

Original Article

Reconfiguring the Talent Pipeline in Industry 4.0: A Systemic Analysis of TVET Misalignment and Competency Gaps in the Heavy Equipment Sector

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Received Date: 01 April 2026

Revised Date: 20 April 2026

Accepted Date: 25 April 2026

Published Date: 02 May 2026

Abstract: This study examines the declining acceptance rate of vocational high school (SMK) graduates in the UT School entrance selection process, which has decreased significantly from 9% in 2023 to 4% in 2025. This phenomenon indicates a weakening quality of the talent pipeline in the heavy equipment industry. The research aims to identify the key factors contributing to this issue and formulate strategic interventions to improve recruitment readiness among vocational graduates. A qualitative case study approach was employed, using the UT School as the main unit of analysis. Data were collected through in-depth interviews, observation, and document analysis involving multiple stakeholders, including UT School management, recruitment teams, vocational school principals, and industry representatives. The study applies the TVET Input Framework and the KSAT (Knowledge, Skills, Attitude, and Transversal Competencies) model to analyze competency gaps. Findings reveal that the low acceptance rate is primarily driven by misalignment in curriculum, inadequate training facilities, weak industry partnerships, and insufficient development of transversal competencies. The study proposes strategic solutions such as curriculum synchronization, pre-assessment programs, bridging classes, and strengthening teaching factory implementation. These strategies are expected to enhance vocational graduate readiness and support the development of a sustainable talent pipeline for the heavy equipment industry.

Keywords: Technical and Vocational Education and Training (TVET), Talent Pipeline, Competency Gap, Skill Mismatch, Industry 4.0.

I. INTRODUCTION

The Industry 4.0 revolution has fundamentally changed workforce needs in the heavy equipment industry, with rapid change from digitalization, automation, artificial intelligence, and data-driven maintenance systems. Telematics, predictive maintenance, and cyber-physical systems have integrated various technologies, increasing operational complexity and driving the demand for the requisite workforce to not only be technically proficient but also agile, collaborative, and receptive to continuous learning [1].

Consequently, enterprises need more and more people who hold a mixture of technical skills along with transversal competencies such as resolution of problems, communication, teamwork, and adaptability [2], [3] that are viewed as essential to preserve employability in changing industrial environments.

However, the structural problems in vocational education continue to exist despite these changing needs of the market, especially in developing countries like Indonesia. A major problem is that the competencies acquired in Technical and Vocational Education and Training (TVET) institutes do not meet industry needs [4].

This mismatch has been commonly due to old-fashioned curricula, insufficient practical facilities, limited familiarisation with modern industrial technologies, and a lack of co-operation between industry sectors/engineering educational institutions [5], [6].

This ultimately leads to insufficient readiness amongst most vocational graduates, and low employability and competitiveness [7].

The most prominent case is this regarding the SMK graduates entering industry-based training programs. Impactful StoryTelling: The case of UT School, a corporate vocational training institution under PT United Tractors Tbk. that has seen a significant drop-off in acceptance rate over the past three years. Even though the number of applicants has grown considerably, the share of candidates who pass the selection process continues to drop, which suggests that it happens not due to numbers but rather due to the skills and readiness of candidates.



This declining acceptance rate is symptomatic of a wider systemic problem: vocational education at all levels has failed to align the outcomes from courses with the actual competencies required by industry. The results suggest structural deficiencies in the preparation of fundamental skills—technical comprehension, numerical reasoning, work discipline, and problem-solving ability—rather than solely the limitations of individual candidates. The systematic patterning of these deficiencies across multiple stages of the selection process suggests that it is a poor competence formation system rather than an issue at the individual level. This pattern aligns with the global evidence on skills mismatch in the Industry 4.0 era, where education systems are failing to keep pace with the speed of technological and industrial transition [3], [4].

This issue has operational and strategic ramifications. As one of the important institutions in the corporate talent development ecosystem, UT School serves as a key tool that is vital to sustaining this pipeline of talent for the heavy equipment industry. The deterioration in input quality increases the push towards basic training and competency development, as well as increasing recruitment costs and the span of time required to be trained before actually deploying into the workforce. In the long run, it could prove to be a substantial threat to organizational productivity, service quality, and competitive viability, especially in tech-heavy fields.

Performing an in-depth, systemic analysis as opposed to a data analysis of individual competency gaps must come first in order to avoid linking the vocational education results to the requirements of industry. This study provides the enabling conditions for such efforts by exploring structural and capability factors that characterize sources of readiness among candidates in an effort to discern potential causes of declining acceptance rates during UT School selection.

