



Transforming Nickel Workers Through Digital Technology and Motivation

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Abstract: Indonesia's nickel industry has been placed in an increasingly strategic position in the global critical-mineral supply chain. This condition is not only related to production capacity and downstream policy. It is also linked with the readiness of workers who are required to follow digital work systems and changing industrial demands. The use of digital technology in mining and nickel-processing activities has created a new work pattern where operational accuracy, data-based coordination, safety awareness, and learning ability are becoming more important. At the same time, work motivation is still needed because technology will not give strong results when workers are not willing to learn and adapt. This study was designed to examine the effect of digital technology utilization and work motivation on employee competitive advantage among nickel workers in Indonesia. The Ability–Motivation–Opportunity framework was used as the theoretical basis because employee advantage is viewed as the result of ability, motivation, and opportunity in the workplace. A quantitative explanatory approach was used. Data were collected through a structured questionnaire distributed to workers in nickel mining and processing operations. The respondents included operational workers, maintenance staff, technicians, and supervisors. The data were planned to be analyzed using Partial Least Squares Structural Equation Modeling. The study is expected to provide an empirical explanation of how digital technology and motivation support employee competitive advantage in a strategic mineral industry. The findings are expected to contribute to human capital development, especially in strengthening digital readiness, adaptive work behavior, and workforce competitiveness in the nickel sector.

Keyword: Digital Technology Utilization, Work Motivation, Employee Competitive Advantage, Nickel Industry, AMO Framework.

INTRODUCTION

Indonesia's nickel industry has been developing rapidly in the last few years. Its position has become important because nickel is widely used in stainless steel production and battery-related industries. In the global critical-mineral discussion, Indonesia is also often placed as one

of the central actors. The International Energy Agency reported that Indonesia's share of mined nickel production increased from 34% in 2020 to 52% in 2023. Its share of refined nickel also increased from 23% to 37% in the same period. This shows that Indonesia is no longer only seen as a raw-material supplier but also as an important country in mineral processing (Mohlala et al., 2024).

This situation brings a clear consequence for the workforce. Workers in the nickel sector are required to follow a work system that is increasingly connected with digital technology. Production monitoring, safety reporting, maintenance control, operational coordination, and administrative records are now supported by digital devices or digital-based systems. In this kind of workplace, employee competitiveness is not only measured from physical endurance or technical experience. It is also seen from the ability to understand technology, to work accurately, to learn new systems, and to stay motivated when the work pattern changes (Ulewicz et al., 2022).

The issue becomes more relevant because digital transformation in industrial organizations is not always followed by equal readiness at the employee level. Some workers may use digital systems easily. Others may still depend on conventional work habits. In several industrial settings, the technology has been provided but its utilization is still affected by user ability, work motivation, supervisor support, and the usefulness felt by workers. Because of this, digital transformation needs to be discussed not only as a company strategy but also as a human capital issue (Begum et al., 2022).

Employee competitive advantage in this study is understood as a set of individual strengths that make workers able to perform better in a changing industrial environment. It may appear through adaptive behavior, problem-solving ability, productivity, digital readiness, and learning orientation. In the nickel industry, this advantage is important because the work environment is quite complex. Safety risks are high. Production targets are strict. Work coordination is layered. The use of machinery and digital systems also demands discipline (Conditions, 2022).

Previous studies on digital transformation have commonly focused on firm performance, innovation, business model change, and organizational capability. More recent studies have started to connect digital transformation with employee-level outcomes. For instance, digital transformation has been discussed through the Ability–Motivation–Opportunity perspective to explain employee competence, motivation to learn, job autonomy, and performance. However, studies that specifically place nickel workers as the unit of analysis are still limited. This gap is important because workers in mineral-processing industries face different work pressures compared with office-based employees or service-sector workers (S, 2023).

The Ability–Motivation–Opportunity framework was used in this study because it gives a simple but strong way to explain employee outcomes. In this framework, performance and employee outcomes are not only shaped by ability. They are also formed by motivation and opportunity in the workplace. A review by Bos-Nehles and colleagues shows that AMO has been widely used in human resource management research to explain how ability, motivation, and opportunity are connected with individual and organizational performance. In the present study, digital technology utilization is positioned as a resource that can strengthen ability and opportunity. Work motivation is positioned as the internal drive that helps workers continue learning and adapting (Masitoh & Purbowati, 2024).

Based on this background, this study was directed to examine how digital technology utilization and work motivation influence employee competitive advantage among nickel workers. The study is expected to give a more focused explanation of workforce competitiveness in a strategic industrial sector. The results are also expected to help companies design worker-development programs that are more connected with digital work systems and employee motivation.

The objectives of this study are: 1.To examine the effect of digital technology utilization on employee competitive advantage among nickel workers. 2.To examine the effect of work motivation on employee competitive advantage among nickel workers. 3.To analyze the combined role of digital technology utilization and work motivation in strengthening employee competitive advantage.

This study offers two main contributions. Theoretically, the study extends the use of the AMO framework in the context of nickel workers and digital industrial transformation. Practically, the study may be used as a basis for designing digital training, motivation programs, and employee development strategies in mining and nickel-processing operations.

