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Evaluation of Environmental Performance in the Development of the Purwokerto -Kroya and Kroya - Kutoarjo Train Route

Evaluasi Kinerja Lingkungan pada Pembangunan Jalur Kereta Api Purwokerto – Kroya dan Kroya - Kutoarjo

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Abstract

Train is an effective and efficient mode of communal transportation. During the development phase it has an impact on the environment and according to the recommendation of an environmental permit, impact management is carried out. An environmental performance evaluation was carried out at the Central Java Railroad Class I Central Java Region by referring to part of the environmental management performance standard, known as the Environmental Performance Evaluation (EPE) ISO 14031: 2013, which has become the Indonesian National Standard on Environmental Management. There are environmental parameters that exceed quality standards because they are not efficient in implementing environmental management. Based on the results of the performance evaluation, it can be found that the main performance indicators that need to be improved, namely the environmental condition indicators, namely the impact of vibration, noise and TSP at the mobilization of materials and TSS at the stage of land maturation.

[*Kereta api adalah moda transport komunal yang efektif dan efisien. Dalam tahap pembangunan memberikan dampak terhadap lingkungan dan sesuai rekomendasi izin lingkungan dilakukan pengelolaan dampak. Dilakukan evaluasi kinerja lingkungan pada Balai Teknik Perkeretaapian Kelas I Wilayah Jawa Bagian Tengah dengan merujuk bagian dari standar kinerja pengelolaan (atau manajemen) lingkungan, yang dikenal sebagai Environmental Performance Evaluation (EPE) ISO 14031: 2013, yang sudah menjadi Standar Nasional Indonesia tentang Manajemen Lingkungan. Terdapat parameter lingkungan yang melebihi baku mutu karena tidak efisien dalam implementasi pengelolaan lingkungan. Berdasarkan hasil*

evaluasi kinerja dapat ditemukan indikator kinerja utama yang harus dilakukan perbaikan yaitu terhadap indikator kondisi lingkungan yaitu dampak getaran, kebisingan dan TSP pada tahap mobilisasi material dan TSS pada tahap pematangan lahan.]

Keywords: Train, environmental impact, environmental management, Environmental Performance Evaluation, Environmental Management System

I. Introduction

Infrastructure development must be carried out by considering sustainable development and prioritizing instruments for preventing and/or environmental damage, this also applies to railway development infrastructure projects in Central Java. If not, it will damage the environment and have an impact on the social life of the surrounding community. Rail transportation has many advantages over other modes of transportation, including: large (mass) capacity, fast, safe, energy efficient and environmentally friendly and requires relatively little land. The stronger the environmental issue, the superiority of railways can be used as a strong reason for building railway infrastructure so as to realize effective, efficient and environmentally friendly transportation. The National Railway Master Plan is an embodiment of the railway arrangement which contains the current state of the national railways and the national railway development plan until 2030 to come. The development of railway transportation means participating in energy saving programs and improving environmental quality (Ditjen Perkeretaapian, 2011). The implementation of national railways is expected to be able to support national economic growth through the realization of the national railways vision in 2030, namely "Realizing railways that are competitive, integrated, technology, synergized with industry, affordable and able to answer developmental challenges" (Kementerian Perhubungan Republik Indonesia, 2018).

Railway transportation in the Central Java region is currently facing serious problems. Railway passenger transportation has decreased in demand due to competition from low-cost air transport as well as with private vehicles and buses using toll roads. In addition, many freight train customers have also switched to using trucks and trailers as a result of unreliable travel times and train operations. In 2006, there were a total of 4,675 km of railway lines in use in Indonesia. Among them, 3,370 km (or 72%) of these railway lines are in Java Island. Including unused railway lines, the total length of railway lines in Indonesia is 8,067 km, 6,076 km (or 75%) of which are in Java Island. In the Central Java region, there are plans to complete the construction of the main railway line north of Java (Cirebon - Tegal - Semarang - Surabaya), the main southern line of Java (Kroya - Yogyakarta - Solo),

and the connecting north-south route (Cirebon - Purwokerto - Kroya) (Japan International Cooperation Agency, 2009). As an activity that has an impact on the construction of a railway line of more than 25 km. for urban areas it has an important impact on the environment.

One of the environmental management (or management) performance standards, known as Environmental Performance Evaluation (EPE) ISO 14031: 2013 which is voluntary in nature has been adopted by the Government through the Indonesian National Standardization Agency to become Environmental Management Standards - Environmental Performance Evaluation - Guidelines. These standards allow organizations to measure evaluate and communicate their performance using key performance indicators, based on reliable and verifiable information and organizations can apply corrections and techniques to other environmental management in a coherent, transparent and cost effective manner. From the background described above, the purpose of this study is to evaluate environmental performance in the implementation of railroad construction in Central Java using ISO 14031 as a guide.