Accordingly, this study aims to:

1. Identify the key internal and systemic factors contributing to the low acceptance rate of vocational high school graduates in the UT School selection process; and
2. Formulate targeted strategic interventions to enhance graduate readiness and improve talent pipeline alignment within the UT School context, with implications for similar industry-based vocational training systems.

II. LITERATURE REVIEW

In order to add a certain structure to the understanding about the relationship between vocational education and graduate employability, this study proposes a conceptual framework, integrating key elements of system thinking into the Technical and Vocational Education and Training (TVET) system alongside competency formation and degree of job readiness outcomes for graduates. This framework is developed based on the view that vocational graduate quality depends not only on individual ability but also on system features in the education ecosystem [4].

Earlier literature draws a point on how skill mismatch emerges due to educational inputs (curriculum, infrastructure, and policy) being mismatched with industry needs during Industry 4.0 transformation.[1]

Additionally, the value of vocational graduates is shaped through a multi-pronged approach by practical exposure, competency development, and industry partnership that together define the ability to be hired and advance in career [7].

Based on these perspectives, this study proposes a framework that positions TVET system components as input variables, competency formation as a mediating process, and graduate readiness as the outcome, as shown in Figure 1.

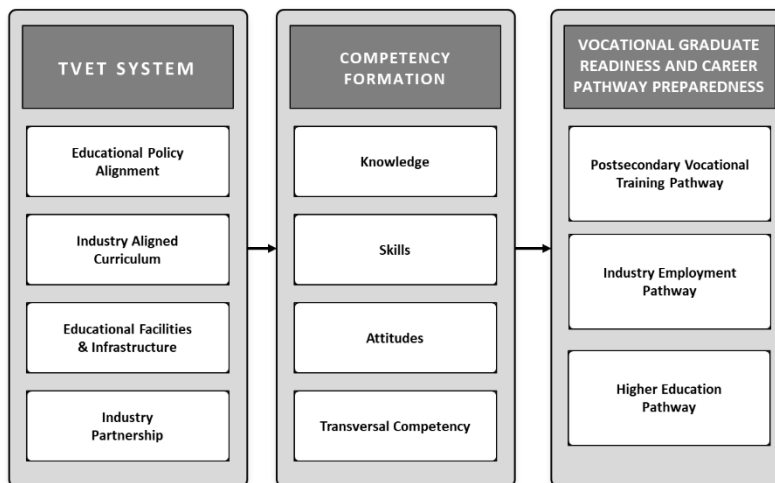


Figure 1. Conceptual Framework

The conceptual framework presented in Fig.1 illustrates a structured and sequential relationship between the Technical and Vocational Education and Training (TVET) system, competency formation, and vocational graduate outcomes. The framework is organized into three interconnected domains: TVET system inputs, competency formation processes, and graduate readiness and career pathway preparedness, reflecting a systemic input–process–output model.

At the input level, there are four main elements defining the TVET system, i.e., education policy linkage, labor market-oriented curriculum) matching educational facilities and infrastructure; partnerships with industry, partnerships with businesses. These factors jointly influence the responsiveness of vocational education systems to industry requirements. Aligning educational policies makes sure the strategies undertaken at the national or institutional level, such as those for workforce development priorities, are also supported by curricula that academic institutions use to transmit relevant learning content. Well-equipped facilities and infrastructure help in imparting practical and technology-based training, while robust industry partnerships deliver essential exposure to real-world practices, technologies, and standards. Weakness in any of these cylinders can throw the structure out of alignment and rob proficiency growth downline of its full potential.

At the process level, competency formation can be conceptualized in terms of four core dimensions: knowledge, skills, attitudes, and transversal competencies. It signifies a comprehensive view of workforce readiness wherein domain knowledge and skill sets need to be supported by behavioral competencies, as well as adaptability. Knowledge refers to the theoretical and technical knowledge in certain areas of a profession, whereas skills represent the application of that knowledge in practice. Attitudes include work discipline, responsibility, and professionalism, which are extremely important in an industrial environment. Transversal competencies, such as critical thinking skills for problem-solving, communication skills, teamwork competencies, and adaptability skills, which are specific to the workforce in settings with rapid technological change dynamics, Industry 4.0, and complex work systems, have been lacking in workplace practices lately. The framework asserts that it is essential to also embed these four dimensions together for competency formation, as an un-integrated or uneven development may yield graduates who are technically proficient but lack skills for workplace adaptation.