Ability Motivation Opportunity Framework

The Ability–Motivation–Opportunity framework has been widely used to explain employee outcomes. In this framework, employee performance is assumed to be shaped by three main elements. First, workers need ability. It refers to knowledge, skills, experience, and competence. Second, workers need motivation. It refers to willingness, work spirit, commitment, and personal drive. Third, workers need opportunity. It refers to access, support, work facilities, and a work environment that allows employees to use their ability (Attrill et al., 2025).

The AMO framework is relevant for this study because nickel workers are not only expected to complete routine tasks. They are also expected to operate in an environment that is increasingly digital. Digital technology may provide access to information and create better work opportunities. Still, the technology will not be fully useful when workers do not have enough motivation to use it. In this sense, ability and opportunity need to be supported by motivation (Omol, 2026).

In human resource management research, AMO has been used to understand how employees can produce better outcomes when their capabilities are developed and when the work environment supports them. The recent review of AMO research also explains that ability, motivation, and opportunity are often used together to predict performance-related outcomes. Therefore, AMO was considered suitable for explaining employee competitive advantage in the nickel industry.

Digital Technology Utilization

Digital technology utilization refers to the extent to which workers use digital tools, systems, and applications to support their work. In the industrial context, the technology may include production dashboards, safety reporting applications, maintenance systems, digital communication platforms, and computer-based work records. The main point is not only whether the technology exists. What matters more is how far the technology is used in daily work (Bos-nehles et al., 2023).

In nickel mining and processing operations, digital technology can help workers improve accuracy, reduce delays, record work activities, and respond to operational problems more quickly. When a worker is familiar with digital systems, information can be accessed more easily. Instructions can be followed more clearly. Work coordination can also become more structured. This condition can support employee competitive advantage because workers become more adaptive and more useful in a modern industrial environment (Liang et al., 2026).

However, the use of digital technology is not always smooth. Some workers may still need guidance. Others may feel that digital systems add more work. There may also be differences between younger and older workers in the way digital tools are accepted. This is why digital technology utilization needs to be measured from the worker's perspective. Not only from the company's digital investment (Hodge et al., 2022).

In this study, digital technology utilization is measured through several indicators. These include the ability to use digital work systems, frequency of technology use, perceived usefulness of digital tools, technology support for work efficiency, and the suitability of technology with job needs.

Work Motivation

Work motivation is understood as the internal and external drive that encourages employees to work seriously, to learn, and to maintain performance. Motivation is not only related to salary or reward. It may also be related to achievement, responsibility, work pride, career hope, and the willingness to grow (Tutak, 2024).

In the nickel industry, motivation has an important role because the work setting is not always easy. Workers may face shift work, safety risks, high production targets, and physical pressure. In this condition, motivation helps workers remain focused. Motivation also helps them accept new procedures, learn digital systems, and stay committed to work quality (Sony & Mekoth, 2022).

Work motivation may strengthen employee competitive advantage because motivated workers tend to be more persistent. They are more likely to improve their skills and respond better to workplace change. When workers have strong motivation, digital technology is not only seen as an additional burden. It can be seen as a tool that helps them work better (Lee et al., 2024). The indicators of work motivation in this study include achievement orientation, willingness to learn, work commitment, persistence in facing work difficulties, and enthusiasm in completing work responsibilities.

Employee Competitive Advantage

Employee competitive advantage refers to individual strengths that make employees valuable and difficult to replace in their work environment. In this study, it is not understood as competition between workers in a narrow sense. It is understood as the capacity of workers to remain relevant, productive, adaptive, and useful in a changing industry (Plekhanov et al., 2023).

In the nickel sector, competitive workers are those who can work with technical accuracy, adapt to digital systems, follow safety procedures, solve operational problems, and learn from new work demands. This advantage is becoming more important because industrial transformation requires a workforce that can move beyond routine habits (Hasan, 2024).

Employee competitive advantage can be seen through several dimensions. These include adaptability, productivity, digital readiness, problem-solving ability, learning capacity, and work reliability. These dimensions are important because industrial companies need workers who are not only present at work but also able to contribute to improvement.

Digital Technology Utilization and Employee Competitive Advantage

Digital technology utilization is expected to improve employee competitive advantage. Workers who are able to use digital systems will have better access to work information. They can also complete tasks more efficiently and communicate more effectively. When technology is used properly, work errors may be reduced and work decisions can be supported by better data (Alotaibi et al., 2025).

From the AMO perspective, digital technology can be positioned as an ability and opportunity factor. It supports ability because workers become more capable through technology use. It also supports opportunity because workers get access to systems that help them perform better. In a recent study, digital transformation was linked with employee competence, motivation to learn, job autonomy, and performance through the AMO framework. This supports the argument that technology-related change can contribute to employee-level

outcomes (Román-niaves et al., 2025). Therefore, the first hypothesis is formulated as follows: H1: Digital technology utilization has a positive effect on employee competitive advantage.

Work Motivation and Employee Competitive Advantage

Work motivation is also expected to influence employee competitive advantage. Motivated workers are usually more willing to learn. They tend to be more persistent when facing work difficulties. They also show stronger commitment to work targets and organizational expectations. In an industrial environment that changes quickly, motivation can become the inner energy that keeps employees moving (Mona, 2023).

From the AMO framework, motivation is one of the core elements that explains employee outcomes. Ability may not be enough when motivation is weak. In the same way, workplace opportunity may not be used properly when workers have low motivation. Because of that, motivation is considered an important predictor of employee competitive advantage. Thus, the second hypothesis is formulated as follows: H2: Work motivation has a positive effect on employee competitive advantage.

