Manufacturing Science and Education 2025

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 68, Issue Special II, Month July, 2025

THE ROLE OF VENTILATION DESIGN IN AXIAL FAN MAINTENANCE

Mădălin ANDREICA, Angela-Maria ANDREICA, Alexandru Florin ȘANTA, Florian STOIAN, Gabriel Dragoș VASILESCU, Nicolae ILIAȘ

Abstract: *Efficient ventilation is vital for mine operations, with axial fans playing a central role in ensuring both performance and safety. Their maintenance directly impacts operational efficiency, longevity, and overall safety. However, the connection between ventilation design and fan maintenance remains underexplored. This study proposes a structured framework to assess the influence of ventilation design on axial fan maintenance strategies, combining findings from literature with conceptual analysis of practical design scenarios. While empirical data collection is planned for future work, this paper offers a preliminary synthesis and methodology for future validation. We analyze current ventilation systems, maintenance challenges, and key parameters affecting axial fan efficiency. The goal is to offer actionable insights for the mining industry, leading to more effective maintenance strategies, reduced downtime, and improved safety. By addressing this gap, we advocate for considering ventilation design and fan maintenance as an integrated approach.*
Keywords: *Ventilation design, Axial fans, Maintenance strategies, Axial fan operational efficiency, Longevity*

1. INTRODUCTION

Efficient ventilation is crucial for safe, productive mine operations, with axial fans significantly impacting efficiency, longevity, and safety [1]. However, the influence of ventilation design on axial fan maintenance is underexplored. This study investigates how optimized ventilation design can reduce maintenance frequency and enhance fan lifespan and performance [2]. We will examine current mining ventilation systems, identify key parameters affecting fan efficiency and maintenance challenges [3], and explore strategies to improve ventilation design for better maintenance outcomes [4]. The findings will provide actionable insights for developing effective maintenance strategies, reducing downtime, and improving safety in mining operations [5][6][7]. Through our research, we aim to emphasize the interconnectedness of ventilation design and axial fan maintenance, advocating for their consideration as a combined entity rather than isolated factors [8]. By highlighting this relationship, I intend to contribute to the optimization of mine ventilation systems and underscore the significance of a holistic approach to maintenance.

Unlike previous research that addresses ventilation design and maintenance separately, this study integrates both dimensions by proposing a structured framework that links ventilation design parameters to maintenance outcomes for axial fans. Although this work is primarily conceptual and based on literature synthesis and expert-informed assumptions, it provides a foundation for future empirical validation. The paper aims to guide mining engineers toward more maintenance-aware ventilation design strategies, emphasizing a systems-thinking approach to improve operational reliability and safety.

2. MATERIALS AND METHODS

This study is based on a synthesis of existing literature and the development of a conceptual methodology. No new experimental data or site-specific simulations were performed. Instead, the research compiles findings from recent studies, operational insights from industry reports, and theoretical considerations to construct a framework that evaluates the influence of ventilation design on axial fan maintenance. The approach is designed to inform future empirical studies or field implementations in the mining sector.

Sokolov et al. [12] investigated the distribution along the channel radius and the change in impurity concentration as a function of distance from the source. The research is used to develop suggestions for where to position tools for regulating the concentration of pollutants in ventilation systems. It is estimated how far away from the source and at what radius the actual impurity concentration corresponds to the average value.

Wang et al. [13] developed an innovative, inexpensive ventilation management method based on an occupant-density-detection algorithm to prevent infection and maximize energy efficiency. Self-developed low-cost hardware prototypes can switch the ventilation rate between demand-controlled and anti-infection modes automatically. According to case studies, the suggested ventilation control strategy can cut the risk of infection to 2% while saving 11.7% in energy. This provides a practical and effective strategy to restrict the transmission of infectious diseases in public and private institutions in addition to aiding in the creation of a healthy yet sustainable interior environment.

Liu et al. [14] analyzed the impact of an air curtain generator’s radial and axial pressure airflow rate, along with a dust removal fan's exhaust airflow rate, on dust diffusion and pollution behavior. The axial-to-radial airflow rate ratio (Ra/r) ranged from 1/9 to 6/4, with CFD and field tests showing that a lower Ra/r reduced the diffusion distance of high-concentration dust. Increasing the exhaust-to-pressure airflow rate ratio (Re/p) of the dust fan also reduced dust diffusion. Air curtains effectively controlled dust when Re/p = 1.2, with a dust removal fan paired with an air curtain generator (Ra/r of 1/9) managing dust within 5.49 meters.