At the output level, three key outcomes represent readiness of vocational/non-vocational degree graduates for postsecondary education and career pathways: pathways leading to postsecondary vocational training; pathways leading to industry employment; and pathways leading to higher education. Those pathways are a testament to the versatility and adaptability of graduates as they can navigate between diverse career trajectories. And so graduate readiness is not just job-ready; it is also learning-ready, the ability to pursue further training or education where necessary. These pathways are critical because, based on your score in certain industry-based recruitment processes, achieving a competency level demonstrates a degree of success and preparedness in meeting industry needs.

The framework identifies a simple causal link: the quality of inputs to the TVET system influences processes creating competencies, which influence readiness and then career (and income) results for graduates. Collectively, this misalignment at the input level, e.g., dated curricula or poor industry cooperation, leads to inadequate development of competencies, which reduces employability and undermines success in hiring processes. Thus, in the case of this study, decreasing acceptance rates at the UT School can be explained through such an alignment problem that would indicate gaps in competency formation as an upstream failure of elements within the TVET system. Thus, vocational graduate outcomes improvement needs a more holistic approach, including institutional alignment, wellbeing and progression at KSAT dimensions, which should be consistent between the education system and industry.

A) TVET System as Input Factors

The first component of the framework highlights the TVET system as the primary input influencing graduate quality. Educational policy alignment plays a critical role in ensuring coherence between national education objectives and labor market needs, as misaligned policies often result in fragmented competency development [8].

In addition, curriculum alignment with industry requirements is essential to ensure that students acquire relevant technical and digital competencies, particularly in sectors experiencing rapid technological change [9].

The availability of educational infrastructure, such as workshops and teaching factories, significantly affects the effectiveness of practice-based learning, which is a core component of vocational education [10], [11]. Strong industry partnerships enhance the relevance of learning by providing real-world exposure and facilitating smoother school-to-work transitions [12].

B) Competency Formation (KSAT Model)

The second component focuses on competency formation as the mediating process linking TVET inputs to graduate readiness. Competency development in vocational education is commonly conceptualized through the KSAT framework, which includes Knowledge, Skills, Attitude, and Transversal competencies [2], [13]. Knowledge represents the theoretical foundation

necessary for understanding technical systems, while skills refer to the practical ability to apply such knowledge in real-world tasks [14].

Attitude, including discipline and work ethics, is increasingly recognized as a critical determinant of employability, particularly in high-risk industries such as heavy equipment [3], [15]. Furthermore, transversal competencies such as communication, teamwork, and adaptability are essential for navigating dynamic work environments and are strongly linked to long-term career success [16], [17]. The final component of the framework represents graduate readiness as the output of the TVET system and competency formation process. Graduate readiness is defined as the ability to successfully transition into employment, further training, or higher education pathways [7], [18].

In the context of vocational education, employability is not limited to securing initial employment but also includes adaptability, continuous learning, and career mobility [3]. Studies show that graduates with strong technical and transversal competencies are more likely to succeed in recruitment processes and sustain long-term career development.

C) Relationship Between TVET Inputs, Competency Formation, and Outcomes

The framework illustrates a causal relationship in which the quality of TVET inputs directly influences competency formation, which subsequently determines graduate readiness and recruitment outcomes. Weaknesses in any input dimension, such as curriculum misalignment, inadequate infrastructure, or limited industry collaboration, can lead to incomplete competency development and reduced employability [19]. This relationship confirms that improving vocational graduate outcomes requires a systemic approach that integrates institutional reform with individual competency development [20].

Table 1: Summary Table of Conceptual Framework

Component	Key Elements	Literature Insight	Impact on Employability
TVET Input	Policy, Curriculum, Infrastructure, Partnership	Determines alignment with industry needs	Influences the quality of graduate input
Competency Formation (KSAT)	Knowledge, Skills, Attitude, Transversal	Integrates technical and soft skills	Shapes work readiness
Graduate Readiness	Employment, Training, Higher Education	Reflects adaptability and career flexibility	Determines recruitment success
Relationship	Input → Process → Output	Systemic interaction	Explains the skill mismatch phenomenon

The conceptual framework presented in Table 1 demonstrates a structured causal relationship between TVET inputs, competency formation, and graduate outcomes. At the input level, elements such as policy design, curriculum relevance, infrastructure adequacy, and industry partnership play a critical role in determining the extent to which educational systems are aligned with industry requirements. Weaknesses in these components, such as outdated curricula, limited exposure to industry practices, and insufficient collaboration, can constrain the effectiveness of competency formation processes.