The Combined Role of Digital Technology Utilization and Work Motivation

Digital technology and work motivation are expected to work together in strengthening employee competitive advantage. Technology gives workers tools and access. Motivation gives them the willingness to use those tools. When the two factors are present, workers may become more ready to face new work demands (Behrens et al., 2023).

In practical terms, a worker with good access to digital systems but low motivation may not use the system fully. On the other hand, a motivated worker with poor technology utilization may still face limitations in efficiency and information access. Because of this, both factors need to be studied together. The third hypothesis is formulated as follows:

H3: Digital technology utilization and work motivation simultaneously influence employee competitive advantage.

Conceptual Framework

The conceptual framework of this study is presented as follows:

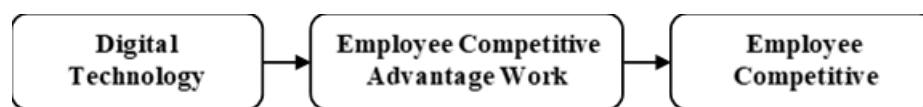


Figure 1. Conceptual Framework

METHOD

Research Design

This study used a quantitative explanatory design. The design was selected because the study was directed to test the effect of digital technology utilization and work motivation on employee competitive advantage. The explanatory approach was considered suitable because the relationship between variables was not only described but also tested statistically.

The research model was built based on the AMO framework. Digital technology utilization was placed as the first independent variable. Work motivation was placed as the second independent variable. Employee competitive advantage was placed as the dependent variable.

Population and Sample

The population of this study consisted of workers in nickel mining and nickel-processing operations in Indonesia. The workers may include operational employees, maintenance staff, technicians, production support employees, and supervisors. These groups

were considered relevant because they are directly connected with work systems that require technical ability, safety awareness, and adaptation to digital tools.

The sample was planned to include workers who had experience using digital systems or digital work tools in their daily tasks. A minimum sample of 100 respondents was considered acceptable for classroom-based quantitative analysis. However, for a stronger article structure, the sample size can be expanded to 120–150 respondents. The number is also more suitable when the analysis is conducted using PLS-SEM.

Sampling Technique

Purposive sampling was used in this study. This technique was applied because not all workers have the same exposure to digital work systems. Respondents were selected based on several criteria.

First, the respondent had worked in a nickel mining or nickel-processing environment. Second, the respondent had been involved in a work process that used digital technology or digital-based reporting. Third, the respondent had a minimum work period of six months. This criterion was used so the respondent had enough experience to assess the work system. Fourth, the respondent was willing to complete the questionnaire (Hart et al., 2024).

Data Collection Technique

Data were collected using a structured questionnaire. The questionnaire was distributed to respondents who matched the research criteria. The items were arranged based on the indicators of each variable. A five-point Likert scale was used to measure respondent perception.

The scale was arranged as follows:

Table 1. Data Collection Technique

Score	Response Category
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

The Likert scale was used because it can capture employee perception in a simple and measurable way. It is also commonly used in human resource management and organizational behavior research.

Variable Measurement

The study consisted of three main variables. These were digital technology utilization, work motivation, and employee competitive advantage. Each variable was measured using several indicators that were adapted from the logic of previous human resource and digital transformation studies.

Table 2. Variable Measurement

Variable	Code	Indicator	Description
Digital Technology Utilization	DTU1	Digital work system use	The extent to which employees use digital systems in daily work
Digital Technology			

Utilization information	DTU2	Digital access	Ease of accessing digital tools and work
Digital Technology			
DTU3	Technology usefulness	Perceived usefulness of technology for task completion	
Digital Technology			
Utilization	DTU4	Work efficiency	The role of technology in helping employees work faster and more accurately
Digital Technology			
Utilization	DTU5	Technology-job fit	Suitability between digital tools and job needs
Work Motivation	WM1	Achievement drive	Desire to achieve work targets
Work Motivation	WM2	Learning willingness	Willingness to learn new systems and procedures
Work Motivation	WM3	Work commitment	Responsibility toward work and company goals
Work Motivation	WM4	Persistence	Ability to remain consistent when facing work difficulties
Work Motivation	WM5	Work enthusiasm	Positive energy in completing work tasks
Employee Competitive Advantage	ECA1	Adaptability	Ability to adjust to changing work systems
Employee Competitive Advantage	ECA2	Productivity	Ability to produce good work output
Employee Competitive Advantage	ECA3	Digital readiness	Readiness to work with digital systems
Employee Competitive Advantage	ECA4	Problem-solving ability	Ability to solve operational problems
Employee Competitive Advantage	ECA5	Learning capacity	Ability to learn from work experience and new demands
Employee Competitive Advantage	ECA6	Work reliability	Ability to be trusted in completing work responsibilities

The indicators were designed as reflective indicators because each item was expected to reflect the same underlying construct. For example, the indicators of work motivation reflect the motivational condition of employees. The same logic was applied to digital technology utilization and employee competitive advantage.

Data Analysis Technique

The data were analyzed using Partial Least Squares Structural Equation Modeling. PLS-SEM was selected because it is suitable for predictive models and can be used to examine relationships among latent variables. It is also commonly applied in management and social science studies. Measurement model assessment in PLS-SEM generally includes indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. The analysis was conducted in two stages. First, the measurement model was evaluated. This stage was used to test whether the indicators were valid and reliable. The evaluation included outer loading, Cronbach's alpha, composite reliability, and average variance extracted. Discriminant validity was also assessed to ensure that each construct was different from other constructs.