II. Literature Review

Train is a mode of transport with the most efficient fuel or energy consumption in terms of the number of passengers it can transport and the distance it travels. Compared to land transportation modes such as buses or private cars. With its transport capacity and reliability, trains have the advantage of commuting trips (urban trains), because these services really require punctuality, where the train is very reliable.

Table 1. Comparison of fuel consumption for land transportation modes

Modes of transportation	Transport Volume (Person)	Fuel Energy Consumption/Km (liter)	Energy Use BBM/Km/Pnp
Train	1500	3	0.0020
Bus	40	0.5	0.0125
Car	5	0.1	0.0200

Source: Decree of the Minister of Transportation of the Republic of Indonesia Number KP 2128 of 2018.

The existence of railroad construction can have a negative impact on the environment. The negative impacts that may be caused by the construction of railway lines are a decrease in air quality, a decrease in water quality, noise, vibrations and an increase in the volume of vehicle traffic.

ISO 14031: 2013 is a standard that provides guidance on the design and use of environmental performance evaluation (EPE) in an organization. ISO 14031 focuses on developing performance indicators that organizations can use to track and report environmental performance. EPE is a management process that uses

main indicators to compare the past and current environmental performance of an organization for organizational objectives and targets. EPE standards are implemented using a management model approach, namely Plan-Do-Check-Act (PDCA). In evaluating environmental performance, among others, the Management Performance Indicator (MPI) is an indicator which is an information on the organization's management activities that can affect environmental performance; Environmental Condition Indicators (ECI), namely environmental performance indicators that provide information on local, regional, national or global environmental conditions and Environmental Performance Indicators (EPI) which are indicators that provide information about an organization's environmental performance. And to measure, evaluate and communicate environmental performance, key performance indicators (KPI) are used. KPIs are performance indicators that are considered important by an organization and provide excellence and attention to certain aspects (Badan Standardisasi Nasional, 2016).

Several studies on environmental performance evaluation have been carried out using various scientific method approaches. Research on companies in the European Union (Baltic, Mediterranean, Central, Atlantic) on a small, medium and large scale in the manufacturing, industrial and service sectors. The selected company is an organization that implements the Eco-management and Audit Scheme (EMAS) program by using an Environmental Management System (EMS) implementation evaluation. The research objective was to evaluate the performance of the EMAS Regulations on the effect of firm performance from both an environmental aspect and a competitive point of view. Econometric analysis shows a positive impact on environmental performance and the effects of other competitive variables such as market performance, productivity of resources and assets are not supported (Iraldo et al., 2009). Another study is to evaluate company performance by conducting a study of the activities of suppliers of white goods industrial goods in Turkey. By using the Fuzzy ANP and Fuzzy Promethee methods which are based on the decision making team at each evaluation stage. It is concluded that the environmental performance of the company is not only affected by the efforts made in the corporate environment but also influenced by the performance and environmental image of the supplier (Tuzkaya, Ozgen, Ozgen, & Tuzkaya, 2009). Research on environmental performance by selecting a health management system in several companies in Beijing using Fuzzy Cognitive Maps (FCM), a methodology that is driven by causal knowledge to model complex decision systems, which comes from a combination of fuzzy logic and neural networks. This fuzzy technique combines the accumulated experience and knowledge by employing experts who are aware of system operations and behavior in different situations, and then provide hidden patterns of the problem. The results recommend (1) the health, safety, environmental elements and sub- performance of the system are determined and structured and then through the

use of FCM and show their cause and effect relationships and then build leadership indicators for system performance, and (2) in a weight distribution model of all The available knowledge is used to enrich the FCM which serves as a knowledge-based decision-making model, thereby better handling the opinions of experts (Kang, Zhang, & Gao, 2016). In power plant activities, research was carried out on the performance of PLTU in Iran during the restructuring period of the electricity industry for the 8 year period (2003-2010) by calculating efficiency, eco-efficiency and technological changes. The evaluation results of the restructuring have different effects on individual power plants and the overall growth of power plants for environmental efficiency due to advances in pure technology. The correlation between efficiency and eco-efficiency has a positive effect on power plant performance (Arabi et al., 2014,). Research similar to calculating eco-efficiency by using big data results: There are four problems that may occur in performance evaluation in the context of big data, namely: (1) large amounts of complex information, (2) unstructured dynamic information, (3) lack of data accuracy and stability, and (4) the use of repeated inputs. As a research recommendation, it is necessary to develop predictive models in future research (Song et al., 2017).

III. Methods

a. Time and Location of Research

Research on railway line construction activities in 2017 one semester and 2018 two semesters (SMT1, SMT2). The research location is located in the working area of the Class I Railway Engineering Center for the Central Java Region, which is on the double track railway between Purwokerto - Kroya with a track length of ± 26.2 km through two districts, namely Banyumas and Cilacap, and the Kroya - Kutoarjo route has a long line. ± 76.1 km through four districts namely Cilacap, Banyumas, Kebumen and Purworejo.