At the process level, competency formation is conceptualized through the KSAT framework, which integrates knowledge, technical skills, work attitudes, and transversal competencies. The framework suggests that competency development is not limited to technical proficiency but requires the simultaneous development of cognitive, behavioral, and adaptive capabilities. When TVET inputs are misaligned, this process becomes fragmented, resulting in incomplete or imbalanced competency development. Consequently, graduates may possess partial technical knowledge but lack critical skills such as problem-solving, discipline, and adaptability, which are essential for meeting industry standards.

These limitations directly affect the outcome level, particularly graduate readiness and recruitment performance. Graduate readiness, reflected in the ability to transition into employment, training programs, or further education, serves as a key indicator of the effectiveness of competency formation. In the context of this study, the declining acceptance rate in the UT School selection process provides empirical evidence of this misalignment, indicating that graduates are not sufficiently prepared to meet industry-based selection criteria.

The framework confirms that the low acceptance rate of vocational graduates reflects a systemic issue rooted in the interaction between input, process, and outcome dimensions, rather than isolated individual deficiencies. Specifically, misalignment at the TVET input level constrains the effectiveness of competency formation, which in turn limits graduate readiness and reduces success rates in the UT School selection process. This finding highlights the need for a systemic intervention that strengthens alignment between education and industry while enhancing KSAT competencies as the core foundation of work readiness.

III. RESEARCH METHOD

A) Research Design

This study employs a qualitative case study approach with the UT School as the primary unit of analysis. The case study method is appropriate because the research seeks to understand a complex and contextual phenomenon, namely, the declining acceptance rate of vocational high school (SMK) graduates in the UT School selection process.

This approach allows an in-depth exploration of the interaction between educational systems, candidate readiness, and industry expectations, which cannot be fully explained through quantitative analysis alone.

Furthermore, employability is considered a multidimensional construct involving technical competence, behavioral readiness, and alignment with organizational expectations, making qualitative inquiry essential [3].

B) Data Collection

This study uses a multi-source data collection approach to ensure comprehensive analysis and validity. Data were collected from both primary and secondary sources.

Primary Data

Primary data were collected through:

- In-depth semi-structured interviews
- Direct observation
- Internal document analysis

Key informants include:

- UT School management
- Recruitment team UT School
- Vocational school (SMK) principals
- Industry representatives (DUDI)

This multi-stakeholder approach is important because employability issues are influenced by interactions between education providers, training institutions, and industry users.

Secondary Data

Secondary data includes:

- Academic journals
- Government reports
- Company internal reports
- Policy documents

These sources are used to strengthen the theoretical framework and validate empirical findings.

Table 2: Data Sources Summary

Data Type	Source	Purpose
Primary	Interviews	Identify competency gaps & perceptions
Primary	Observation	Assess real behavior & skill readiness
Primary	Internal Data	Analyze selection trends & performance
Secondary	Journals & Reports	Support theory and comparison

C) Sampling Technique

The study uses purposive sampling, selecting informants based on relevance, experience, and authority in the vocational ecosystem.

This method is appropriate for qualitative research aimed at gaining in-depth insights rather than statistical generalization.

Table 3: Research Informants

No	Informant	Role
1	UT School Director	Strategic perspective
2	Recruitment Team	Selection process insight
3	SMK Headmaster	Education system perspective
4	Industry Representative	Workforce demand perspective

D) Data Analysis

Data analysis is conducted using thematic analysis, which allows identification of patterns, themes, and relationships from qualitative data.

The analysis follows several stages:

- Data familiarization
- Initial coding
- Theme development
- Theme refinement
- Interpretation using analytical frameworks

The identified themes include:

- Academic readiness gap
- Technical skill deficiency
- Attitude and discipline issues
- Weak transversal competencies
- Infrastructure limitations
- Industry linkage gaps

E) Analytical Framework

Two frameworks are used:

- TVET Input Framework → to analyze systemic factors (curriculum, infrastructure, partnership)
- KSAT Model → to assess individual competencies (Knowledge, Skills, Attitude, Transversal)

This dual-framework approach ensures that the analysis covers both system-level and individual-level factors.