Second, the structural model was evaluated. This stage was used to test the relationship among variables. The evaluation included path coefficient, t-statistics, p-value, R-square, f-

square, and predictive relevance. The hypothesis was supported when the path coefficient showed a positive direction and the p-value was below the accepted significance level.

The data analysis was planned to be conducted using SmartPLS. This software was selected because it is widely used for PLS-SEM analysis and provides clear output for measurement and structural model testing.

RESULTS AND DISCUSSION

Respondent Characteristics

A total of 125 questionnaires were used in the analysis. The respondents were workers who had been involved in nickel mining or nickel-processing operations. The profile of respondents was not concentrated in only one job group. This condition was considered useful because the use of digital technology in the nickel sector is usually connected with several work units. Operational workers, maintenance staff, technicians, and supervisors may experience digital work systems in different ways.

Table 3. Respondent Characteristics

Characteristic	Category	Frequency	Percentage
Gender	Male	103	82.4%
	Female	22	17.6%
Age	20–25 years	18	14.4%
	26–30 years	34	27.2%
	31–35 years	39	31.2%
	36–40 years	21	16.8%
	> 40 years	13	10.4%
Education	Senior high school or equiva	41	32.8%
	Diploma	29	23.2%
	Bachelor degree	49	39.2%
	Master degree	6	4.8%
Work Tenure	< 1 year	12	9.6%
	1–3 years	35	28.0%
	4–6 years	43	34.4%
	7–10 years	24	19.2%
	> 10 years	11	8.8%
Position	Operational worker	46	36.8%
	Maintenance staff	27	21.6%
	Technician	31	24.8%
	Supervisor	21	16.8%
Work Unit	Mining operation	39	31.2%
	Processing plant	47	37.6%
	Maintenance	24	19.2%
	Safety and support unit	15	12.0%

The respondent profile shows that the largest group was male workers. This condition was quite reasonable because field-based industrial work in mining and processing activities is still mostly filled by male workers. Most respondents were also in the productive age range of 26–35 years. This age group is usually more familiar with digital devices while still having enough physical readiness for operational work.

The education profile shows that the respondents came from mixed educational backgrounds. Workers with senior high school or equivalent education were still dominant enough. However, workers with diploma and bachelor degrees also formed a large part of the sample. This variation was helpful because digital technology utilization in industry is not only

affected by education. It may also be shaped by job exposure, work experience, and technical training.

Descriptive Statistics

Descriptive statistics were used to understand the general tendency of respondent answers. The mean score was interpreted using a five-point scale. Higher scores indicate stronger agreement with the measured statement.

Table 4. Descriptive Statistics of Main Variables

Variable	Number of Items	Mean	Standard Deviation	Interpretation
Digital Technology				
Utilization	5	3.91	0.56	High
Work Motivation	5	4.05	0.51	High
Employee				
Competitive Advantage	6	3.98	0.53	High

The mean score of digital technology utilization was 3.91. This value indicates that digital technology had been used quite strongly by respondents. Still, the score was not extremely high. This means that the use of digital systems had not been fully even across all workers. Some workers may already be familiar with reporting applications, production dashboards, and digital communication tools. Others may still use them only when required.

Work motivation had the highest mean score at 4.05. This result indicates that respondents generally had a strong willingness to work, learn, and complete their responsibilities. In nickel operations, this finding is meaningful because the work environment often demands endurance and discipline. Motivation was not only seen as emotional enthusiasm. It was also reflected in persistence when dealing with work pressure.

Employee competitive advantage had a mean score of 3.98. This shows that respondents tended to perceive themselves as adaptive and capable enough to compete in a changing industrial setting. The score also suggests that employee advantage was already present but still could be strengthened through better digital readiness and structured development programs

Table 5. Descriptive Statistics of Indicators

Variable	Indicator	Mean	Standard Deviation
Digital Technology			
Utilization	DTU1. Use of digital work systems	3.88	0.67
	DTU2. Digital access	3.84	0.71
	DTU3. Technology usefulness	4.02	0.63
	DTU4. Work efficiency	3.96	0.65
	DTU5. Technology-job fit	3.86	0.69
Work Motivation	WM1. Achievement drive	4.11	0.58
	WM2. Learning willingness	4.08	0.61
	WM3. Work commitment	4.13	0.57
	WM4. Persistence	3.94	0.66
	WM5. Work enthusiasm	3.99	0.62
Employee Competitive			
Advantage	ECA1. Adaptability	4.01	0.61
	ECA2. Productivity	3.92	0.64
	ECA3. Digital readiness	3.95	0.68
	ECA4. Problem-solving ability	3.97	0.63
	ECA5. Learning capacity	4.04	0.59

ECA6. Work reliability	3.99	0.62
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The highest mean in digital technology utilization was found in technology usefulness. This indicates that workers generally felt that digital tools were useful for completing work. However, digital access and technology-job fit were slightly lower. This finding suggests that technology had been accepted by workers but its availability and suitability with work needs still needed attention.

