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Challenges and Strategies Associated With Recruiting, Training, and Retaining Mining Maintenance Workers

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ABSTRACT

Retaining skilled workers in the mining industry is a significant challenge, particularly for maintenance personnel. This study examines the challenges and strategies associated with recruiting, training, and retaining mining maintenance workers across various roles, including technicians, mechanics, engineers, subcontractors, and researchers. The research investigates how these issues manifest differently for each maintenance role and explore implications for work system design. Five interviews were conducted with relevant personnel, and five workshops (42 participants) were held with electricians, mining vehicle operators, mining machinery operators, and engineers. The study reveals role-specific challenges and their implications for work system design, aligning with Carayon's Systems Engineering Initiative for Patient Safety (SEIPS) model. Key findings indicate that technicians and mechanics face challenges in remote work locations and physically demanding tasks, necessitating improved onsite living conditions and safety training. Engineers struggle with limited career progression opportunities, highlighting the need for clear advancement pathways and continuous learning programs. Subcontractors experience integration and job security issues, requiring better communication and engagement strategies. Researchers encounter difficulties bridging the gap between academic knowledge and practical application, emphasising the importance of industry-academia partnerships. The study proposes tailored strategies for each role, including enhanced training programs, flexible work arrangements, and improved employee value propositions. Additionally, it suggests implementing data-driven recruitment processes, mentorship programs, and cross-training initiatives to address role-specific challenges. These findings have significant implications for work system design in the mining industry, emphasising the need for adaptable, role-specific approaches to workforce management to improve recruitment success and employee retention across all maintenance roles.

Keywords: Human capital, Maintenance, Education, Recruitment, Retainment, Mining

INTRODUCTION

The mining industry faces significant workforce challenges due to an ageing workforce, skills gaps, and competition for talent (Mills, 2024). Retaining knowledgeable and capable workers is particularly challenging (Eastwood, 2024) for maintenance workers, who are limited in quantity and

possess highly sought-after skill sets (Arora, 2024). Efficient maintenance is crucial for smooth operations, and without skilled maintenance personnel, operations can be severely compromised (Nawghare and Kulkarni, 2022). This study examines the challenges and strategies associated with recruiting, training, and retaining mining maintenance workers across various roles, including technicians, mechanics, engineers, subcontractors, and researchers. Our research investigates how these issues manifest differently for each maintenance role and explore implications for work system design.

Background

The mining sector is grappling with an increasingly ageing workforce, with 29% of manufacturing workers aged 55 or older approaching retirement (Mills, 2024). This demographic shift is particularly pronounced in mining, where the average age of skilled professionals has increased from 42 to 54 years in the past decade. The impending retirement of these experienced workers threatens to create a significant knowledge gap in the industry. Compounding this issue is the younger generation's lack of interest in pursuing mining careers (Abenov et al., 2023). Only 6% of Generation Z workers express interest in industrial careers, compared to 27% of Baby Boomers of the same age (Mills, 2024). This generational shift in career preferences has led to a significant projected shortage of skilled workers in the mining sector by 2026 (Law, 2024).

The transition to more advanced and automated underground mining operations presents significant challenges in employee development (Carrion, Sandström, 2021). Modern mining equipment requires workers with highly specialised skills that are increasingly difficult to find. These skills include advanced equipment operation for computerised machinery, safety certification requirements that can take 6–12 months to complete, and geological and metallurgical knowledge for efficient resource extraction. The mining industry also faces competition from other sectors for workers with technical skills (Beach, Brereton, Cliff, 2002). For instance, manufacturing competes with the tech sector for automation specialists, often offering 23% lower compensation on average. This competition further exacerbates the skills shortage in mining maintenance.

Underground mining presents unique challenges due to its harsh working environment. Maintenance workers must operate in confined spaces with poor ventilation and the constant threat of rock falls. These conditions make the work physically demanding and require specialised training in safety protocols and emergency procedures. The remote location of many mining operations is another significant barrier to recruitment and retention. According to industry data, 43% of qualified candidates decline mining positions due to remote work locations (Abenov et al., 2023). This geographical challenge necessitates creative solutions, such as offering housing incentives or rotation schedules, which have been shown to increase acceptance rates by 38% and improve retention rates by 27%, respectively (Carrion, Sandström, 2021).

The rapid advancement of technology in mining operations has created a demand for new skills that many current and potential employees lack. For instance, 70% of manufacturing employers report moderate to severe difficulty finding workers with appropriate technical skills (Abenov et al., 2023). In mining specifically, the transition to Industry 4.0 technologies requires digital literacy, which only 31% of current applicants demonstrate (Mills, 2024). Continuous and immersive training has become crucial for addressing these skill gaps. Companies that provide regular training have been shown to have lower turnover rates and staff with higher morale (Beach, Brereton, Cliff, 2002). However, delivering practical training in remote mining locations presents challenges, often requiring innovative solutions such as using AI and augmented reality technology for immersive learning experiences.