Table 4: Analytical Framework Summary

Framework	Focus	Purpose
TVET Input	System factors	Identify root causes
KSAT Model	Individual competency	Assess readiness

F) Data Validity

To ensure trustworthiness, this study applies qualitative validity criteria:

- Credibility → member checking
- Transferability → detailed context description
- Dependability → audit trail documentation
- Confirmability → evidence-based interpretation

Additionally, triangulation is applied:

- Source triangulation (multiple stakeholders)
- Method triangulation (interview, observation, documents)

Table 5: Validity Techniques

Technique	Description	Purpose
Source Triangulation	Multiple informants	Reduce bias
Method Triangulation	Multiple data types	Increase reliability

This methodology enables a comprehensive understanding of the declining acceptance rate by integrating perspectives from education, training institutions, and industry. The use of thematic analysis combined with TVET and KSAT frameworks provides a robust basis for identifying root causes and formulating strategic solutions.

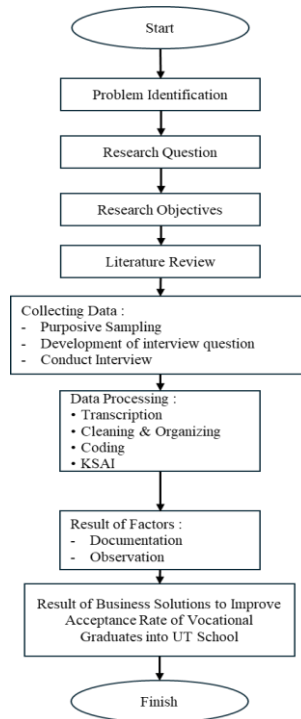


Figure 2. Research Framework

Figure 2 illustrates a systematic and problem-based research framework that begins with identifying the declining acceptance rate of vocational graduates and progresses through research question formulation, data collection, analysis, and strategy development. The framework integrates the TVET input factors and the KSAT competency model to explain how both systemic conditions and individual competencies influence graduate readiness and recruitment outcomes. Ultimately, the framework guides the formulation of strategic solutions aimed at strengthening the talent pipeline and aligning vocational education with industry needs.

IV. RESULT AND DISCUSSION

A) Overview of Thematic Coding

The results of this study are derived from a qualitative analysis of verbatim interview data involving multiple stakeholders within the vocational education and industry ecosystem. A total of 104 coded statements were identified and categorized into themes using thematic analysis.

The coding results were then grouped into main themes, sub-themes, and polarity classifications (negative, neutral, and positive) to understand the dominant issues affecting the acceptance rate of vocational graduates.

The following table presents the complete thematic coding structure, including the distribution of polarity, number of quotes, and the linkage to research questions.

Table 6: Complete Thematic Coding Results

No	Code	Main Theme	Quotes	Negative	Neutral	Positive	Dominant Polarity	Sub-Themes	RQ	Informants
1	T1	Selection Process & System Gap	15	8	2	5	Negative	Admin selection, physical requirement, tech gap, triple gap, curriculum policy	RQ1, RQ2	I1-I6
2	T2	Academic Competency Decline	13	9	3	1	Negative	TPA relevance, standardization, failure	RQ1, RQ2	I1

								rate, and regional disparity		
3	T2	Behavior & Safety Gap	5	4	0	1	Negative	Industry behavior priority, safety awareness, MCU standard	RQ1, RQ2	I3
4	T2	Industry–School Collaboration (SOBAT)	4	1	2	1	Neutral	Communication limitation, collaboration model	RQ1, RQ2	I2
5	T2	Collaboration Effectiveness	3	1	0	2	Positive	Collaboration impact, absorption rate	RQ1, RQ2	I4
6	T2	Graduate Competency & Character	3	0	1	2	Positive	Character priority, competency hierarchy	RQ1, RQ2	I6
7	T2	Recruitment Progress & Feedback	3	2	0	1	Negative	Selection failure stages, absorption issue	RQ1, RQ2	I5
8	T3	Character & Motivation Decline (Gen Z)	6	4	1	1	Negative	Motivation, discipline, soft skill weakness	RQ1, RQ2	I1
9	T3	Hard vs Soft Skill Balance	4	3	1	0	Negative	Soft skill gap, placement readiness	RQ1	I2
10	T3	Mental Readiness & Parent Role	4	2	0	2	Negative	Career motivation, parental influence	RQ1, RQ2	I4
11	T3	Character Development Programs	4	1	0	3	Positive	Discipline culture, training programs	RQ1, RQ2	I5
12	T3	Retention Challenge	3	3	0	0	Negative	Low resilience, turnover	RQ1	I3
13	T3	Generational Challenge	2	2	0	0	Negative	placement mismatch, environment impact	RQ1	I6
14	T4	TVET System Transformation	15	8	1	6	Negative	QA system, teaching factory, teacher capacity, industry exposure	RQ1, RQ2	I1–I6
15	T5	Selection Capacity Limitation	4	3	1	0	Negative	Interview standard, safety gap,	RQ1, RQ2	I1