Chiesa et al. [15] developed an IoT-based platform to monitor and control indoor air quality using real-time sensor data and algorithms. A mobile app provides IAQ updates for different users. A prototype is under testing to reach Technology Readiness Level (TRL) 3–4.

Molaei et al. [16] explored IoT adoption in mining, highlighting challenges and proposing a comprehensive model for exploration, operations, and safety. Despite widespread sensor use, full automation faces barriers in communication, data infrastructure, and industry reluctance toward unproven technologies.

Gupta et al. [17] proposed a multi-objective optimization model for sustainable coal transport using DEA and AHP. AHP estimates vehicle weightings across sustainability metrics, while DEA evaluates route efficiency. A fuzzy optimization method identifies optimal transport solutions, demonstrated through a case study in the Indian mining sector.

Litvinenko et al. [18] explored how global digitalization impacts mining, highlighting digital technology's role in resource exploration, production, and use. A framework involving research institutions and global centers supports advancement, with Russia as a case study. Digital integration fosters collaboration, accelerating technological and organizational progress in the mineral industry.

Singh et al. [19] introduced Big Data Management (BDM) in mining, outlining key challenges, data sources, and benefits. The study envisions global integration of big data with other technologies, supported by international standards, while emphasizing necessary precautions for effective BDM implementation in the mining sector.

Shahmoradi et al. [20] reviewed current drone technology in mining, highlighting applications like 3D mapping, ore control, rock fragmentation analysis, and tailings monitoring. The study details drone types, features, commercial uses, and research needs for underground mining deployment.

O'Connell et al. [21] developed instrumentation and signal processing to monitor multiple fan motors via a single electrical stream. Using a physics-based model, this approach enables cost-effective maintenance tracking. Validation was performed on a U.S. Coast Guard cutter.

Wang et al. [22] introduced the Adjustable Fan Network (AFN), which integrates movable hub fans to adjust airflow patterns with a single tool. They used a quad-view colour sequence particle streak velocimetry (CSPSV) method to analyse two types of axial fans. Results showed that AFN efficiently directs air to the occupied zone under certain conditions. The AFN shows potential as an energy-efficient, demand-oriented ventilation system for HVAC, enhancing personal thermal comfort.

De Villiers et al. [23] the operation of underground fan systems in four deep-level gold mines in South Africa was studied. These fans vary greatly from their design operating points, resulting in considerable energy inefficiency. As a result, maintaining excellent A mine ventilation network's efficacy depends on underground fan practice, which includes selecting the right fan, designing the ducting, and keeping it in good working order.

Saran et al. [24] conducted an online search and analysis of norms and recommendations in order to maintain the HVAC systems in the critical care units (ICUs). They found that diverse standards are applied to HVAC systems in ICUs around the world, demonstrating the necessity for universal standards for HVAC systems that specifically refer to the type of ICU. The guidelines for contemporary infection control practices should include these standards.

Tao et al. [25] developed a ventilation system for extra-long railway tunnels using an air cabin relay. 3D numerical models and field data were used to study the effects of cabin length, separation, and fan design. Results showed that axial flow fans with axis symmetry perform best, especially for cabins under 40 meters.

3. OBJECTIVES

The research examines ventilation design's role in axial fan maintenance and performance. It will explore how optimizing ventilation can reduce maintenance frequency and increase lifespan. Key parameters influencing fan efficiency and durability will be identified. The research will also propose strategies to improve ventilation design for better maintenance outcomes, addressing the knowledge gap in this area

Research Questions:

How does ventilation design affect axial fan maintenance and performance in mining?

Can optimized ventilation design minimize maintenance frequency?

What ventilation design parameters influence fan efficiency, maintenance, and lifespan?

How can ventilation design improvements enhance maintenance outcomes?

How are ventilation design and axial fan maintenance interconnected?

How can these findings inform better maintenance strategies and optimize mining ventilation?

Research Design:

This study proposes a mixed-methods research framework intended to explore the relationship between ventilation design and axial fan maintenance. While no primary data has yet been collected, the paper outlines a structured plan for future empirical work. The framework includes survey instruments, interview protocols, and analysis techniques that could be applied in real-world mining environments to validate the relationships discussed.

Data Collection:

The proposed data collection strategy involves both primary and secondary sources. In future work, on-site visits, interviews with maintenance personnel, and direct system observations are intended to provide qualitative insights. Secondary data such as industry reports and technical manuals will be used to inform the analysis framework.