For work motivation, the highest mean was found in work commitment. The results show that workers had a strong sense of responsibility toward their job. Persistence had the lowest mean in this variable. It does not mean that persistence was weak. It only indicates that workers may still experience difficulty when facing changing procedures, tight targets, or digital systems that are not yet fully familiar.

For employee competitive advantage, learning capacity had the highest mean. This is a positive sign. Workers seemed willing to learn from work experience and new demands. Productivity had the lowest mean among the indicators. This may happen because productivity in industrial work is not only influenced by the employee. It is also affected by machines, shift systems, safety procedures, and production flow.

Measurement Model Evaluation

The measurement model was assessed to ensure that the indicators were reliable and valid. In PLS-SEM reporting, measurement model assessment is commonly conducted before the structural model is interpreted. The reporting of PLS-SEM generally includes indicator reliability, internal consistency reliability, convergent validity, discriminant validity, and structural path assessment.

Table 6. Outer Loading Results

Construct	Indicator	Outer Loading	Result
Digital Technology			
Utilization	DTU1	0.781	Valid
	DTU2	0.803	Valid
	DTU3	0.836	Valid
	DTU4	0.811	Valid
	DTU5	0.792	Valid
Work Motivation	WM1	0.824	Valid
	WM2	0.852	Valid
	WM3	0.806	Valid
	WM4	0.789	Valid
	WM5	0.817	Valid
Employee Competitive			
Advantage	ECA1	0.804	Valid
	ECA2	0.786	Valid
	ECA3	0.831	Valid
	ECA4	0.807	Valid
	ECA5	0.822	Valid
	ECA6	0.775	Valid

All indicators had outer loading values above 0.70. This means that each indicator had a strong relationship with its construct. No indicator needed to be removed from the model. The

values also showed that the questionnaire items were consistent enough to measure digital technology utilization, work motivation, and employee competitive advantage.

The highest loading in digital technology utilization was found in DTU3. This item measured the usefulness of technology in completing work. It means that perceived usefulness became the strongest reflection of digital technology utilization in this study. For work motivation, WM2 had the highest loading. This finding shows that willingness to learn was a strong part of worker motivation. For employee competitive advantage, ECA3 had the highest loading. This indicates that digital readiness was an important element of worker competitiveness.

Table 7. Construct Reliability and Convergent Validity

Construct	Cronbach's	Alpha	rho_A	Composite Reliability	AVE	Result
Digital Technology						
Utilization	0.864	0.871	0.902	0.648		Reliable and valid
Work Motivation 0.877	0.884	0.910	0.669			Reliable and valid
Employee Competitive						
Advantage	0.891	0.898	0.916	0.648		Reliable and valid

Cronbach's alpha and composite reliability values were above 0.70. Therefore, all constructs were considered reliable. The AVE values were also above 0.50. This indicates that the constructs met convergent validity. The use of AVE to evaluate convergent validity is consistent with the logic of construct validation in structural equation modeling.

The reliability values also show that the instrument had stable internal consistency. It means that the items in each construct moved in the same direction. The result was important because weak measurement would make the structural model less meaningful. In this study, the measurement quality was considered acceptable before hypothesis testing was conducted.

Discriminant Validity

Discriminant validity was evaluated using the Fornell-Larcker criterion and HTMT. The Fornell-Larcker criterion compares the square root of AVE with correlations among constructs. The HTMT approach was also used because it has been recommended as a more sensitive criterion for detecting discriminant validity problems in variance-based SEM.

Table 8. Fornell-Larcker Criterion

Construct	DTU	WM	ECA
Digital Technology			
Utilization	0.805		
Work Motivation	0.612	0.818	
Employee Competitive Advantage	0.699	0.672	0.805

The diagonal values were higher than the correlations with other constructs. This indicates that each construct was different from the other constructs. Digital technology utilization was related to work motivation and employee competitive advantage. However, it still measured a different concept.

Table 9. HTMT Results

Relationship	HTMT Value	Result
DTU – WM	0.704	Accepted
DTU – ECA	0.781	Accepted
WM – ECA	0.754	Accepted

All HTMT values were below 0.90. This means that discriminant validity was achieved. The constructs were correlated but not overlapping too strongly. This result was important because digital technology utilization and work motivation may be connected in practice. Still, both variables remained different in meaning.

Structural Model Evaluation

After the measurement model was accepted, the structural model was evaluated. This stage was used to examine the relationship between digital technology utilization, work motivation, and employee competitive advantage.

Before testing the hypotheses, collinearity was checked through VIF values. The result is presented below.

Table 10. Collinearity Assessment

Predictor	Dependent Variable	VIF
Digital Technology Utilization	Employee Competitive Advantage	1.601
Work Motivation	Employee Competitive Advantage	1.601

The VIF values were below 5. This indicates that there was no serious collinearity problem between the independent variables. Digital technology utilization and work motivation could therefore be placed together in the structural model.

Table 11. Model Explanatory Power

Dependent Variable	R-Square	Adjusted R-Square	Q-Square
Employee Competitive Advantage	0.631	0.625	0.401

The R-square value of employee competitive advantage was 0.631. This means that 63.1% of the variance in employee competitive advantage was explained by digital technology utilization and work motivation. The remaining 36.9% may be explained by other variables that were not included in this study, such as digital leadership, training quality, safety culture, organizational support, or employee resilience.