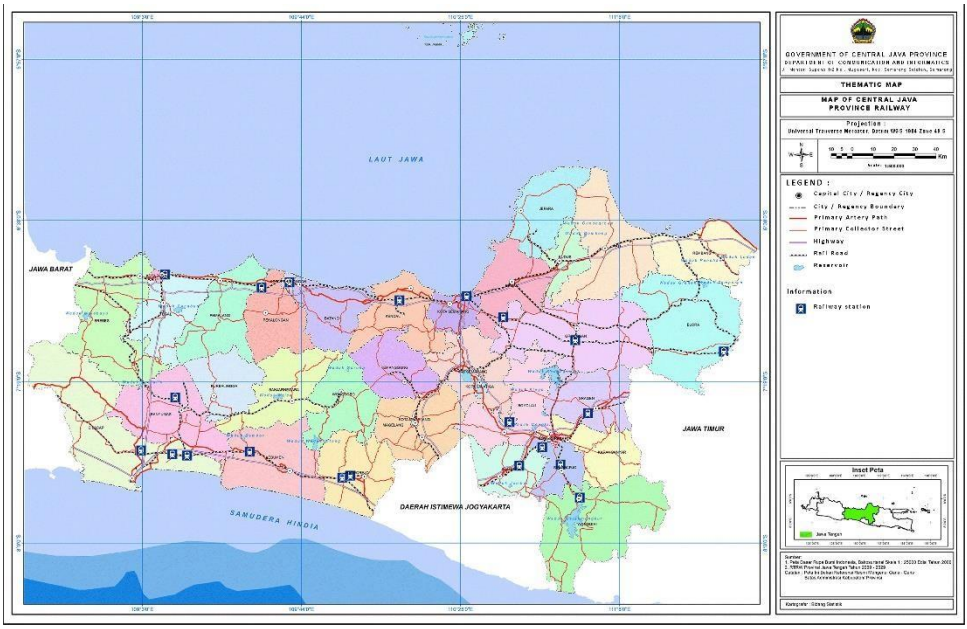


Figure 1. Railways in Central Java

b. Methods

The method used in this research is environmental performance evaluation by referring to ISO 14031, namely by determining Management Performance Indicators (MPI), Environmental Condition Indicators (ECI) and Environmental Performance Indicators (EPI) which are obtained from secondary data from environmental monitoring of AMDAL (*Analisis mengenai dampak lingkungan*/ Environmental impact assessment) based on PERMEN LH No. 45 of 2005 which will then be compared with the applicable regulations, namely:

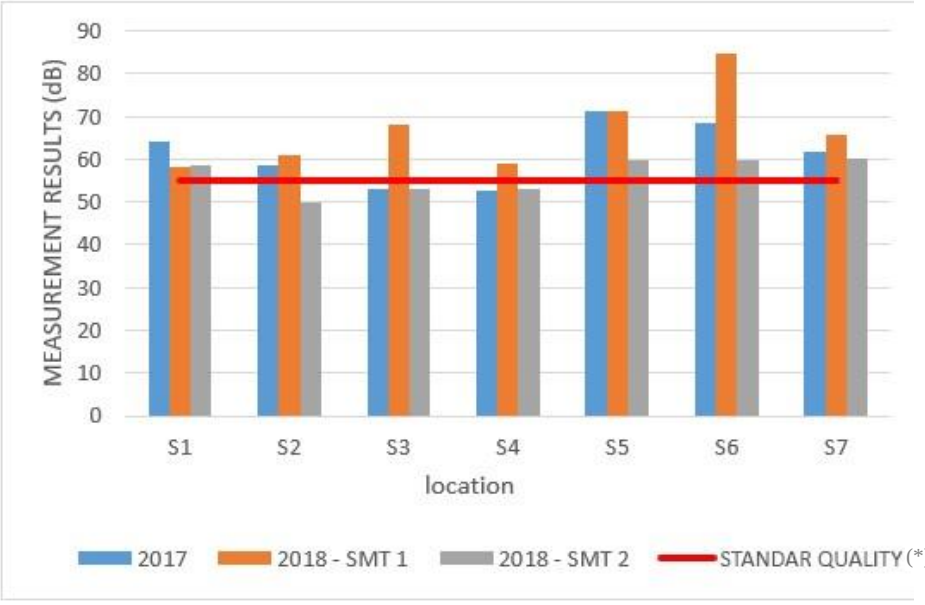
1) Environmental Noise Level Quality Standards according to Kep-48/MENLH/11/1996
2) Vibration Quality Standards based on Kep-49/MENLH/11/1996
3) Air Quality Standards based on the Decree of the Governor of Central Java Number 8 of 2001 include Carbon Monoxide (CO), Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2), and Dust (TSP)
4) Water Quality Standards based on Government Regulation Number 82 of 2001 include Dissolved Residues (TDS), Turbidity, Suspended Solids (TSS), pH, and DO

IV. Results

By planning (Plan) a study on environmental management carried out by the Class I Railroad Engineering Center for the Central Java Region, based on environmental quality measurement data as the implementation of environmental monitoring

which is an AMDAL recommendation in the environmental performance evaluation stage is the implementation stage (Do). And as the evaluation stage (Check and Action) used as an effort to evaluate environmental performance. The results of the implementation of evaluation (do) and efforts to improve (action) include environmental parameters measured in the implementation of environmental management, namely noise, vibration, air quality and water quality.