								recruitment capacity		
16	T5	Education System Constraint	3	3	0	0	Negative	teacher retention, SMK disparity	RQ1, RQ2	I2
17	T5	Industry Structural Barrier	1	1	0	0	Negative	gender barrier	RQ1	I3
18	T6	Curriculum Misalignment	4	3	0	1	Negative	curriculum synchronization gap	RQ1, RQ2	I1
19	T7	Structural & Contextual Factor	2	2	0	0	Negative	gender issue	RQ1	I1
20	T8	Best Practices & Strategy	3	0	0	3	Positive	industry-based SMK model	RQ2	I1
21	T9	Weak Feedback Loop	3	2	1	0	Negative	ineffective feedback system	RQ1, RQ2	I1

The full thematic coding results can be found in Table 6, with the vast majority of themes displaying a negative polarity, indicating that decline rates are largely systemic issues instead of being isolated debacles. Stability of polarity by code type also suggests that critical themes T1—Selection Process & System Gap; T2—Academic Competency Decline; and T3—Character & Motivation Decline, are consistently negative: the problem is endemic in educational program input dimensions as well as candidate readiness dimension. Especially, very high frequencies of negative codes were discovered in all three Pathways (8 out of 15 in T1 and 9 out of 13 in T2), indicating structural inefficiencies of selection mechanisms and fundamental weaknesses in academic competency formation.

At a deeper level, findings indicate that competency-related problems go beyond just hard skills but include behavioral and attitudinal aspects. The behavior and safety gap, soft skill imbalance, and mental readiness are subthemes surrounding Gaps in non-technical skills, especially discipline, motivation, and adaptability, that are major barriers to candidate success. It indicates that there is a gap between the competency structure created through the TVET system, as opposed to industry needs, where soft competencies and work preparedness take precedence over hard technical ones.

Moreover, systemic constraints are made worse by structural limitations embedded within education and industry systems. Themes T4 (TVET System Transformation) and T5 (Selection Capacity Limitation) show that institutional elements, including low capacity for training, differences among the quality of SMKs, and limited exposure to industries, are responsible for varying competency levels. Simultaneously, the presence of themes like Weak Feedback Loop (T9) indicates that the system in place does not lead to solid ways for continuous improvement, leading to more problems being repeated in hiring cycles.

Although the vast majority of research findings on this topic are negative polarity, we highlight some important positive and neutral results which provide strategic guidance. A wide range of emerging interventions that cover both educational and collaborative perspectives are indicated by themes such as Best Practices & Strategy (T8) and the selected sub-themes under T2 and T3, which include industry-based training models and character development programs. Nevertheless, these practices remain siloed and not yet adopted at scale, which undermines their full impact on system performance.

Results in Table 6 show that the declining acceptance rate takes an existing inter-dependent set of causes spanning from competency formation through institutional capacity to systemic alignment. The predominance of negative polarity across themes demonstrates that the problem is systemic rather than incidental, requiring systemic interventions that link educational inputs and processes of competency development together.

Table 7: Polarity Summary

Category	Count	Percentage
Negative	62	59.6%
Neutral	13	12.5%

Positive	29	27.9%
Total	104	100%

Table 7 indicates that negative findings account for 59.6% of total coded data, significantly higher than positive 27.9% and neutral 12.5% responses.

This dominance of negative polarity confirms that the issue of declining acceptance rate is primarily driven by systemic problems rather than isolated individual cases. However, the presence of positive findings suggests that improvement opportunities exist and can be leveraged through targeted interventions.

Table 8: Theme Aggregation

Level	Theme Group	Codes	Meaning
System Level (TVET Input)	Structural & System Issues	T1, T4, T5, T6, T7, T9	Education system gap
Individual Level (KSAT)	Competency Gap	T2, T3	Knowledge, skills, and attitude issues
Positive Insight	Strategic Solution	T8	Improvement opportunity

Table 8 provides a basic aggregation of the top themes identified, which collapse into three main areas of analysis: system-level (TVET input), individual-level competency gaps (KSAT), and positive perspectives (strategic solutions).

Firstly, the system-level dimension relates to structural vulnerabilities of the vocational educational ecosystem and comprises themes T1, T4, T5, T6, T7, and T9. They are curriculum misalignment, limited infrastructure, weak industry collaboration, and ineffective feedback systems. This means that the education system has not yet aligned itself with industry requirements, and so there are gaps between training outputs and labor market needs.