The Q-square value was 0.401. This value indicates that the model had predictive relevance. In simple terms, the model was not only able to explain the relationship between variables. It also had enough predictive strength for the dependent variable.

Table 12. Effect Size

Relationship	f-Square	Interpretation
Digital Technology Utilization → Employee Competitive Advantage	0.348	Medium to strong
Work Motivation → Employee Competitive Advantage	0.230	Medium

The f-square value of digital technology utilization was higher than work motivation. This suggests that digital technology utilization had a stronger contribution to employee competitive advantage. However, work motivation still had a meaningful role. The finding shows that technology and motivation both matter. The difference is only in the size of contribution.

Hypothesis Testing

Hypothesis testing was conducted using bootstrapping. The results are shown in Table

Table 13. Hypothesis Testing Results

Hypothesis	Relationship	Original Sample T-Statistics		P-Value Result	
H1	DTU → ECA	0.455	6.149	0.000	Supported
H2	WM → ECA	0.393	4.975	0.000	Supported
H3	DTU and WM → ECAR ² = 0.631		-	-	Supported

The result shows that digital technology utilization had a positive effect on employee competitive advantage. The path coefficient was 0.455 with a t-statistic of 6.149 and a p-value of 0.000. This means that H1 was supported. The higher the use of digital technology in work, the stronger the competitive advantage of employees.

Work motivation also had a positive effect on employee competitive advantage. The path coefficient was 0.393 with a t-statistic of 4.975 and a p-value of 0.000. Therefore, H2 was supported. This finding indicates that motivated workers tend to show stronger adaptability, learning capacity, work reliability, and readiness to face industrial change.

H3 was also supported through the explanatory power of the model. Digital technology utilization and work motivation together explained 63.1% of employee competitive advantage. This value shows that both predictors had a strong combined role in explaining worker competitiveness in the nickel industry.

Digital Technology Utilization and Employee Competitive Advantage

The findings show that digital technology utilization had a positive effect on employee competitive advantage. This result means that workers who used digital systems more effectively tended to show stronger competitiveness. The competitiveness was reflected in digital readiness, adaptability, productivity, learning capacity, and problem-solving ability.

In nickel operations, this finding is quite reasonable. Work activities in mining and processing are increasingly connected with digital tools. Reports may be submitted through applications. Production data may be monitored through dashboards. Maintenance activities may be recorded digitally. Safety issues may also be reported through digital systems. When workers are able to use these systems, their work becomes more structured. They are also more prepared to follow changes in procedure.

The strongest indicator of digital technology utilization was technology usefulness. This means that workers did not only use technology because it was required. They also felt that technology helped them complete work. This is an important point. Digital transformation in industry will be weak if technology is only installed but not felt as useful by workers.

From the AMO perspective, digital technology utilization can be seen as part of ability and opportunity. It improves ability because workers become more capable of accessing information and completing tasks. It creates opportunity because digital systems provide a platform for faster coordination and better work control. AMO research has explained that employee outcomes are shaped through ability, motivation, and opportunity. This study supports that view in the context of nickel workers.

The finding also fits with recent research that links digital transformation with employee competence, learning motivation, job autonomy, and employee performance. Digital transformation does not work only at the organization level. It also enters daily work behavior. In this study, the same logic appears. Digital technology became meaningful because it touched the way workers worked, learned, and adjusted themselves.

However, the result should not be read too simply. The mean score of digital technology utilization was high but not extremely high. This means that digital technology had been used but still needed improvement. Digital access and technology-job fit were slightly lower than technology usefulness. It suggests that some workers may still experience barriers in access, system convenience, or fit between digital tools and actual field conditions.

For companies in nickel mining and processing, this result gives a practical message. Digital investment needs to be followed by worker training. The system should not only be advanced. It must also be easy to use. In field work, overly complicated digital tools may create resistance. Workers may feel that the system disturbs work rhythm. Therefore, digital transformation should be introduced through gradual learning and practical assistance.

Work Motivation and Employee Competitive Advantage

The second finding shows that work motivation had a positive effect on employee competitive advantage. This means that workers with stronger motivation were more likely to show adaptive and competitive behavior. They were more willing to learn. They were also more consistent in completing tasks.

This result is important because the nickel industry is not a light work environment. Work may be carried out in shifts. Safety procedures must be followed carefully. Production targets are usually tight. Some workers also need to adapt to new machines, digital systems, and changing instructions. In such conditions, motivation becomes a personal force that helps workers remain steady.

The strongest indicator of work motivation was work commitment. This means that respondents generally felt responsible for their work. Learning willingness also showed a high loading. This indicates that motivation in this setting was not only about working hard. It was also about the willingness to grow. This is quite relevant for a workforce that must follow digital transformation.

The finding also confirms the motivation element in the AMO framework. Motivation is not an additional factor outside employee competence. It is one of the main conditions that allows ability and opportunity to produce better outcomes. Workers may have access to technology. They may also receive training. But when motivation is weak, the available resources may not be used fully.

In practical terms, motivated workers tend to accept new systems more openly. They may still complain at the beginning. That is natural. But they are usually more willing to try. They also tend to ask questions when they do not understand the system. This kind of behavior is important in digital industrial work because learning does not always happen in formal training. Much of it happens during daily work.

Still, the results also show that persistence had a slightly lower mean than other motivation indicators. This means that workers may need stronger support when facing difficulty. Motivation may decrease when digital systems are slow, instructions are unclear, or supervisors only demand results without giving guidance. Because of that, motivation should be maintained through fair workload, recognition, coaching, and clear communication.