1) Noise
   The results of noise measurements (Figure 2.) that occur are caused by activities of mobilization/demobilization of equipment, mobilization of materials, utilization of access roads, land clearing, and tunnel construction. Monitoring is carried out by measuring the noise level around the location of the double railroad construction activity between Purwokerto - Kroya. The location is a settlement. The measurement of the noise level during the day and night (L_{sm}) was carried out for 24 hours. In the 2017-2018 construction, the results of noise measurements exceeded the quality standard due to the ineffective implementation of noise absorbers in the form of guardrails bordering construction activities.

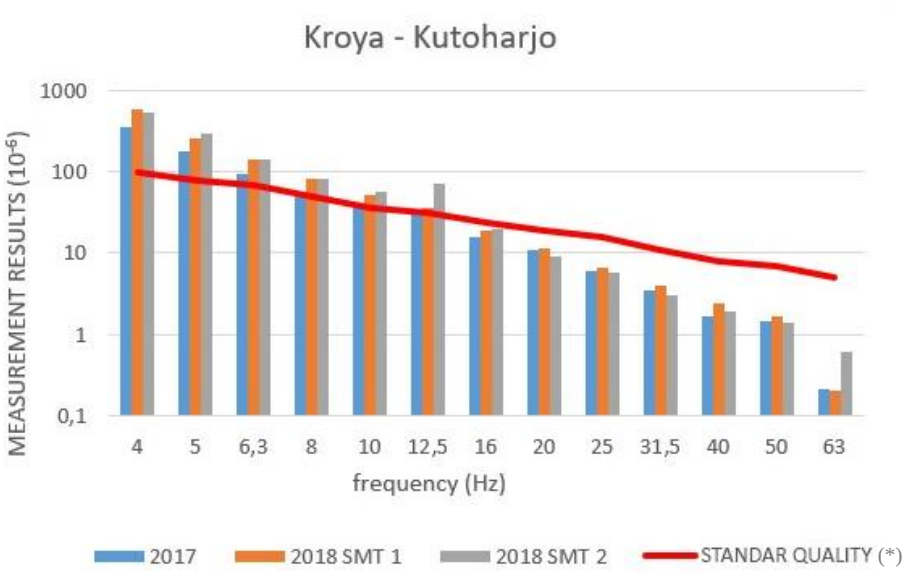


Source: Environmental management Report on the Construction of a Double Track Line between Purwokerto - Kroya and Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Decree of Ministry of Environment of the Republic of Indonesia Number KEP-48/MENLH/11/1996 concerning Noise Level Standards.*

Figure 2. Noise Level Measurement Results

2) Vibration

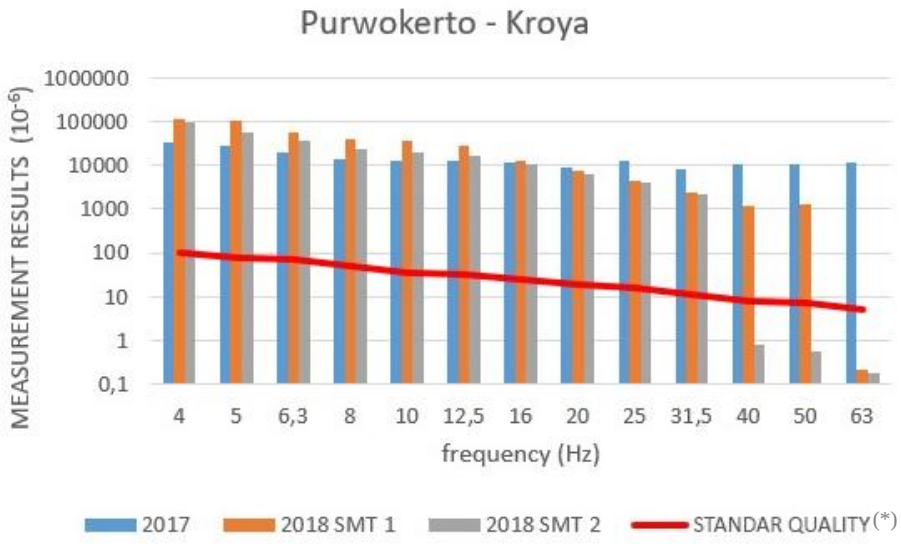
Increased vibration can be caused by mobilization/demobilization of equipment, material mobilization, and utilization of access roads, land clearing and tunnel construction. The impact of health and comfort vibrations is measured based on the level of vibration (micron UNITS) at frequencies of 4 Hz, 5 Hz, 6.3 Hz, 8Hz, 10 Hz, 12.5 Hz, 16 Hz, 20 Hz, 25 Hz, 31.5 Hz, 40 Hz, 50 Hz and 63 Hz which is then presented on a graph and analyzed to obtain impact criteria. In Figure 3, the following are the results of vibration measurements at the research location:



