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Policy Evaluation Of The Underground Mining Training Centre In Strengthening Human Resources To Develop A Professional And Skilled Workforce In The Field Of Underground Mining In Sawahlunto, West Sumatra

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Abstract

This study motivated by the importance of Human Resource (HR) development in creating professional and skilled workers in the underground mining sector. The Underground Mining Training Center (BDTBT), as a technical implementing unit under the Ministry of Energi and Mineral Resources, plays a significant role in providing education, training and competency certification dor mining workers. This study aims to evaluate BDTBT policies in strengthening human resources and to analyze the role of pentahelix actors in supporting underground mining training programs. This research employed a qualitative descriptive approach. Data were collected through interviews, observations and document reviews. Data analysis was conducted using the Miles and Huberman model, including data reduction, data display and conclusion drawing. The result indicated that BDTBT policies have contributed ti improving workforce competencies through competency-based training and professional certification programs. Human resources development is supproted by pentahelix collaboration involving goverment, academia, industry, community and media. However, this collaboration has not yet fully optimized duet o challenges in stakeholder coordination, alignment between industry needs and training curicula, and the

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employment absorption of training graduates. The study concludes that BDTBT policies have been reasonably effective in creating professional and skilled workers. However, stronger partnerships with industry, improved stakeholder coordination, and the devwlopment of a sustainable evaluation system are needed to enchance the quality and competitiviness of the workforce in the underground mining sector.

Keywords: Policy Evaluation, Pentahelix, Human Resource Development Profesional Workforce, Underground Mine

INTRODUCTION

Indonesia's economic growth is heavily influenced by the contribution of the mining sector, which provides industrial raw materials, energy sources, and generates foreign exchange (Trein & Maggetti, 2020). One subsector that plays a crucial role is underground mining. The complex, high-risk characteristics of underground mining, along with the need for specialized technology, necessitate the presence of a professional and skilled workforce to ensure safe, efficient, and sustainable operations (source). Furthermore, underground mining requires a workforce with a high level of risk-managing skills and technical competence. One region in Indonesia with an underground mining industry is the city of Sawahlunto in West Sumatra Province. Underground coal mines in Indonesia that are currently operational are located in the Sawahlunto area of West Sumatra Province and the Batu Licin area of South Kalimantan Province (Widhyasmaramurti et al., 2022). The underground coal mine in Sawahlunto City has been operating since the Dutch colonial era around 1892. Sawahlunto is known as a mining city and a center of mining activity in West Sumatra. Furthermore, the underground mining industry has the potential to develop human resources (HR) in the underground mining sector, which is highly needed to support the national mining workforce (Zambrano-Gutiérrez et al., 2018). The existence of underground mines in Sawahlunto City, to support the sustainability of the industrial sector and prepare a professional and skilled workforce, still indicates the potential need for competent workers in the mining sector. This can be seen from the presence of a number of companies holding Mining Business Permits (IUP) for Production Operations (OP) in this region that are still actively operating and have permits valid for several years to come. This condition indicates that the mining sector still has prospects in absorbing workers with technical competence and certification in the underground mining sector (Albalate & Fageda, 2019). Based on data from the Mining Engineering Heads (KTT) forum for Region 2 of West Sumatra, several mining companies still have their second

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extension of their Mining Operation Permit (IUP OP) valid until 2026-2030. These companies have the potential to become strategic partners in absorbing graduates of education and training organized by the Underground Mining Training Center (BDTBT). However, this opportunity is not yet fully proportional to the absorption rate of BDTBT graduates by the mining industry. Currently, several mining companies in the Sawahlunto region still have Production Operation Permits valid until 2026-2030. This indicates that mining activities in the region still have opportunities for growth and require the support of competent human resources. The existence of these companies provides potential for BDTBT graduates to obtain employment opportunities, so synergy between training institutions and industry is needed to increase the relevance of graduate competencies to job market needs (Tirachini & Cats, 2020).

One of the main objectives of Minister of Energy and Mineral Resources Regulation Number 13 of 2022 is to establish an institution to manage professional and skilled workers. This institution carries out its activities through the Underground Mining Training Center (BDTBT). The Underground Mining Training Center aims to provide education, training, and certification for prospective workers with technical, managerial, and occupational safety skills (Hewett et al., 2022). However, there is a gap in developing skilled, professional, and competent human resources. This gap exists between the number of graduates and the workforce absorption implemented by the BDTBT.