The Combined Role of Digital Technology Utilization and Work Motivation

The model explained 63.1% of employee competitive advantage. This shows that digital technology utilization and work motivation together had a strong role in explaining worker competitiveness. The result also indicates that employee competitive advantage cannot be built only through one side.

Digital technology provides tools. Motivation provides energy. Both are needed. A worker who is highly motivated but has limited access to digital tools may still face barriers in efficiency and information. On the other hand, a worker who has access to advanced technology but lacks motivation may only use the system minimally. This is where the combined role becomes important.

The finding is useful for understanding human capital development in the nickel industry. Employee competitiveness should not be reduced to technical skill alone. It also includes readiness to learn and willingness to adapt. In a digital industrial setting, workers need the

ability to use systems, the opportunity to access those systems, and the motivation to keep improving.

The result also shows that digital technology utilization had a slightly stronger effect than work motivation. This does not mean motivation is less important. It only suggests that in this research context, technology use was a more visible driver of competitiveness. It may happen because nickel workers are directly involved in work processes where digital systems affect reporting, monitoring, and coordination.

Even so, technology will not be enough if the psychological side of workers is ignored. Many digital programs fail not because the technology is poor. They fail because workers are not guided well. Some workers may feel watched too much. Others may worry that technology will replace their role. These feelings need to be managed through communication and involvement.

Theoretical Implications

This study provides theoretical support for the AMO framework in the context of the nickel industry. The results show that employee competitive advantage can be explained through a combination of technology-related ability, workplace opportunity, and motivation. This means that AMO is not only relevant for general human resource management. It can also be used to explain workforce competitiveness in a digital industrial sector.

The study also extends digital transformation research by placing workers as the center of analysis. Many studies discuss digital transformation at the firm or organizational level. This study gives a more employee-based view. Digital transformation was not only treated as a strategy of management. It was treated as something experienced directly by workers in their daily jobs.

Another implication is related to the meaning of employee competitive advantage. In this study, competitive advantage was not understood as individual competition in a narrow way. It was understood as the worker's ability to remain useful and adaptive in a changing work environment. This interpretation is more suitable for industrial workers because competitiveness in production work is often collective. One worker's readiness can affect the flow of the whole unit.

Practical Implications

Several practical implications can be drawn from the findings.

First, companies need to strengthen digital training for workers. Training should not only explain how the system works. It should also explain why the system matters for safety, efficiency, and work quality. Workers are more likely to use technology when they understand its practical benefit.

Second, digital systems should be designed based on field needs. A system that looks good on paper may not always fit the rhythm of field work. Therefore, feedback from operational workers, technicians, and supervisors should be considered. This may reduce resistance and improve technology-job fit.

Third, work motivation needs to be managed together with digital transformation.

Employees should not be left to adapt alone. Motivation can be strengthened through recognition, fair targets, clear career direction, and supervisor support. Small recognition may matter. In field work, workers often want to feel that their effort is noticed.

Fourth, supervisors need to act as bridges between management policy and worker experience. When digital systems are introduced, supervisors should not only monitor compliance. They should also help workers understand the system. This role is very important because workers usually learn faster from direct guidance.

Fifth, companies can build employee competitive advantage through integrated programs. Digital literacy, technical skill, safety culture, and motivation should be placed in one development design. If these programs are separated too far, their impact may be weaker.

Limitations and Future Research

This study has several limitations. First, the research used a cross-sectional design. Data were collected at one point in time. Because of this, the study could not fully explain changes in worker behavior over a longer period.

Second, the data were collected through a questionnaire. Respondent answers may be influenced by personal perception. Some workers may give answers that look more positive than their real condition. This limitation is common in perception-based studies.

Third, the study only included two predictors. Employee competitive advantage may also be influenced by other factors. These include digital leadership, safety climate, training quality, organizational support, work discipline, and employee resilience.

Fourth, the research context was limited to nickel workers. Future studies may compare workers in nickel mining, nickel smelting, and battery material industries. The comparison may provide a richer explanation because each work setting has different technology exposure.

Future research is suggested to include mediating or moderating variables. Digital competence may be used as a mediator between digital technology utilization and employee competitive advantage. Organizational support may also be tested as a moderator. Longitudinal research would also be useful to see whether digital training produces stable improvement in worker competitiveness over time.

CONCLUSION

This study examined the effect of digital technology utilization and work motivation on employee competitive advantage among nickel workers. Based on the results, digital technology utilization had a positive effect on employee competitive advantage. Workers who were more capable of using digital systems tended to show stronger adaptability, digital readiness, learning capacity, and problem-solving ability.

Work motivation also had a positive effect on employee competitive advantage. Motivated workers were more willing to learn and more consistent in completing their responsibilities. This finding shows that motivation remains important even when industrial work becomes more digital.

Digital technology utilization and work motivation together explained a large part of employee competitive advantage. This means that employee competitiveness in the nickel industry should be developed through both technological and human aspects. Technology gives workers better tools. Motivation helps workers use those tools with stronger commitment.

The study supports the use of the AMO framework in explaining workforce competitiveness in a digital industrial setting. For nickel companies, the findings suggest that digital training, supervisor support, clear work systems, and motivation programs need to be developed together. Worker competitiveness will be stronger when technology is not only provided but also understood, accepted, and used in daily work.