Second, the individual level (T2 and T3) indicates considerable deficiencies in graduates' skills. These include not only technical aspects such as knowledge and skills, but also behavioural dimensions including attitude, motivation, and transversal competencies. It is consistent with the finding that a combination of cognitive and non-cognitive influences can affect graduate readiness. Thirdly, positive evidence (T8) suggests developing strategic opportunities through models of vocational education based on the industry and collaboration mechanisms. This suggests limitations from the current environment, yet practical strategies exist that can be tapped into to improve graduate readiness and support the talent pipeline.

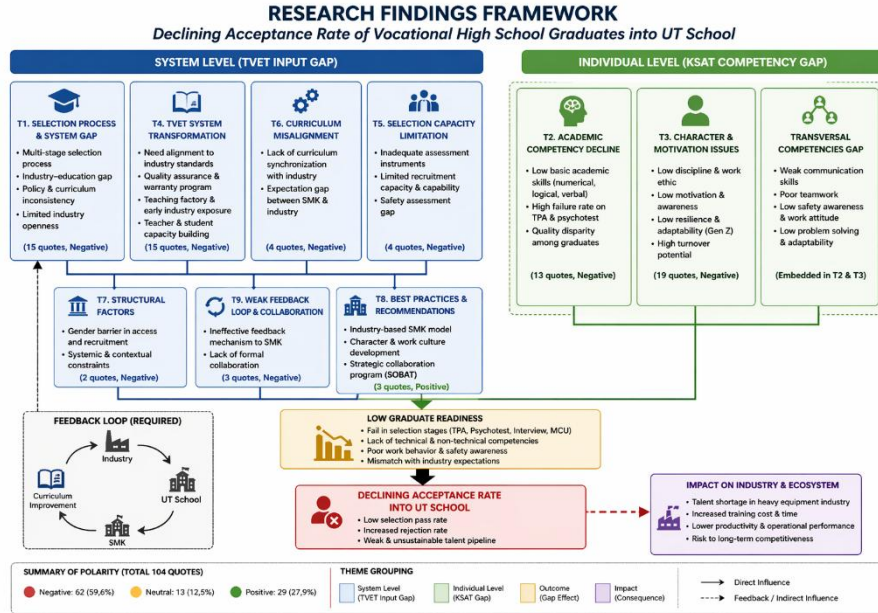


Figure 3. Research Finding Network

B) Discussion

The findings of this study demonstrate that the declining acceptance rate of vocational high school graduates into UT School is not merely a short-term recruitment issue but reflects a structural misalignment within the Technical and Vocational Education and Training (TVET) system, as shown in Figure 3. This result reinforces the argument that employability is shaped by the dynamic interaction between education systems and labor market demands, rather than being solely determined by individual capability [4], [7].

a. Structural Misalignment of TVET Inputs

One of the study's key conclusions highlights that system-level issues are most prevalent, suggesting that the TVET system has not sufficiently transformed in response to rapid shifts in the heavy equipment industry.

Given the persistence of curriculum misalignment, lack of infrastructure, and very weak industry linkages, vocational institutions seem locked into a model of adaptation; reverse educational change is not keeping up with industrial evolution. This is consistent with prior literature highlighting that outdated curricula and inadequate industry engagement are major contributors to skill mismatch in vocational education [1], [5], [18].

Additionally, the lack of a robust feedback mechanism between industry and academia further complicates this gap, stifling improvement. These findings are consistent with studies that stress the importance of iterative feedback mechanisms and co-creation between education providers and industry stakeholders for sustainable TVET systems [6].

b. Reframing Employability: Beyond Technical Competence

The results also showed that employability in the heavy equipment industry goes beyond just technical competence, requiring a more comprehensive combination of KSAT (Knowledge, Skills, Attitude, and Transversal competencies). The study emphasizes though that, even in an era where gaps in cognitive and technical skills especially in numerical reasoning and problem-solving supported by modern assessment technology is still a major challenge, behavioral and attitudinal dimensions are just as important, if not more so, in determining recruitment success. This result is in line with the employability framework by Akkermans et al. [3], where it is argued that organizations assess candidates not just based on capability signals, but also readiness to carry out specific job behaviors. In heavy equipment and other high-risk, operationally intensive industries, attributes like discipline, safety awareness, and resilience are not niceties but prerequisites for a productive workforce.