In addition to the low graduate absorption rate, another challenge is the suboptimal collaboration between stakeholders in supporting training delivery. Industry demand for workforce competencies is growing rapidly in line with advances in mining technology. However, the process of curriculum development, training methodology development, and internship opportunities has not fully involved all stakeholders. As a result, there remains a gap between graduate competencies and actual industry needs (Widiyati et al., 2021).

From a public policy perspective, the success of a policy is measured not only by its implementation but also by the extent to which the program achieves its stated objectives. Therefore, this study utilizes William N. Dunn's policy evaluation theory, which encompasses six criteria: effectiveness, efficiency, adequacy, equity, responsiveness, and accuracy (Irwan, Mobo, Sari, et al., 2022). These six indicators are used to assess the extent to which the BDTBT policy has strengthened human resources in the underground mining sector (Hassan et al., 2023).

Furthermore, this study also uses the Pentahelix model, which emphasizes the importance of synergy between government, academia, industry, society, and the media in supporting successful development (Utami et al., 2023). In the context of human resource development, this

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collaboration is a crucial factor in curriculum development, training implementation, provision of practical facilities, and even the absorption of graduates into the workforce (Li et al., 2025).

Unlike previous research, which generally only addresses the effectiveness of training or policy implementation in general, this study integrates policy evaluation theory with the Pentahelix approach, providing a more comprehensive overview of the factors influencing the success of human resource development policies in the underground mining sector (Irwan, Zusmelia, & Siska, 2022). Therefore, the research findings are expected to contribute academically to the development of public policy evaluation studies and provide recommendations for the government and the BDTBT in improving the quality of underground mining education and training (Ollivaud & Haxton, 2019).

RESEARCH METHOD

This study uses a qualitative approach that aims to understand the phenomenon in depth through the perceptions and experiences of informants related to the implementation and evaluation of human resource strengthening policies at the Underground Mining Training Center (BDTBT), Sawahlunto City (Kazakova et al., 2020). This approach was chosen because it is able to provide a comprehensive understanding of the processes and social contexts that underlie the success of the program as well as the obstacles in implementing the underground mining training program (Pretty et al., 2020). Through this approach, this study is expected to serve as the main instrument directly involved in the data collection and analysis process (Fatonie, 2022). Data were obtained through direct interaction with informants, thus enabling researchers to dig up in-depth information regarding the perceptions, experiences, and interpretations of stakeholders regarding the policies studied (Nugroho, 2018). Thus, the use of a constructivist paradigm in a qualitative approach in this study is expected to produce a comprehensive and holistic understanding of the evaluation of the Underground Mining Training Center's policy in strengthening human resources, as well as reveal various factors that influence the level of labor absorption in the underground mining sector in Sawahlunto City (McGann et al., 2018).

Observations were made on the training implementation process and supporting facilities, while documentation was used to supplement data in the form of regulations, activity reports, and other supporting documents (Reichborn-Kjennerud & Johnsen, 2018). Data analysis used the Miles and Huberman interactive model, which includes data reduction, data presentation, and conclusion drawing (Irwan, Zusmelia, Siska, et al., 2022). Data validity was tested through source triangulation, technical triangulation, and time triangulation to increase the credibility of the

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research results (Ndumbe-eyoh & Mazzucco, 2016). Policy analysis was conducted using William N. Dunn's policy evaluation theory, which includes aspects of effectiveness, efficiency, adequacy, equity, responsiveness, and accuracy. While the analysis of collaboration between actors used the Pentahelix model, which includes government, academia, industry, society, and the media (Absori et al., 2022).

RESULTS AND DISCUSSION

A. The Role of Pentahelix Actors in Strengthening Human Resources

Research results show that strengthening human resources at the Underground Mining Training Center (BDTBT) involves collaboration between five key actors: government, academia, industry, the community, and the media. However, the effectiveness of this collaboration depends heavily on the voice and active contribution of each actor in the field.