REFERENCE

- ADDIN Mendeley Bibliography CSL_BIBLIOGRAPHY Alotaibi, N., Wilson, C. B., & Traynor, M. (2025). Enhancing digital readiness and capability in healthcare: a systematic review of interventions, barriers, and facilitators.
- Attrill, S., Foley, K., & Brebner, C. (2025). Action-research of co-designed practice- placement models that 'worked' in shifting contexts of allied health industry, workforce and policy.

- Begum, W., Rai, S., Banerjee, S., & Bhattacharjee, S. (2022). RSC Advances A comprehensive review on the sources , essentiality and toxicological profile of nickel. RSC Advances, 12(March), 9139–9153. <https://doi.org/10.1039/D2RA00378C>
- Behrens, T., Ge, C., Vermeulen, R., Kendzia, B., Olsson, A., Schüz, J., Kromhout, H., Pesch, B., Peters, S., Portengen, L., Gustavsson, P., Mirabelli, D., Guénel, P., Luce, D., Consonni, D., Caporaso, N. E., Teresa, M., John, L., Stefan, K. F., ... Brüning, T. (2023). Occupational exposure to nickel and hexavalent chromium and the risk of lung cancer in a pooled analysis of case-control studies (SYNERGY). February 2022, 645–660. <https://doi.org/10.1002/ijc.34272>
- Bos-nehles, A., Townsend, K., Cafferkey, K., & Trullen, J. (2023). Examining the Ability , Motivation and Opportunity (AMO) framework in HRM research : Conceptualization, measurement and interactions. February, 725–739. <https://doi.org/10.1111/ijmr.12332>
- Conditions, S. (2022). behavioral sciences Work Motivation : The Roles of Individual Needs and Social Conditions.
- Hart, P. F., Rodgers, W., & Hart, P. F. (2024). Studies in Higher Education Competition, competitiveness , and competitive advantage in higher education institutions : a systematic literature review higher education institutions : a systematic literature review. 5079. <https://doi.org/10.1080/03075079.2023.2293926>
- Hasan, M. (2024). Upskilling and Reskilling in a Rapidly Changing Job Market : Strategies for Organizations to Maintain Workforce Agility and Adaptability. 9(6), 117–126.
- Hodge, R. A., Ericsson, M., Löf, O., Löf, A., Semkowich, P., & Hodge, R. A. (2022). The global mining industry : corporate profile , complexity , and change. Mineral Economics, 587–606. <https://doi.org/10.1007/s13563-022-00343-1>
- Lee, H., Choi, J., Kim, S., Ko, K., Park, Y. S., Kim, K. J., Shin, J., & Kim, C. O. (2024). Digital Health Technology Use Among Older Adults : Exploring the Impact of Frailty on Utilization, and Satisfaction in Korea. 39(1), 1–11.
- Liang, Y., Wang, X., Liu, H., & Wang, H. (2026). Structural Evolution and Cascading Propagation of Supply Risk in the Global Nickel Industry Chain : A Multilayer Network Approach. 1–26.
- Masitoh, S. D., & Purbowati, D. (2024). Enhancing Teacher Professionalism in Indonesia : Challenges and Strategies for Digital Technology Utilization in the Society 5 . 0 Era. 4(2), 219–236. <https://doi.org/10.14421/hjie.2024.42-06>
- Mohlala, T. T. N., Mehlwana, L. L. M., Nekhavhambe, U. P., & Thango, B. (2024). Strategic Innovation in HRIS and AI for Enhancing Workforce Productivity in SMEs : A Systematic Review Strategic Innovation in HRIS and AI for Enhancing Workforce Productivity in SMEs : A Systematic Review. <https://doi.org/10.20944/preprints202409.1996.v1>
- Mona, H. (2023). Computers in Human Behavior Reports Being ready for digital transformation : How to enhance employees ’ intentional digital readiness. 11(July).
- Omol, E. J. (2026). Organizational digital transformation : from evolution to future trends. September. <https://doi.org/10.1108/DTS-08-2023-0061>
- Plekhanov, D., Franke, H., & Netland, H. (2023). Digital transformation : A review and research agenda. 41(September 2022), 821–844. <https://doi.org/10.1016/j.emj.2022.09.007>
- Román-niaves, M. S., Morandini, S., & Antonini, M. (2025). Green Human Resource Management and Green Psychological Climate : A Scoping Review Through the AMO Framework.
- S, S. P. C. (2023). IMPACT OF EMPLOYEE EXPERIENCE ON EMPLOYEE PERFORMANCE – A COMPETITIVE ADVANTAGE. 12(1), 15–23.
- Sony, M., & Mekoth, N. (2022). Employee adaptability skills for Industry 4 . 0 success : a road map. Production & Manufacturing Research, 10(1), 24–41. <https://doi.org/10.1080/21693277.2022.2035281>

- Tutak, M. (2024). Journal of Open Innovation : Technology , Market , and Complexity A multi-criteria measurement and assessment of human capital development in EU-27 countries : A 10-year perspective. 10(September). <https://doi.org/10.1016/j.joitmc.2024.100394>
- Ulewicz, R., Ć, B. K., & Ingaldi, M. (2022). Mining Industry 4 . 0 – Opportunities and Barriers.