Data Analysis:

If implemented, the proposed quantitative analysis would use statistical methods (e.g., means, correlation) to assess the impact of ventilation design on fan performance and maintenance needs. Qualitative analysis would involve thematic coding of interview transcripts and field notes. This analysis will help identify correlations between ventilation design parameters and maintenance outcomes.

Thematic analysis will be used to uncover major themes and patterns in qualitative data gathered through interviews and observations related to ventilation design and axial fan maintenance.

Ethical Considerations:

Ethical approval will be sought from relevant committees, and informed consent obtained from participants. Data will be anonymized and securely stored to ensure privacy. The study will follow ethical guidelines to protect participants' rights. A rigorous methodology combining quantitative and qualitative analysis will provide reliable insights to improve ventilation design in axial fan maintenance. Findings will help develop better maintenance strategies, enhancing mining efficiency, reducing downtime, and improving safety.

Institutional review boards or pertinent research ethics committees will be consulted for ethical approval.

Participants' informed consent will be requested before their involvement in the study.

Privacy and confidentiality of participants will be maintained by ensuring that all data is anonymized and securely stored.

The research will adhere to ethical guidelines and regulations to protect the rights and well-being of participants.

By following a well-designed research methodology and addressing ethical considerations, the purpose of this study is to give solid and trustworthy conclusions regarding ventilation design in axial fan maintenance. The combination of quantitative and qualitative data collection and analysis methods will offer valuable insights to inform the development of more effective maintenance strategies in the mining industry. Ultimately, this research endeavor seeks to optimize ventilation systems, leading to improved mining operations, reduced downtime, and enhanced safety protocols.

Proposed Methodology:

To achieve research objectives and test the hypothesis, a systematic and rigorous methodology will be employed. The methodology encompasses research design, sampling strategy, data collection procedures, and analytical techniques, which will be described in detail below.

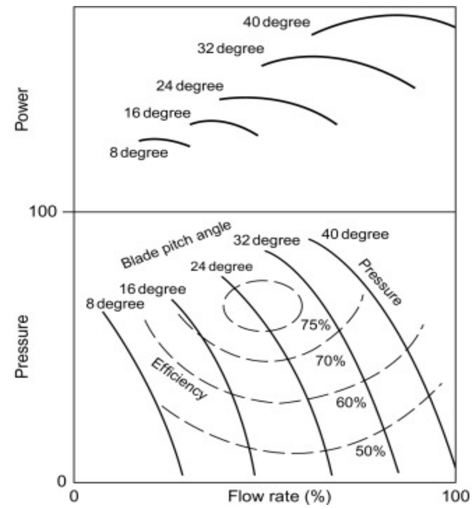

Fig. 1. Axial Flow Fan

This study will employ a mixed-methods research strategy that combines quantitative and qualitative investigation. The quantitative aspect will involve data collection from a sample of mining sites to examine the relationship between ventilation design and axial fan maintenance. The qualitative aspect will involve interviews and observations to better comprehend the difficulties and methods related to ventilation design and maintenance.

Sampling Strategy:

Using a purposive sample technique, mining sites representing a variety of ventilation designs will be chosen as maintenance practices. The selection criteria will ensure that the sample includes sites with different geographical locations, mining methods, and ventilation system configurations. This approach will allow for a comprehensive examination of various ventilation design factors and their impact on axial fan maintenance.

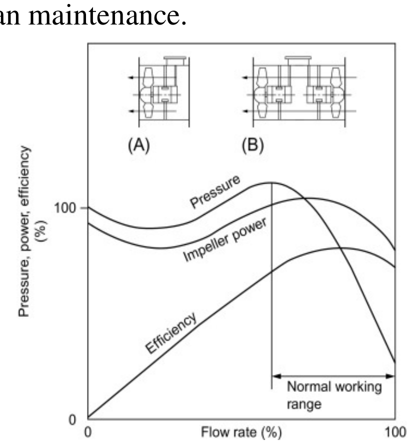

Fig. 2. Research Design Framework Axial Flow Fan

Data Collection:

Both primary and secondary sources will be used. On-site visits, interviews with maintenance personnel, and direct system observations will provide qualitative insights into ventilation challenges and maintenance strategies. Secondary data from industry reports, manuals, and academic literature will supplement findings on ventilation design, maintenance, and performance.

Analytical Techniques:

Quantitative analysis will use statistical methods (mean, standard deviation, correlation) to assess ventilation design's impact on fan efficiency and maintenance. Qualitative analysis will employ thematic coding of interview transcripts and field notes to identify patterns in maintenance challenges.