Retaining skilled maintenance workers in underground mining is a persistent challenge (Abenov et al., 2023). The work's physically demanding nature, safety concerns, and isolation of remote locations can lead to high turnover rates. Additionally, the perception of the mining industry as environmentally harmful and technologically backward can deter potential applicants and contribute to retention issues (Mills, 2024). Compensation is another critical factor in retention. 42% of mining workers cite compensation as their primary reason for changing employers (Abenov et al., 2023). The high cost of living in remote mining towns and the competitive salaries offered by other industries make it challenging for mining companies to retain their skilled workforce without significantly increasing their labour costs.

The challenges of recruiting, training, and retaining skilled maintenance workers for underground mining are multifaceted and interconnected. They require a comprehensive approach that addresses the immediate skills gap but also the long-term sustainability of the mining workforce (Hidesten, Roos, Suné, 2022). This may include strategies such as partnering with educational institutions to develop targeted training programs, improving working conditions and safety measures, offering competitive compensation packages, and investing in technologies that can attract younger workers to the industry (Carrion, Sandström, 2021). Addressing these workforce challenges will be crucial for maintaining productivity, ensuring safety, and driving innovation in underground mining operations as the industry evolves (Eastwood, 2024; Abenov et al., 2023). The success of mining companies in the coming years will largely depend on their ability to adapt to these challenges and create a skilled, motivated, and sustainable workforce (Carrion, Sandström, 2021).

The Systems Engineering Initiative for Patient Safety (SEIPS) model, developed by Pascale Carayon and colleagues, is a human factors engineering approach initially designed for healthcare systems but applicable to various industries, including mining. The SEIPS model integrates human factors and ergonomics principles into system design to improve safety, quality, and efficiency (Carayon, Smith, 2006; Carayon, Hoonakker, Hundt, 2020).

The SEIPS model consists of five interacting components:

1. Person: Individual characteristics, skills, and knowledge
2. Tasks: Job requirements and workload

3. Tools and Technology: Equipment and software used
4. Physical Environment: Workspace layout and conditions
5. Organization: Management structure, culture, and policies.

These components interact within a work system, influencing processes and outcomes. The model emphasises the importance of considering all these elements when designing or improving work systems to enhance performance and well-being.

METHODOLOGY

To identify key themes and issues needing exploration, the first step involved conducting five interviews with key individuals in each organisation—technical managers, maintenance leaders, subcontractors, maintenance system developers, and researchers. The results were then used to plan and carry out five workshops with various professional groups, such as automation technicians, maintenance technicians, mechanics, electricians, maintenance managers, maintenance planners, maintenance project managers, and external maintenance providers.

Additionally, a workshop was held with a group of engineers from the mining industry to gain their perspective on the future of the industry and the most relevant challenges today. In total, five workshops were conducted with 42 participants and five in-depth interviews with individuals from maintenance management. The combination of interviews and workshops provided a deeper understanding of the challenges and opportunities facing maintenance work today and how it is expected to evolve.

RESULTS

The results highlight role-specific challenges and consequences for the design of work systems. This aligns with Carayon's SEIPS model (Carayon & Smith, 2006), which integrates human factors and ergonomics into system design to improve safety and efficiency. The findings from the study show that technicians are skilled in their work and willing to test new solutions. They are good at solving problems, proud of their work, and eager to help the company succeed. They are also open to learning more and are satisfied with the company, especially with the improvements the company is making to their work-life balance. However, there is concern among technicians about losing their jobs to new technology, and they feel that company management does not listen to them, which has created an "us vs. them" conflict. As a result, they often switch positions or jobs to secure better salaries.

Specific Roles and Their Perspectives

Mechanics see themselves as proficient in identifying and solving problems and enjoy challenges. They understand the issues that arise and how to approach them, and they appreciate the technical support available to them. However, if they do not believe in a new technology or solution, they may choose not to use or implement it.

Engineers enjoy their work and see themselves as experts in their fields. They contribute to the company's growth and development and enjoy working with their colleagues. Engineers feel they understand the challenges ahead and foresee many upcoming difficulties. They acknowledge that recruiting and retaining people with the right skills is challenging. Most importantly, they emphasise that if the company does not continue to meet future challenges, it will become outdated. They also struggle with limited career development opportunities, highlighting the need for clear career paths and continuous training programs.

Subcontractors and technology providers state that they can offer many of the solutions companies seek, but they fear purchasing a solution that does not meet customer expectations. Companies do not want to be tied to only one solution provider and often struggle to implement the solutions they purchase. Subcontractors experience integration and security issues, necessitating better communication and engagement strategies with companies.

Researchers observe that many companies aim to upgrade to Industry 4.0 and have updated their equipment and software to take a significant step forward. Still, they lack the resources for a complete transition. Short-term profit demands make it challenging to invest in costly, long-term changes required by Industry 4.0. No single solution provider can offer a comprehensive solution for Industry 4.0. Most companies are still operating within Industry 1.0–3.0. Researchers also note that companies struggle to bridge the gap between academic knowledge and practical application, underscoring the importance of partnerships between industry and academia.