c. The Centrality of Transversal Competencies

A critical contribution of this study is the highlighting of transversal competencies as among the top failure points regarding recruitment. Most of the findings reveal that candidates do not fail due to a lack of technical content but because of their adaptability, communication skills, and teamwork. This finding indicates a larger change in the global labor market, notably that employers increasingly seek more flexible, collaborative, and agile workers [2], [10], [12]. This is a challenge to the model of vocational education with technical specialization but poor integration with soft skills development, resulting in graduates not being chosen for employment in rapidly changing industrial environments.

d. System–Individual Interaction: A Reinforcing Cycle

One of the key findings from this study is that it highlights a cyclical reinforcing interaction between deficiencies in the system and competency levels. The results show that ineffective TVET inputs, including curricula and limited practical exposure, result in poorly developed competencies by counterparts to formal education institutions. This ultimately reduces the overall performance of candidates during selection. This creates a vicious cycle where low-quality inputs create low-quality outputs, thus further eroding down the pipeline of talent. Such systemic interrelationship reinforces the theoretical notion that employability outputs are built up at the intersection between institutional structures and agency [4]. Thus, interventions concentrating on either system reform or individual training will not have lasting effects.

e. Leveraging Positive Practices for System Transformation

While the vast bulk of findings were negative, the research notes some emerging best practices that open up strategic opportunities for making improvements. Specifically, we find work-integrated learning models with industry, collaborative training programs, and more intentional character formation initiatives hold promise to improve graduate readiness. Such practices also resonate with efforts related to global TVET reforms that recognize the importance of work-based learning and industry co-design as well as competency-based training as key success factors [7], [14]. At the same time, the presence of these positive elements indicated to us that the issue was no solution, but rather systemic scaling and integration of effective practice.

f. Implications for Talent Pipeline Sustainability

The implications of these findings extend beyond recruitment outcomes to the broader issue of talent pipeline sustainability. If the current misalignment between vocational education and industry needs persists, it may result in long-term structural consequences, including labor shortages, increased training costs, and reduced industrial competitiveness. This is consistent with previous studies highlighting that workforce sustainability depends on the continuous alignment between education systems and evolving industry requirements [1], [3]. Therefore, strengthening the vocational talent pipeline is not only an educational priority but also a strategic imperative for industrial development.

V. CONCLUSION

This study concludes that the declining acceptance rate of vocational high school (SMK) graduates into UT School is not merely a technical issue within the recruitment process, but rather a reflection of deeper structural challenges within the Technical and Vocational Education and Training (TVET) ecosystem. The findings indicate that this phenomenon is driven by the interaction between systemic weaknesses such as curriculum misalignment, limited training infrastructure, and insufficient industry collaboration, and gaps in individual competencies, particularly in the dimensions of Knowledge, Skills, Attitude, and Transversal competencies (KSAT).

Furthermore, the study highlights a critical shift in industry expectations, where transversal competencies such as adaptability, communication, discipline, and resilience have become key determinants of recruitment success, often surpassing technical skills alone. This suggests that vocational education systems that focus predominantly on technical training without integrating behavioral and soft skill development may struggle to produce graduates who meet contemporary industry standards.

The results also reveal a reinforcing cycle in which weak TVET inputs lead to incomplete competency formation, which subsequently reduces graduate readiness and lowers acceptance rates, ultimately weakening the sustainability of the talent pipeline. However, the presence of positive practices, particularly industry-based vocational models and collaborative training initiatives, demonstrates that effective solutions already exist and can be further developed and scaled.

In this context, the study emphasizes the importance of adopting a holistic and integrated approach that simultaneously improves the alignment between vocational education and industry needs, strengthens KSAT competencies, and enhances collaboration between schools, training institutions, and industry stakeholders. Such an approach is essential not only to improve graduate employability and recruitment outcomes but also to ensure the long-term sustainability and competitiveness of the talent pipeline in the heavy equipment sector.

Interest Conflicts

The author declares that there is no conflict of interest regarding the publication of this paper. This research was conducted independently, and no financial or personal relationships have influenced the results or interpretation of the findings.

Funding Statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgments

The author would like to express sincere gratitude to the UT School for providing access to data and supporting the research process. Appreciation is also extended to all informants, including vocational school representatives, industry practitioners, and UT School personnel, for their valuable insights and contributions to this study.

The author also acknowledges the support and guidance from academic supervisors and colleagues who provided constructive feedback throughout the research process. Their input has been instrumental in improving the quality of this study.

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