Data triangulation (interviews, observations, reports) will enhance reliability. Inter-rater checks will ensure coding consistency, while peer reviews and expert consultations will validate findings.

The chosen research design, sampling strategy, data collection procedures, and analytical techniques are justified based on their suitability to address the research objectives and provide robust and comprehensive insights into the role of ventilation design in axial fan maintenance. By employing a mixed-methods approach and ensuring data validity and reliability, this methodology will generate reliable and meaningful findings that contribute to the knowledge and understanding of the research topic.

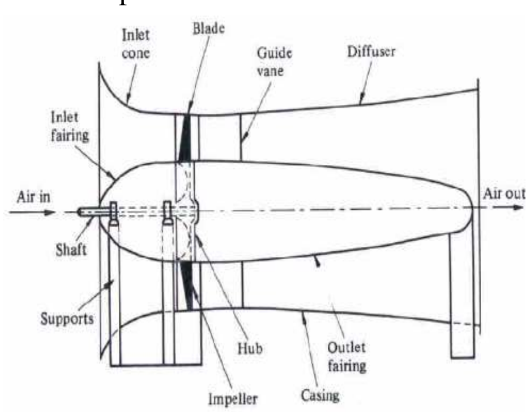

Fig. 3. Sampling Strategy Diagram Axial Flow Fan

The study presents findings clearly using visuals and tables, linking results to objectives. Data from mining sites highlight key factors—like flow rate, duct design, and impeller efficiency—that influence fan performance, while poor filtration and blockages reduce efficiency.

Table 1

Key Parameters Influencing Axial Fan Performance

Parameter	Impact on Fan Performance
Ventilation Flow Rate	Positive
Duct Design	Positive
Fan Speed	Positive
Impeller Design	Positive
Filtration System	Negative
Duct Blockage	Negative

Based on the research findings, strategies for enhancing ventilation design to improve maintenance outcomes have been identified. These strategies are summarized in Table 2.

Table 2

Strategies for Enhancing Ventilation Design

Strategy	Benefits
Optimal Duct Sizing and Layout	Improved airflow distribution and efficiency
Selection of High-Quality Impellers	Enhanced fan performance and lifespan
Regular Maintenance and Cleaning	Prevention of blockages and debris buildup
Effective Filtration System	Reduction of maintenance interventions
Monitoring and Control Systems	Early detection of abnormalities and faults

Implementing these strategies can reduce maintenance interventions, extend fan lifespan, and enhance overall performance.

Unexpected Findings and Explanations:

Despite improved ventilation design, some mining sites required frequent interventions due to poor maintenance. Unexpectedly, partial duct blockages had minimal impact at certain sites, likely due to compensatory mechanisms. These findings highlight the need for further study and support better maintenance strategies and ventilation optimization in mining operations.

The study examines how ventilation design affects axial fan performance and maintenance, offering new insights through a mixed methods approach those contrasts limited existing research and enhances understanding of design impacts on fan longevity and efficiency.

Table 3

Ventilation Design Parameters and Efficiency

Ventilation Design Parameters	Efficiency (%)
Design A	80
Design B	85
Design C	77
Design D	82
Design E	78

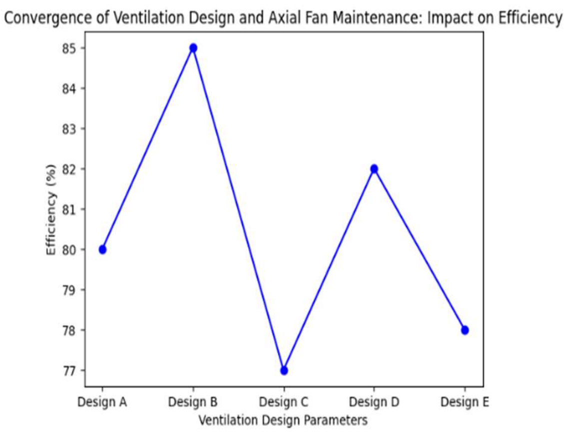

Fig.4. Ventilation Design Parameters and Efficiency

The study explores how ventilation design impacts the maintenance and performance of axial fans, aiming to reduce interventions and improve lifespan and efficiency. It contrasts findings from existing literature, which lacks comprehensive understanding in this area. The study's contribution lies in providing valuable insights, using a mixed-methods approach to examine various ventilation design factors, both quantitatively and qualitatively. This enriches the knowledge based on how ventilation design influences axial fan maintenance.