Source: Environmental management Report on the Construction of a Double Track Line between Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Decree of Ministry of Environment of the Republic of Indonesia Number KEP-49/MENLH/11/1996 concerning Vibration Level Standards*

Figure 3. Vibration Level Measurement Results for Comfort and Health for the Kroya - Kutoharjo Route

The result of vibration measurement at the beginning of construction for the Kroya - Kutoarjo location at a value of 16-63 Hz does not exceed the quality standard because it has carried out the transportation of material by vehicle that is suitable for use and has carried out a good schedule. Whereas at the Purwokerto-Kroya location the results are disturbing for comfort (Figure 4.).

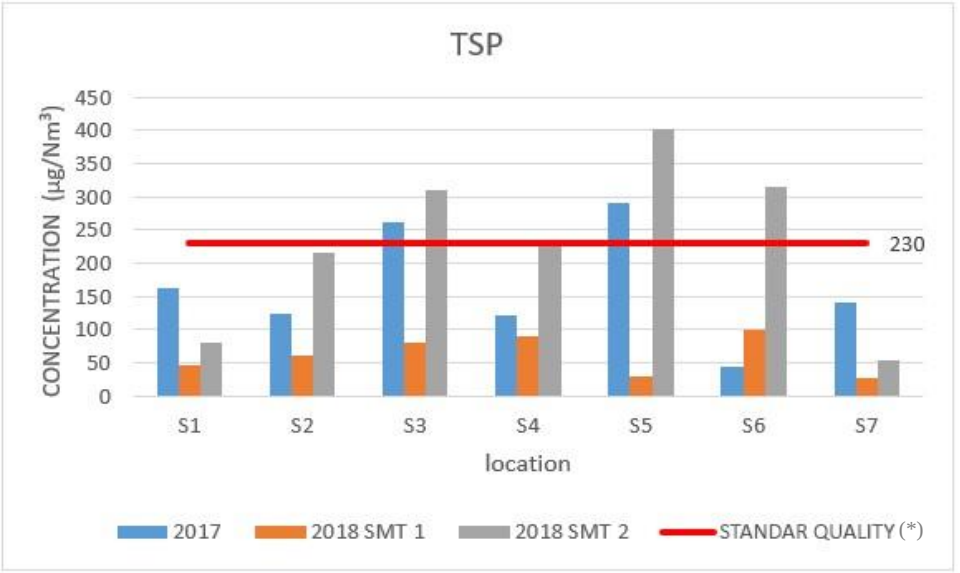


Source: Environmental management Report on the Construction of a Double Track Line between Purwokerto - Kroya and Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Decree of Ministry of Environment of the Republic of Indonesia Number KEP-49/MENLH/11/1996 concerning Vibration Level Standards*

Figure 4. Vibration Level Measurement Results for Comfort and Health of the Purwokerto - Kroya Route