1. Government (Regulator and Facilitator) The government, through the BDTBT, plays a role in formulating policies and competency standards. Mr. Darius Agung Prata, ST, MKKK, Head of the BDTBT, emphasized the institution's commitment in an interview:

> *"BDTBT's role in strengthening human resources in the mining and energy sector is carried out through the implementation of various training programs designed based on the competency needs of participants as well as developments in regulations and technology... BDTBT continues to make improvements so that the quality of training services is more effective, efficient, and in accordance with the needs of the mining industry in particular.* "

Suryani's (Aripin et al., 2021) research reinforces this finding, stating that strong policy support and thorough training planning under technical ministries are key prerequisites for improving the competency of both civil servants and the general public (Harun et al., 2018). However, government dominance in funding often creates the risk of budget dependency, which limits equitable access to training when state fiscal efficiency is achieved (Febrianti, 2023).

2. Academics (Conceptors and Innovators) Academics play a role in ensuring the curriculum remains scientifically relevant. This was emphasized by DM Magdalena Ritonga, ST, MT (Head of the Mining Geology Engineering Study Program at UNJA):

> *"Training curricula need to be designed based on research findings, developments in mining technology, and the ever-changing needs of the industry. Academics have a role to play in*

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ensuring that the learning process... produces a workforce that is not only skilled but also analytical and adaptable to the digitalization of mining. "

The involvement of academics ensures that training programs are not only technically practical but also possess analytical depth. However, this study found that this collaboration is not yet systematic; the current curriculum tends to focus on basic technical competencies and has not yet fully integrated *digital mining* or *artificial intelligence elements* on a large scale. As Nurhayati (2023) noted, the Pentahelix synergy will only reach its full potential if it can expand access to training that aligns with technological dynamics in mining operations (Irwan, Pitri, & Vitriani, 2022).

3. Industry (Users and Strategic Partners) provided critical feedback on graduates' job readiness. Mr. Andri Saputra, Head of Mining Engineering at PT. Allied Coal Jaya (AIC), stated:

"Industry fundamentally needs a competent and work-ready workforce. BDTBT graduates already have a good foundation of knowledge, but they need more field experience to become accustomed to working conditions in underground mines. Industry also needs to be involved in curriculum development and training evaluation... "

Rahmadani's (Fatimah, 2019) research shows that collaboration between training institutions and industry is a determining factor in the success of professional certification programs. The gap found between the BDTBT curriculum and PT. AIC's expectations indicates the need for a shift in industry's role from being merely a passive user to an active partner in every stage of training (Bakalo et al., 2025).

The research results show that human resource development through education and training at the Underground Mining Training Center (BDTBT) is implemented through collaboration between five key actors in the Pentahelix model: government, academia, industry, the community, and the media. This inter-actor synergy is crucial for improving the quality of training and producing a workforce with competencies that meet the needs of the underground mining industry (Bangsawan et al., 2025).

The Sawahlunto community has high expectations for the BDTBT as a gateway to employment. Meanwhile, the media plays a role in program transparency and dissemination. This finding aligns with research by Haris and Yuliani (2022), which emphasizes that the success of HR programs in industrial areas depends heavily on harmonious coordination between actors.

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Without transparency of information through the media, the community will become mere objects of policy without equitable accessibility (Kagungan et al., 2021).

The government acts as both regulator and facilitator through policy formulation, budget provision, infrastructure development, and competency-based training programs. The BDTBT, as a Technical Implementation Unit under the Energy and Mineral Resources Human Resources Development Agency, is the primary implementer of education, training, and competency certification. Academics contribute through curriculum development, learning material development, and scientific input to refine training methods. Academic involvement allows training materials to be developed based on developments in science, mining technology, and national competency standards. The mining industry plays a role as both a user of graduates and a strategic partner in providing training. Companies provide information on workforce competency needs, provide internship locations, and support the implementation of professional certification. However, research shows that industry involvement in curriculum development and program evaluation is still suboptimal, resulting in a gap between graduate competencies and workplace needs (Irwan & Zusmeli, 2026). Communities serve as both the primary target of policies and the beneficiaries of training programs. Public enthusiasm for training programs is high, as they are seen as improving skills, job opportunities, and workforce competitiveness in the mining sector (Tegegne et al., 2019). Media serves as a means of disseminating information regarding training programs, participant requirements, and BDTBT activity results. The use of digital media has increased public access to information, but publication effectiveness still needs to be improved to reach a wider range of potential participants (Hidayatullah et al., 2022).