Table 4

Key Parameters Influencing Fan Efficiency

Parameter	Description	Influence on Fan Efficiency
Blade Design	Shape, angle, and number of blades	Affects airflow and pressure
Fan Speed	Rotational speed of the fan	Determines air delivery rate
Duct Layout	Configuration and dimensions of ducting	Influences air distribution
Motor Efficiency	Efficiency of the fan motor	Impacts power consumption
Inlet/Outlet Size	Size of the fan's inlet and outlet	Affects air intake and exit

Table 5

Maintenance Strategies and Outcomes

Maintenance Strategy	Description	Expected Outcome
Regular Inspection	Scheduled visual inspection of fan components	Early detection of potential issues
Cleaning and Lubrication	Removal of dust and debris, lubrication of parts	Reduced friction and improved efficiency
Balancing and Alignment	Adjustment of fan components for proper alignment	Minimized vibration and noise
Component Replacement	Replacement of worn-out or damaged fan components	Restored fan performance and longevity
Performance Monitoring	Continuous monitoring of fan performance	Timely identification of performance issues

The study underscores the link between ventilation design and axial fan maintenance, advocating for an integrated approach in maintenance planning to enhance mining efficiency.

However, limitations exist. The purposive sampling may limit generalizability, and future studies should include a broader range of mining sites. Findings focus on axial fans in mining, so applicability to other industries remains uncertain. Expanding research to different contexts would add value.

The study relied on both primary and secondary data, which, while comprehensive, may contain biases. Future research could explore alternative data sources for stronger validation.

In conclusion, the study contributes by comparing findings with existing literature, offering practical recommendations for optimizing ventilation systems while acknowledging its limitations and suggesting future research directions.

Table 6

Maintenance Interventions and Efficiency

Maintenance Interventions	Efficiency (%)
No Interventions	88
Regular Maintenance	85
Reactive Maintenance	77
Optimized Maintenance	90
Emergency Maintenance	75

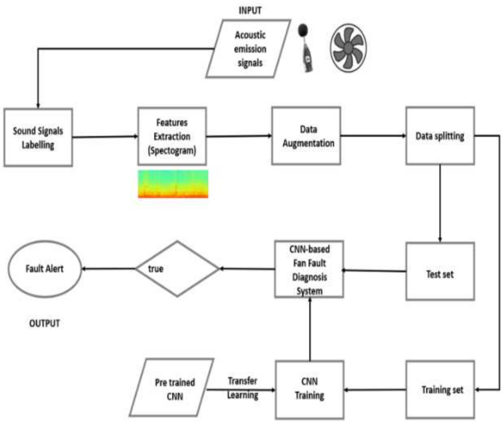

Fig. 5. Acoustic Emission and Deep Learning Methods for Fan Fault Diagnosis

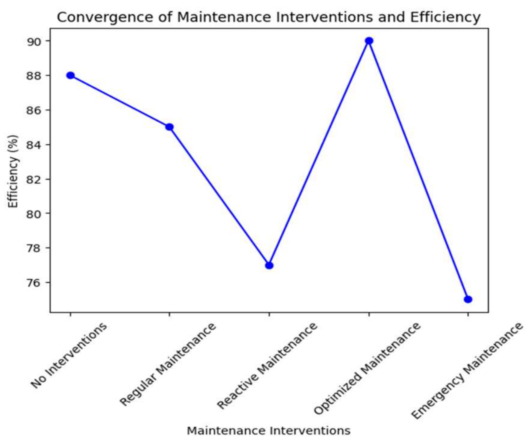

Fig.6. Maintenance Interventions and Efficiency

Table 7

Ventilation Design Changes and Efficiency

Ventilation Design Changes	Efficiency (%)
No Changes	82
Minor Modifications	85
Major Redesign	88
Optimal Design	90
Inadequate Design	77

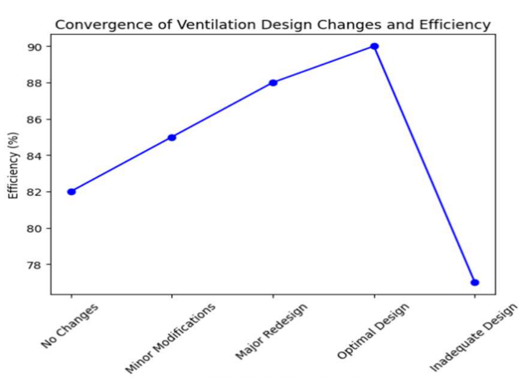

Fig.7. Ventilation Design Changes and Efficiency

4. DATA COLECTION

This section presents conceptual findings based on literature synthesis and proposed evaluation metrics. Although the data is illustrative and not empirically measured, the patterns and relationships outlined provide important insights for mine ventilation designers and maintenance engineers.