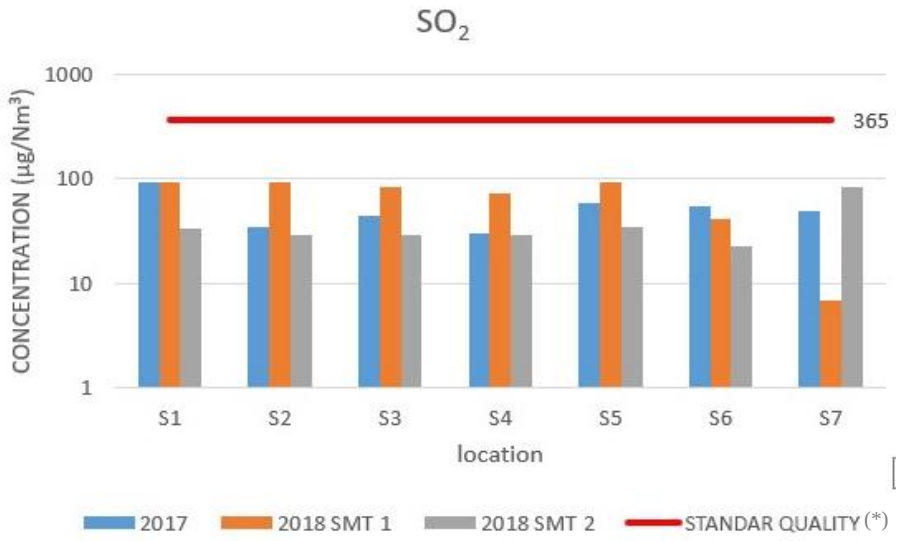
3) Air Quality

Air quality measurements are carried out at locations close to the location of the railway construction activities. Ambient air quality samples were taken for 24 hours. The results of air quality measurements (figure 5,6,7,8) by measuring TSP, SO2, NO2 and CO with 7 locations, namely S1: Nurul Huda Mosque RT 05/02, Sigong, Pucung Lor, Kroya; S2: MI Miftahul Ulum, Pandak, Sumpiuh, Banyumas; S3: Post Ds. Kebekelan, RT 04/02, Prembum; S4: Bp. Marjono, RT 02/05 Need, Purworejo, S: 07 ° 43'28.8 "E: 109 ° 51'48.4"; S5: Gambarsari Village (Overpass), Kebasen District, Banyumas Regency; S6: Tunnel Notog (Inlet), Notog Village, Patikraja District, Banyumas Regency; S7: Bantarsoka Village (Underpass), West Purwokerto District, Banyumas Regency. The complete measurement results are presented in the following figure:



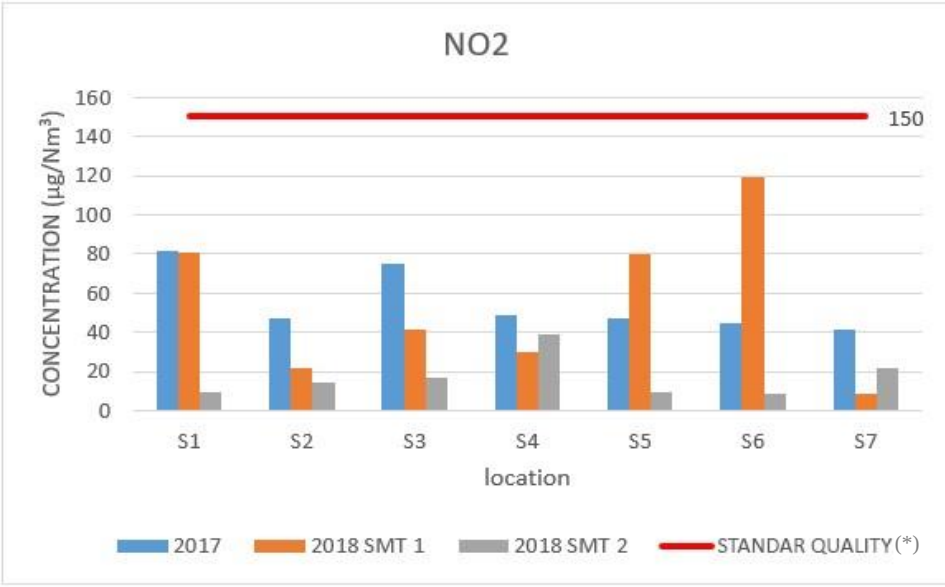
Source: Environmental management Report on the Construction of a Double Track Line between Purwokerto - Kroya and Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Decree of the Governor of Central Java Number 8 of 2001*

Figure 5. TSP Measurement Results



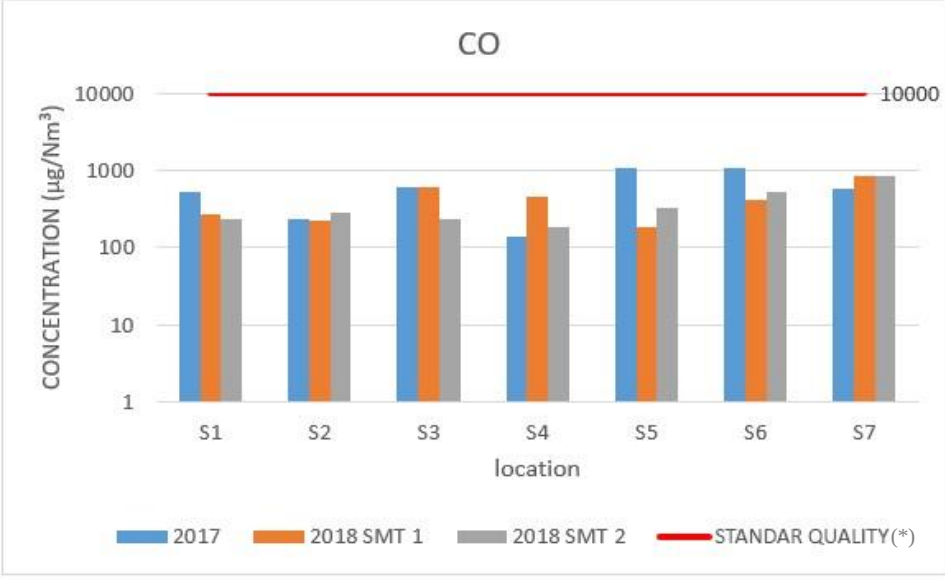
Source: Environmental management Report on the Construction of a Double Track Line between Purwokerto - Kroya and Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Decree of the Governor of Central Java Number 8 of 2001*