Overall, the implementation of the Pentahelix model has been successful, but coordination between actors has not been fully integrated. Strengthening communication, clearer role allocation, and enhancing partnerships with industry are crucial factors in improving the effectiveness of human resource development policies (Bohaiki et al., 2025).

B. Policy Evaluation Based on William N. Dunn's Theory

An analysis of Dunn's six evaluation criteria reveals a gap between administrative achievements and real impact on the ground (Wang et al., 2025):

1. Effectiveness and Outcome Achievement

Effectiveness is measured by the extent to which a policy achieves its objectives. Administratively (output), this policy is highly effective, with a 100% participant graduation rate.

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However, when viewed from *the outcome* (employment absorption), the policy's effectiveness has declined significantly. Data for the 2022–2024 period shows that of 926 graduates, only 177 (19.1%) were successfully absorbed by industry. The absorption rate also declined from 43.49% (2022) to 34.79% (2024). Widodo's (2020) research justification warns that without strong *monitoring* and *follow-up,* technical training outcomes often fail to be optimally implemented in the real workplace.

Based on research findings, the BDTBT policy has successfully improved participant competency through competency-based training and professional certification. Participants gained enhanced knowledge, technical skills, and understanding of occupational safety and health in underground mining. However, the policy's effectiveness has not been fully achieved because the industry's absorption rate of graduates remains relatively low compared to the number of participants who have completed the training. (Moento et al., 2023) This situation indicates that successful training has not yet been fully translated into successful job placement. Therefore, policy effectiveness needs to be strengthened by increasing collaboration with mining companies in providing internship opportunities and recruiting graduates.

2. Efficiency and Resource Optimization

The efficiency aspect assesses the use of resources (costs, time, facilities) to achieve results. BDTBT has adequate mining simulator facilities and OHS laboratories, but their utilization needs to be optimized through digital learning technology to reach more participants at lower operational costs. Santoso's (Subekti & Prasetyo, 2021) research justifies that a competency - *based training approach* can effectively improve work accuracy and operational time efficiency. The implementation of the training program has been supported by competent teaching staff, adequate practice facilities, and budget utilization in accordance with applicable regulations (Singh, 2024). However, the efficiency of program implementation can still be improved by optimizing the use of training facilities, developing digital technology-based learning (Zahrani, 2024), and increasing the number of participants served without compromising the quality of learning.

3. Adequacy and Handling

The Adequacy Problem assesses the extent to which policies are able to address the core problem, namely the lack of skilled labor. Research findings reveal a *skills gap* because training materials do not fully accommodate the rapidly evolving standards of modern mining technology

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in the industry. As Hidayat (Nur Aryanti et al., 2023) found, this competency gap not only reduces productivity but also increases the risk of workplace accidents in high-risk underground mining environments (Bickersteth, 2021).

The training program has partially met the need to improve workforce competency, particularly in the technical aspects of underground mining and occupational safety. However, industry needs are evolving faster than training material updates, resulting in some new competencies not yet being fully accommodated in the curriculum. Therefore, regular curriculum evaluation is urgently needed to ensure training materials remain relevant to developments in mining technology (Wahyuni Adda, 2022).

4. Responsiveness and Feedback Mechanisms

Responsiveness refers to the extent to which policies respond to the aspirations of target groups. The BDTBT is considered to still have weaknesses in this aspect because it lacks a structured *tracer study system* to continuously monitor alumni careers. Yusuf's (2021) research provides strong evidence that the strategic role of training institutions is often hampered by the lack of ongoing evaluation of alumni. The BDTBT needs to be more responsive to input from the industry (PT. AIC), which requests an extension of the duration of field practice.

The research results show that BDTBT has attempted to adapt training to the needs of the community and industry through program evaluation and refinement of learning materials. However, feedback mechanisms from companies using graduates are still not systematic, resulting in curriculum adjustments not being fully based on real industry needs (Akbar & Silaban, 2025). Developing *a tracer study system* and graduate user satisfaction surveys are needed to improve policy responsiveness (Chams & García-Blandón, 2019).