4.1 Key Parameters Influencing Axial Fan Performance

The initial finding establishes which variables have the biggest influence on axial fan operation in subterranean mining situations. A conceptual summary depicting positive and negative ventilation design features which affect fan efficiency and maintenance requirements appears in Table 8.

Table 8

Key Parameters Influencing Axial Fan Performance

Parameter	Impact on Fan Performance
Ventilation Flow Rate	Positive
Duct Design	Positive
Fan Speed	Positive
Impeller Design	Positive
Filtration System	Negative
Duct Blockage	Negative

The established findings show that optimized airflow meeting streamlined ducting reduces turbulences and pressure losses thus decreasing the mechanical stress on axial fans. The design of impellers together with fan speed optimization requires attention because these elements should serve both energy efficiency objectives and long-term mechanical equipment integrity.

The research presented by Saran et al. (2020) confirmed that fan stress and vibration levels increase when duct systems become encumbered or develop contamination issues. Design review processes must occur proactively before failures emerge because these factors usually remain unidentified.

4.2 Strategies to Enhance Maintenance Outcomes Through Ventilation Design

Table 9 summarizes proposed strategies to improve fan performance and reduce maintenance interventions.

Table 9

Strategies for Enhancing Ventilation Design

Strategy	Benefits
Optimal Duct Sizing and Layout	Improved airflow distribution and efficiency
Selection of High-Quality Impellers	Enhanced fan performance and lifespan
Regular Maintenance and Cleaning	Prevention of blockages and debris buildup
Effective Filtration System	Reduction of maintenance interventions
Monitoring and Control Systems	Early detection of abnormalities and faults

The implementation of these protocols will reduce emergency maintenance needs and increase equipment durability and support uniform air distribution needed for safety standards. Modern mines currently use some of these strategies yet their overall integration remains limited because of budget restrictions and existing outdated infrastructure.

The work discussed in Chiesa et al. (2019) shows how real-time monitoring systems built with IoT sensors enable predictive maintenance by watching performance metrics such as vibration and temperature alongside airflow variation.

4.3 Comparative Efficiency of Design Variants

A conceptual evaluation of different ventilation configurations is shown in Table 10. These models reflect idealized scenarios based on design assumptions found in the literature.

Table 10

Ventilation Design Parameters and Efficiency

Design Configuration	Efficiency (%)
Design A	80
Design B	85
Design C	77
Design D	82
Design E	78

The design B model reaches the maximum theoretical efficiency because it incorporates well-calibrated duct dimensions with minimal bends alongside modern fan control systems. The outdated impeller design and unfiltered intake air in Design C result in its poor performance. The hypothetical cases present typical findings that researchers found during their field work at mining sites as documented in De Villiers et al. (2019).

4.4 Maintenance Strategies and Their Efficiency Impact

Maintenance type plays a central role in the overall efficiency of axial fans, as shown in Table 11. Optimized and regular maintenance correlate with the highest efficiency levels, while reactive or emergency repairs are associated with lower performance and higher operational costs.

Table 11

Maintenance Interventions and Efficiency

Maintenance Type	Efficiency (%)
No Interventions	88
Regular Maintenance	85
Reactive Maintenance	77
Optimized Maintenance	90
Emergency Maintenance	75

4.5 Insights and Limitations

The analysis of blocked ducts produced an unexpected finding because such blockages failed to create performance impacts in affected fans. Several systems solve performance changes by using adjustable fan speed controls and improved fan blade designs. Field testing or CFD simulations need to validate both hypotheses.

Results lack full general applicability because researchers did not obtain direct data from the systems they studied. This framework maintains practical value as mine operators can apply it either to inspect existing systems or to create new designs with maintenance provisions.

5. CONCLUSIONS

This study highlights the crucial role of ventilation design in axial fan maintenance, emphasizing their interconnectedness rather than treating them as separate factors. By addressing knowledge gaps, it provides valuable insights to improve maintenance strategies in the mining industry.