Figure 6. SO_2 Measurement Results



Source: Environmental management Report on the Construction of a Double Track Line between Purwokerto - Kroya and Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Decree of the Governor of Central Java Number 8 of 2001*

Figure 7. NO_2 Measurement Results



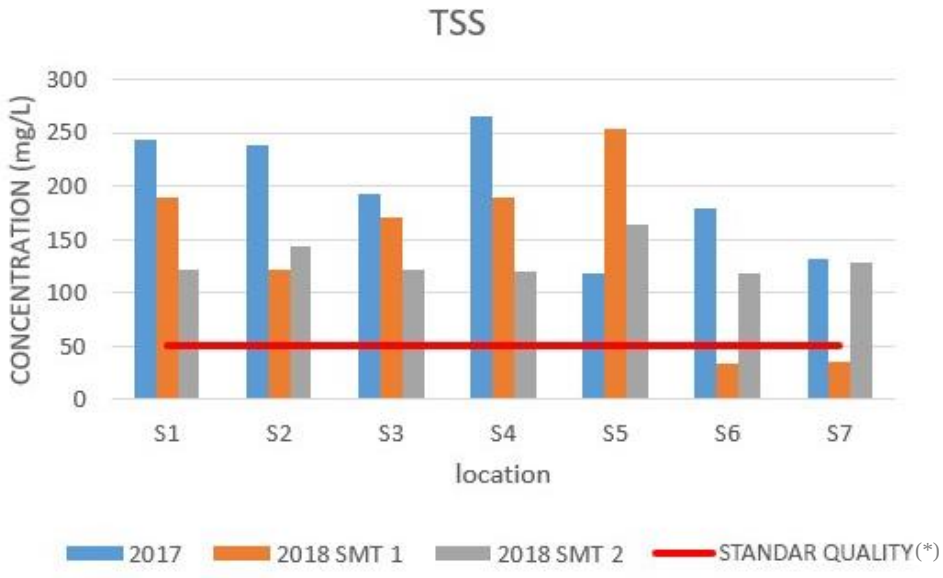
Source: Environmental management Report on the Construction of a Double Track Line between Purwokerto - Kroya and Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Decree of the Governor of Central Java Number 8 of 2001*

Figure 8. TSP measurement results

The results of air quality that experience a value exceeding the quality standard are in the dust parameter (TSP). Management has been carried out to manage the impact of the increase in dust particles, namely by controlling traffic, closing material transport equipment using tarpaulin and cleaning up spilled material immediately. However, due to the high frequency of material transportation, dust management has not been effective. Dust is the resulting impact on material mobilization activities using transport vehicles. Transportation is an activity that has an impact on increasing dust particles (Crilley et al., 2017).

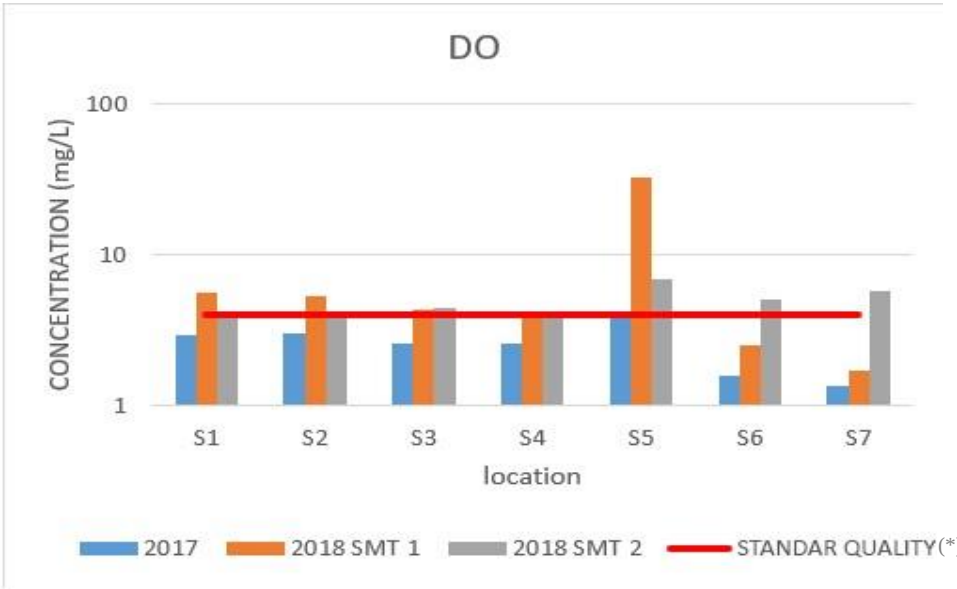
4) Water Quality

Water quality measurements were carried out including TSS, DO and TDS measurements. The complete results are in Figure 9. Land ripening activities provide a high contribution to the increase in turbidity, so that at all locations for TSS measurements there are results that exceed the quality standard. This shows that the management that has been carried out is by making *taluds*/installing shape piles to prevent landslides, erosion and sedimentation which have not been implemented effectively. High TSS occurs at the time of land clearing which results in increased soil erosion. Erosion will cause increased turbidity (Huang, Imran, & Pirmez, 2005).