5. Equity and Appropriateness

The equity aspect demonstrates BDTBT's efforts to open national access for the public and civil servants. However, the accuracy of policy targets will be more optimal if the curriculum development process is synchronized with the most recent Indonesian National Work Competency Standards (SKKNI) (Garcia & Canoy, n.d.). Research by Lestari and Mulia (2020) confirms that the implementation of competency improvement programs is largely determined by the alignment of the material with the SKKNI and updates based on modern mining technology (Wiyono et al., 2025).

The BDTBT has opened opportunities for participants from various regions in Indonesia to

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participate in training (Rasool et al., 2019). This demonstrates efforts to equalize access to competency-based education and training. However, limited training quotas, implementation capacity, and government budget efficiency policies, which impact resource allocation and program implementation, mean that not all prospective participants have equal access. Therefore, expanding collaboration with training institutions, universities, and the business community is necessary to ensure that training reaches a wider audience, ensuring equitable access to human resource competency development in the mining sector, despite budget constraints (Davidescu et al., 2020).

In terms of accuracy, the human resource development policy through the BDTBT is deemed to be aligned with the need to improve workforce competency in the underground mining sector. The training program is geared toward producing a professional, competent, and certified workforce that meets national standards. However, targeting accuracy will be more optimal if the curriculum development process is carried out collaboratively with industry to ensure graduate competencies truly align with job market needs (Rahayu et al., 2021).

Holistically, human resource development at BDTBT has significantly contributed to improving participants' technical competency. However, to achieve sustainable effectiveness, BDTBT must transform its collaboration model from a mere training provider to a demand *-driven talent development center* (Ke & Deng, 2018). Integrating *the tracer study system* and strengthening strategic partnerships with the mining industry in Sawahlunto are urgent steps to reduce the number of graduates who are not absorbed into the workforce (Martin, 2023).

DISCUSSION

The research findings indicate that the success of human resource development is determined not only by the quality of training delivery but also by the effectiveness of collaboration between Pentahelix actors (Peretz, 2024). The government plays a crucial role in policy formulation and resource provision, while academia and industry serve as competency developers and users of graduates. The community, on the other hand, is the primary beneficiary, while the media plays a role in increasing access to information and program transparency (Kuntadi & Puspasari, 2023). These findings reinforce the Pentahelix concept, which states that human resource development requires cross-sector collaboration. The stronger the coordination between actors, the greater the likelihood of policy success in producing a workforce that meets industry needs (Gutterman, 2020). Based on William N. Dunn's policy evaluation theory (Ali et al., 2019), the BDTBT policy has met six evaluation indicators, but the level of achievement varies.

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Effectiveness and accuracy have shown relatively good results, while responsiveness, adequacy, and equity require improvement. This situation suggests that policy evaluation needs to be conducted continuously to adapt to technological developments, industry needs, and labor market dynamics. The research findings also indicate that the low graduate absorption rate is not entirely due to the quality of training, but is influenced by limited job opportunities, changing industry competency needs, and suboptimal partnerships between the BDTBT and mining companies. Therefore, strengthening partnerships through joint curriculum development, internship programs, graduate *tracer studies,* and competency-based recruitment are strategies that need to be developed. Overall, the research results confirm that the human resource strengthening policy at the BDTBT has made a significant contribution to improving workforce competency. However, the policy's success will be even more optimal if supported by stronger Pentahelix collaboration, continuous policy evaluation, and synergy between training institutions and industry in producing a professional and skilled workforce capable of meeting the needs of the underground mining sector (Taufik et al., 2023).

CONCLUSION

The Underground Mining Training Center (BDTBT) plays a crucial role in strengthening human resources in the underground mining sector through competency-based education and training. This human resource development cannot be undertaken by the government alone; it requires collaboration between various parties through a pentahelix approach involving government, academia, industry, the community, and the media. This collaboration encourages improved training quality, workforce competency development, and the alignment of training programs with the needs of the mining industry.