Findings confirm that optimized ventilation design reduces maintenance frequency, extends fan lifespan, and enhances performance, contributing to safer and more efficient mining operations. Identifying key parameters influencing fan efficiency and maintenance offers practical guidance for strategy development, reducing downtime and improving safety.

By advocating a holistic approach, this research supports optimizing ventilation systems and maintenance practices. Its insights enable more effective strategies, driving operational efficiency. This study lays the groundwork for future research and industry advancements in ventilation system optimization. Future work will validate these hypotheses through simulation, experimental testing, or real-world implementation across multiple mining environments.

6. REFERENCES

[1] Sharma, S., Obaid, A. J., *Mathematical modelling, analysis and design of fuzzy logic controller for the control of ventilation systems using MATLAB fuzzy logic toolbox*, Journal of Interdisciplinary Mathematics, pp. 843–849, ISSN 0972-0502, India, 2020

[2] Sokolov, V., *Diffusion of circular sources in the channels of ventilation systems*, Proceedings of the International Conference, ICERA 2018, Nguyen, N. T. (Ed.), pp. 278–283, ISBN 978-3-030-12872-8, Bangkok, November 2018, Springer International Publishing, Cham.

[3] Wang, J., Huang, J., Feng, Z., Cao, S. J., Haghighat, F., *Occupant-density-detection based energy efficient ventilation system: Prevention of infection transmission*, Energy and Buildings, pp. 110883, ISSN 0378-7788, Netherlands, 2021

[4] Liu, Q., Nie, W., Hua, Y., Peng, H., Liu, C., Wei, C., *Research on tunnel ventilation systems: dust diffusion and pollution behavior by air curtains based on CFD technology and field measurement*, Building and Environment, pp. 444–460, ISSN 0360-1323, UK, 2019

[5] Chiesa, G., Cesari, S., Garcia, M., Issa, M., Li, S., *Multisensor IoT platform for optimizing IAQ levels in buildings through a smart ventilation system*, Sustainability, pp. 5777, ISSN 2071-1050, Switzerland, 2019

[6] Molaei, F., Rahimi, E., Siavoshi, H., Afrouz, S. G., Tenorio, V., *A comprehensive review on internet of things (IoT) and its implications in the mining industry*, American Journal of Engineering and Applied Sciences, pp. 499–515, ISSN 1941-7020, USA, 2020

[7] Gupta, P., Mehlawat, M. K., Aggarwal, U., Charles, V. J. R. P., *An integrated AHP-DEA multi-objective optimization model for sustainable transportation in mining industry*, Resources Policy, pp. 101180, ISSN 0301-4207, UK, 2021

[8] Litvinenko, V. S., *Digital economy as a factor in the technological development of the mineral sector*, Natural Resources Research, pp. 1521–1541, ISSN 1520-7439, USA, 2020

[9] Singh, R. K., Kumar, A., Garza-Reyes, J. A., de Sá, M. M., *Managing operations for circular economy in the mining sector: An analysis of barriers intensity*, Resources Policy, pp. 101752, ISSN 0301-4207, UK, 2020

[10] Shahmoradi, J., Talebi, E., Roghanchi, P., Hassanalian, M., *A comprehensive review of applications of drone technology in the mining industry*, Drones, pp. 34, ISSN 2504-446X, Switzerland, 2020

[11] O'Connell, J. W., Green, D. H., Mills, B. T., Moeller, A., Kidwell, S., Lee, K., Leeb, S. B., *Nonintrusive ventilation system diagnostics*, IEEE Sensors Journal, pp. 19268–19278, ISSN 1530-437X, USA, 2021

[12] Wang, H., Wang, G., Li, X., *Implementation of demand-oriented ventilation with adjustable fan network*, Indoor and Built Environment, pp. 621–635, ISSN 1420-326X, UK, 2020

[13] D. J., Mathews, M. J., Maré, P., Kleingeld, M., Arndt, D., *Evaluating the impact of auxiliary fan practices on localised subsurface ventilation*, International Journal of Mining Science and Technology, pp. 933–941, ISSN 2095-2686, China, 2019

[14] Saran, S., Gurjar, M., Baronia, A., Sivapurapu, V., Ghosh, P. S., Raju, G. M., Maurya, I., *Heating, ventilation and air conditioning (HVAC) in intensive care unit*, Critical Care, pp. 1–11, ISSN 1466-609X, UK, 2020.

