantee compliance, as technological infrastructure, management commitment, and ongoing training are also vital ([Rosental & Sambursky, 2023](#); [Yohana, Purwanto, & Warsito, 2023](#)). In the context of Semarang City, where industrial concentration and environmental pressures are particularly high, there remains a gap in understanding the relationship between certified personnel competence and wastewater treatment performance.

This study addresses this gap by examining the effect of certified personnel competence on the fulfillment of industrial wastewater quality standards in Semarang. The findings aim to contribute valuable insights for policymakers and industry leaders, emphasizing the need for an integrated approach that combines certification, technological advancement, and strong organizational support to achieve sustainable industrial environmental management.

## METHODS

This research employed a quantitative descriptive approach to investigate how certified personnel competence influences industrial wastewater quality compliance in Semarang City, Indonesia. The study was conducted between January and March 2025, focusing on large and medium-sized manufacturing industries that generate significant amounts of wastewater and pose substantial environmental risks.

To ensure relevant and reliable results, the sample was drawn from a population of 464 manufacturing industries listed in the Semarang City Industrial Data Portal. A purposive sampling technique was

used to select 26 industries that have operational wastewater treatment plants and employ personnel responsible for wastewater management. The main respondents in this study were certified wastewater treatment operators (POPAL) and their direct supervisors (PPPA), as these individuals are most directly involved in daily operations and regulatory compliance.

Data collection was carried out using structured questionnaires, in-depth interviews, and direct field observations. The structured questionnaire, designed based on the Indonesian National Work Competency Standards (SKKNI), assessed the level of competence, certification, and training received by the personnel, as well as their perception of how certification impacts their work. In-depth interviews with supervisors and environmental managers provided qualitative insights into company policies, operational practices, and managerial support. Direct field observations were conducted at the wastewater treatment facilities, focusing on the actual performance of critical quality parameters, including Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS).

Quantitative data from the questionnaires were analyzed using descriptive statistical methods, such as frequency distributions and percentage calculations, to capture the characteristics of respondents and their compliance with regulatory standards. Qualitative data from interviews and observations were used to enrich the analysis and to identify factors that facilitate or hinder compliance. The validity and reliability of the research instruments were ensured through expert review, factor analysis, and internal

consistency checks using Cronbach's Alpha. By combining these methods, the study offers a comprehensive assessment of the link between certified personnel competence and the effectiveness of industrial wastewater management in achieving regulatory compliance.

## **RESULT AND DISCUSSION**

The findings of this study reveal compelling evidence for the significant role of certified personnel competence in achieving compliance with industrial wastewater quality standards in Semarang City. Among the 26 manufacturing industries surveyed, the vast majority have already appointed certified wastewater treatment operators (POPAL), with most operators holding undergraduate degrees and possessing extensive professional experience. This high level of educational attainment and certification reflects a strong commitment by local industries to meet increasingly stringent environmental regulations.

Analysis of the questionnaire responses and field observations indicates that industries with certified personnel demonstrate substantially higher rates of compliance with key wastewater quality parameters, namely Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS). Certified operators are perceived to be more proficient in hazard identification, daily operation, maintenance, and the adoption of best practices in wastewater treatment processes. Their expertise is reflected in the consistent achievement of regulatory thresholds for effluent discharge quality, contributing directly to the protection of local water bodies and ecosystems.

Furthermore, the study reveals that certification is widely acknowledged as a catalyst for improved operational standards. Over 80% of respondents rated the impact of certification as “very significant” or “significant” in supporting effective wastewater management. This suggests that formal recognition of skills through certification not only elevates individual competence but also drives organizational improvements in environmental performance.

However, the research also highlights several challenges. In a minority of cases, even certified personnel encountered difficulties in maintaining compliance due to outdated technology, insufficient investment in infrastructure, or a lack of ongoing professional development. These findings suggest that while certification is essential, it must be complemented by adequate management support, modern technology, and continuous training to ensure sustained compliance.

Qualitative insights from interviews further reinforce the quantitative results, emphasizing that companies with strong leadership commitment and regular training programs achieve higher standards of environmental stewardship. The study underscores that a holistic approach—integrating human resource competence, technological advancement, and supportive management is vital for sustainable industrial wastewater management.

In summary, this research demonstrates that certified personnel competence is a key driver of regulatory compliance in industrial wastewater management in Semarang. However, to maximize effectiveness, certification initiatives should be embedded within

broader strategies that include technological upgrades, ongoing capacity building, and strong organizational support. This integrated approach is necessary to meet the dual goals of industrial growth and environmental sustainability.

## CONCLUSION

This research provides clear evidence that the competence of certified personnel plays a vital role in ensuring industrial compliance with wastewater quality standards in Semarang City. The majority of manufacturing industries surveyed have appointed certified wastewater treatment operators (POPAL), most of whom possess high educational qualifications and extensive operational experience. The study demonstrates that certified personnel significantly enhance the ability of industries to achieve and maintain regulatory standards for critical parameters such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS).

Certification was found to contribute not only to individual competence but also to the overall effectiveness and reliability of industrial wastewater management systems. Most respondents acknowledged that certification had a substantial positive impact on operational practices, risk management, and the achievement of environmental compliance targets. Nevertheless, the findings also highlight that certification alone is not sufficient. Industries that lack modern treatment technology, continuous professional development, or adequate management support still face challenges in maintaining consistent compliance.

The study concludes that a holistic approach is required to optimize the

effectiveness of industrial wastewater management. Certification of personnel should be supported by regular training, technological upgrades, and strong organizational commitment. By adopting this integrated strategy, industries can more effectively meet regulatory requirements, protect the environment, and support sustainable urban and industrial development in Semarang. Overall, this research underscores the strategic importance of certified personnel competence as a cornerstone for sustainable environmental management in Indonesia's industrial sector. Future efforts should focus on strengthening certification programs while simultaneously promoting continuous improvement in technology, infrastructure, and institutional support.

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