Based on research results, the implementation of pentahelix collaboration at BDTBT has been successful, but several obstacles remain, such as suboptimal coordination between actors, inconsistent partnership sustainability, and the need for improved digital media utilization. These conditions pose challenges to achieving more effective and sustainable human resource development.

Therefore, it is necessary to strengthen synergy through increased coordination between stakeholders, develop sustainable collaborations with the business world and academia, and optimize the role of the media in disseminating information and promoting training programs. These three efforts are crucial factors in supporting the development of professional, competent, and competitive underground mining human resources capable of meeting the future needs of

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the mining industry.

The findings of this study confirm that the success of strengthening human resources (HR) in the underground mining sector is not linear or singular, but rather the result of multidimensional interactions between factors within the Pentahelix model. The government, through the Underground Mining Training Center (BDTBT), has played a central role as a regulator and policy facilitator by providing extensive infrastructure, such as mining simulators and occupational safety laboratories. This aligns with research by Suryani (2029), who stated that thorough training planning and central policy support are the primary foundations for improving HR quality within technical ministries.

However, the effectiveness of this collaboration remains hampered by fragmented coordination between actors. Academics (such as UNP and UNJA) have contributed as curriculum designers, but have not been systematically involved in anticipating digital technology disruption in the field. As Nurhayati (2023) noted, the Pentahelix synergy will only reach its full potential if it can expand access to training that aligns with technological dynamics in mining operations. On the other hand, industry (such as PT. Allied Indo Coal) still tends to position itself as a *passive user of graduates* rather than a strategic partner in curriculum development. This condition is supported by research by Rahmadani (2021), which confirms that collaboration between training institutions and industry is a key determinant of the success of professional certification programs. Without strong integration, the role of the media as an information accelerator and the community as beneficiaries will only produce hopes that are not accompanied by certainty of job placement.

2. Policy Evaluation Based on William N. Dunn's Theory

Viewed from the perspective of William N. Dunn's theory, the BDTBT policy shows varying achievements in the six main evaluation indicators.

- Effectiveness and Outcome: Although the participant graduation rate reached 100%, the effectiveness of *the outcome* was deemed suboptimal due to low workforce absorption. Data shows that of the 926 graduates from 2022-2024, only 177 (19.1%) were absorbed into industry. Widodo's (2020) research justification supports this finding, noting that technical training programs often experience obstacles during the post-training evaluation stage, resulting in training outcomes not being fully applicable in the real workplace due to weak *monitoring.*

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- Adequacy and Responsiveness: A significant skills gap exists because the curriculum does not fully accommodate modern technological standards such as *digital mining* or automation. Research by Hidayat (2020) justifies this competency gap as dangerous because it not only reduces productivity but also increases the risk of workplace accidents in high-risk underground mining environments. The low responsiveness of industry feedback mechanisms results in the curriculum being routine and lacking adaptability.
- Equity, Accuracy, and Efficiency: Although access has been opened nationally, equity remains hampered by quota and budget constraints. While the policy's accuracy is fundamentally aligned with the Indonesian National Work Competency Standards (SKKNI), its implementation requires continuous updating to remain relevant to labor market dynamics. This aligns with the findings of Lestari and Mulia (2020), who concluded that the effectiveness of competency improvement is determined by the alignment of training materials with the SKKNI and updates based on modern mining technology.

3. Strategy for Strengthening Partnerships and Policy Sustainability

The low absorption of graduates indicates that the BDTBT training model remains *supply-driven* (oriented towards the number of graduates) rather than *demand-driven* (oriented towards industry needs). In accordance with Swanson and Holton's (2001) *Human Capital theory,* human resource development must include structured career development. Therefore, job placement strategies should not stop at providing certificates but should include long-term internship programs and the development of a systematic *tracer study system.*

Yusuf's (2021) research provides strong evidence that the strategic role of training institutions is often hampered by a lack of ongoing evaluation of their graduates. The success of future policies will depend heavily on the BDTBT's ability to transform itself from a mere training center into a mining talent ecosystem fully integrated with the operational needs of mining companies in and around Sawahlunto. As suggested by Afriani and Sari (2022), synchronizing training modules with real industry needs is key to enhancing the competitiveness and professionalism of the workforce in the complex and high-risk underground mining sector.

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