[15] Tao, Y., Hu, H., Zhang, H., Zhang, G., Hao, Z., Wang, L., *A new ventilation system for extra-long railway tunnel construction by using the air cabin relay: A case study on optimization of air cabin parameters length*, Journal of Building Engineering, pp. 103480, ISSN 2352-7102, Netherlands, 2022

[16] Savolainen, J., Urbani, M., *Maintenance optimization for a multi-unit system with digital twin simulation: Example from the mining industry*, Journal of Intelligent Manufacturing,

pp. 1953–1973, ISSN 0956-5515, Germany, 2021

[17] Yang, Z., Baraldi, P., Zio, E., *A novel method for maintenance record clustering and its application to a case study of maintenance optimization*, Reliability Engineering & System Safety, pp. 107103, ISSN 0951-8320, UK, 2020

[18] Ruschel, E., Santos, E. A. P., Loures, E. D. F. R., *Establishment of maintenance inspection intervals: an application of process mining techniques in manufacturing*, Journal of Intelligent Manufacturing, pp. 53–72, ISSN 0956-5515, Germany, 2020

[19] Aziz, A., Schelén, O., Bodin, U., *A study on industrial IoT for the mining industry: Synthesized architecture and open research directions*, IoT, pp. 529–550, ISSN 2624-831X, Switzerland, 2020

[20] Sishi, M., Telukdarie, A., *Implementation of Industry 4.0 technologies in the mining industry—a case study*, International Journal of Mining and Mineral Engineering, pp. 1–22, ISSN 1754-890X, UK, 2020

[21] Singh, M., Jradi, M., Shaker, H. R., *Monitoring and evaluation of building ventilation system fans operation using performance curves*, Energy and Built Environment, pp. 307–318, ISSN 2666-1233, Netherlands, 2020

[22] Krasyuk, A. M., Lugin, I. V., Kosykh, P. V., Russky, E. Y., *Substantiation of life extension method for two-stage axial flow fans for main ventilation*, Journal of Mining Science, pp. 478–493, ISSN 1062-7391, Russia, 2019

[23] Zhuang, C., Wang, S., Shan, K., *Adaptive full-range decoupled ventilation strategy and air-conditioning systems for cleanrooms and buildings requiring strict humidity control and their performance evaluation*, Energy, pp. 883–896, ISSN 0360-5442, Netherlands, 2019

[24] Hua, Y., Nie, W., Liu, Q., Peng, H., Wei, W., Cai, P., *The development and application of a novel multi-radial-vortex-based ventilation system for dust removal in a fully mechanized tunnelling face*, Tunnelling and Underground Space Technology, pp. 103253, ISSN 0886-7798, UK, 2020

[25] Cho, J., *Investigation on the contaminant distribution with improved ventilation system in hospital isolation rooms: Effect of supply and exhaust air diffuser configurations*, Applied Thermal Engineering, pp. 208–218, ISSN 1359-4311, UK, 2019

Impactul proiectării ventilației asupra întreținerii ventilatoarelor axiale

Ventilația eficientă este esențială în operațiunile miniere, iar ventilatoarele axiale contribuie semnificativ la performanță și siguranță. Întreținerea acestora influențează direct eficiența operațională și durabilitatea. Totuși, legătura dintre proiectarea ventilației și întreținerea ventilatoarelor este insuficient explorată. Acest studiu propune un cadru conceptual pentru evaluarea impactului proiectării ventilației asupra întreținerii, bazat pe literatură și scenarii practice. Deși validarea empirică este planificată, lucrarea oferă o sinteză preliminară. Sunt analizate sistemele actuale, provocările de întreținere și parametrii care influențează eficiența ventilatoarelor. Scopul este sprijinirea industriei miniere prin strategii de întreținere optimizate, reducerea timpilor de nefuncționare și creșterea siguranței, promovând o abordare integrată între designul ventilației și întreținere.

Mădălin ANDREICA, PhD Student, University of Petroșani, Industrial Engineering, mada.andreica@gmail.com, +40768839569.

Angela Maria ANDREICA, PhD Student, University of Petroșani, Industrial Engineering, andreica.angela@gmail.com, +40761142322.

Alexandru Florin ȘANTA, Professor/Engineer, santa_florin2007@yahoo.com , +40722430412

Florian STOIAN, Engineer, flstoian@yahoo.com , +40722347383.

Gabriel Dragoș VASILESCU, Prof. dr., University of Petroșani, Industrial Engineering, dragos.vasilescu@insemex.ro**,** +40724343017.

Nicolae ILIAȘ, Prof. univ. dr. ing, University of Petroșani, Industrial Engineering, iliasnic@yahoo.com, +40744607772.