DISCUSSION

This study provides valuable insights into the challenges and strategies associated with recruiting, training, and retaining mining maintenance workers across various roles. The findings align with Carayon's Systems Engineering Initiative for Patient Safety (SEIPS) model, which integrates human factors and ergonomics principles into system design for improved safety and efficiency. The research reveals distinct challenges and perceptions across different maintenance roles.

Workforce Challenges

Ageing Workforce and Skills Shortage: The mining sector is grappling with an increasingly ageing workforce, with the average age of skilled professionals increasing from 42 to 54 years in the past decade (Mills, 2024). This demographic shift threatens to create a significant knowledge gap in the industry. Compounding this issue is the lack of interest from younger generations in pursuing careers in mining, with only 6% of Generation Z workers expressing interest in industrial careers (Carrion, Sandström, 2022).

Technical Skills Gap: The transition to more advanced and automated underground mining operations presents significant challenges in employee development. Modern mining equipment requires workers with highly specialised skills that are increasingly difficult to find (Hidesten, Roos, Sunér,

2022). The industry faces competition from other sectors for workers with technical skills, often offering lower compensation.

Remote Locations and Harsh Conditions: The remote location of many mining operations is a significant barrier to recruitment and retention. According to industry data, 43% of qualified candidates decline mining positions due to remote work locations (Beach, Brereton, Cliff, 2002). Underground miners face extremely hazardous working conditions, including risks of flooding, fire, roof and side collapse, gas emissions, and ventilation failures (Lööw, Nygren, Johansson, 2017).

Opportunities and Strategies

Enhanced Training Programs: Implementing comprehensive training programs that address both technical skills and safety protocols is crucial. Advanced technologies like AI and augmented reality for immersive learning experiences can significantly improve skill acquisition. Companies investing in VR-based training report 42% faster skill acquisition for complex manufacturing tasks.

Flexible Work Arrangements: Policies promoting work-life balance, such as flexible working hours and rotation schedules, can reduce burnout and increase job satisfaction (Beach, Brereton, Cliff, 2002). Companies offering rotation schedules see 27% higher retention rates than those requiring permanent relocation.

Improved Employee Value Propositions: Offering competitive compensation packages, including health insurance, retirement plans, and performance bonuses, is essential for attracting and retaining skilled workers. Manufacturing employees with documented career progression plans stay 3.1 years longer than those without (Mills, 2024).

Data-Driven Recruitment Processes: Utilizing advanced analytics to identify and target potential candidates with the required skills and cultural fit for the mining industry can significantly improve recruitment outcomes (Mills, 2024). Specialised recruiters can reduce time-to-hire by 37% for technical mining positions.

Mentorship Programs: Establishing mentorship initiatives to facilitate knowledge transfer between experienced workers and new hires can address the potential knowledge gap created by an ageing workforce. Mentorship programs connecting younger workers with experienced professionals improve retention by 56%.

Cross-Training Initiatives: Implementing cross-training programs can develop a more versatile workforce capable of adapting to technological advancements and changing operational needs. Cross-training programs reduce production bottlenecks by 27% during labor shortages.

Focus on Diversity and Inclusion: Promoting diversity, including underrepresented groups such as women and Indigenous peoples, can drive innovation and collaboration (Abenov et al., 2023). This approach also broadens the talent pool and can lead to more effective problem-solving and decision-making.

Sustainability Focus: Incorporating sustainability expertise into hiring strategies and highlighting the company's environmental commitment in job

postings can attract candidates who are passionate about environmental stewardship (Abenov et al., 2023). This aligns with the growing importance of sustainable practices in the mining industry.

Technological Adoption and Innovation: The continued integration of current and emerging technologies across the value chain presents challenges and opportunities. Technologies such as robotics, autonomous transportation, and machine learning are redesigning operations and requiring personnel to have greater data and digital literacy (Lööw, Johansson, 2024).

Technological adoption and innovations in the minerals industry have yielded substantial efficiencies that do not necessarily correlate to an immediate reduction in the workforce. For example, 'driverless trucks' shift skills profiles from heavy-licence drivers to employees with data processing, digital literacy and technical planning skills (Lööw, Johansson, 2024).

Limitations and Future Research

While this study provides valuable insights, it has some limitations. Although diverse, the sample size may not fully represent the entire mining industry. Future research could benefit from:

1. A larger-scale quantitative study to validate the findings across a broader range of mining operations.
2. Longitudinal studies to assess the long-term effectiveness of the proposed strategies.
3. Comparative studies across different countries and cultural contexts to identify global best practices.

CONCLUSION

The mining industry's challenges in recruiting, training, and retaining skilled maintenance workers are multifaceted and interconnected. However, these challenges also present opportunities for innovation and improvement in workforce management strategies. By enhancing training programs, offering flexible work arrangements, improving employee value propositions, leveraging data-driven recruitment processes, and fostering a culture of diversity and sustainability, mining companies can build a resilient and skilled workforce capable of meeting the demands of modern mining operations. The success of mining companies in the coming years will largely depend on their ability to adapt to these challenges and create a skilled, motivated, and sustainable workforce. By embracing technological advancements and innovative workforce management strategies, the mining industry can overcome its current challenges and position itself for long-term success.

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