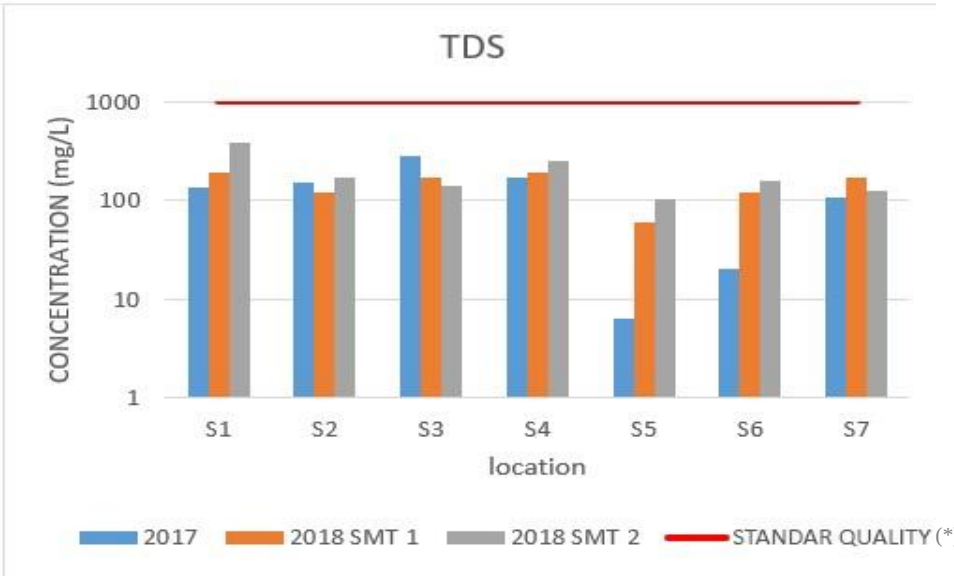
Source: Environmental management Report on the Construction of a Double Track Line between Purwokerto - Kroya and Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Government Regulation Number 82 of 2001*

Figure 9. TSS Measurement Results



Source: Environmental management Report on the Construction of a Double Track Line between Purwokerto - Kroya and Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Government Regulation Number 82 of 2001*

Figure 10. Dissolve Oxygen (DO) Measurement Results



Source: Environmental management Report on the Construction of a Double Track Line between Purwokerto - Kroya and Kroya - Kutoarjo 2017-2018 Class I Railway Engineering Center of Central Java Region
**Government Regulation Number 82 of 2001*

Figure 11. TDS measurement results

V. Discussions

The data from the measurement of environmental quality during construction by the Class I Railroad Engineering Center for the Central Java Region when carrying out the construction of the train line for the 2017 - 2018 period for the Kroya-Kutoarjo and Purwokerto-Kroya lines are the implementation stages (Do) in environmental performance evaluation. Environmental management indicators (management performance indicators) have been established, namely the management of impacts on environmental quality parameters in the form of vibration, noise, air quality and water quality. As an indicator of environmental conditions (environmental condition indicator) is the result of measuring environmental parameters according to the environmental permit recommendation. The results obtained from environmental indicators that exceed quality standards are vibration, noise, TSP (dust) and TSS. Parameters that exceed the quality standard are environmental performance indicators. As a stage of reviewing and improving (Check and Action) by reviewing all conditions that exceed the quality standard and then being used as the main performance indicator (key performance indicator) in environmental performance evaluation. From the main performance indicators, there are conditions that exceed the quality standard due to inefficient implementation of environmental management recommended in the environmental permit. And the existence of an environmental impact that exceeds the quality standard causes inefficient construction performance because it requires further management efforts with other technological approaches. Eco-efficiency and performance efficiency are positive correlations to environmental performance (Arabi et al., 2014). With efforts to improve the implementation of inefficient management of the main environmental indicators based on the results of the performance evaluation, the Class I Railway Engineering Center for the Central Java Region can realize development that is environmentally sound. Environmental performance evaluation is an implementation of an environmental management system that can achieve sustainable development (Iraldo et al., 2009).

VI. Conclusion

Environmental management indicators (management performance indicators), namely the management of impacts on environmental quality parameters, including vibration, noise, air quality and water quality. As an indicator of environmental conditions (environmental condition indicator) is the result of measuring environmental parameters according to the environmental permit recommendation. The results obtained from environmental indicators that exceed quality standards are vibration, noise, TSP (dust) and TSS. Parameters that exceed the quality standard are environmental performance indicators. Based on the results of the performance evaluation, it can be found that the main performance

indicators are also indicators of environmental performance that must be improved, namely the environmental parameters including vibration, noise and TSP at the material mobilization stage and TSS at the land maturation stage.

Acknowledgement

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Disclosure and Conflicts of Interest

There is no conflict of interest in this study.

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