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Readiness and Needs for Professional Development of Vocational School Teachers in Implementing Link and Match in The Industry 4.0 Era

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ABSTRACT

The high rate of open unemployment among vocational school graduates shows that their skills don't fully match industry needs, especially in the Industry 4.0 era, which demands an adaptive, digitally literate, and vocationally skilled workforce. This condition emphasizes the importance of teacher readiness and professionalism as the key to the successful implementation of link and match so that learning is relevant to the demands of the business and industrial world (DUDI). This study aims to analyze the readiness of vocational school teachers and the need for professional development in North Sumatra by comparing teachers in urban and rural areas. The study uses a qualitative descriptive approach with written interviews. Participants consisted of four productive teachers from schools in Medan City and six teachers from one rural school. The interview instrument explored understanding of link and match, pedagogical readiness, digital competence, vocational skills, collaboration with DUDI, obstacles, and training needs. Data were analyzed using Elo and Kyngäs content analysis. The results showed that urban teachers were more prepared in terms of implementation due to the support of facilities, technology, and access to industry training, while rural teachers were more prepared conceptually but were hampered by limited facilities and access to industry. Both had similar needs regarding vocational training, digital technology, and industry-based programs. The findings emphasized the need for context-based professional development to strengthen the role of teachers in preparing graduates who are relevant to industry needs.

Keywords: Industry 4.0 Era, Vocational School Teachers, Readiness, Link and Match, Professional Development

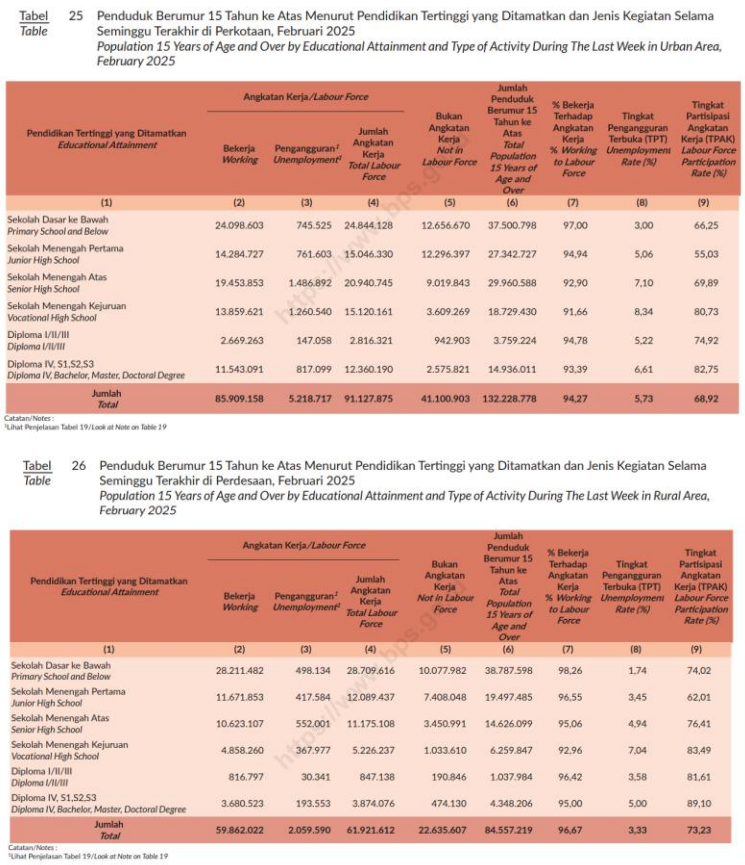
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1. INTRODUCTION

Vocational education plays a strategic role in preparing skilled workers who are able to meet industry needs, especially in the current era of digital transformation. However, the reality on the ground shows that vocational school graduates still contribute the highest rate of open unemployment in Indonesia. Based on BPS data from February 2025, the open unemployment rate (TPT) of SMK graduates was recorded as the highest among all education levels, both in urban and rural areas. In urban areas, the TPT for SMK graduates reached 8.30%, higher than that of high school graduates (7.10%), Diploma I/II/III graduates (5.22%), Diploma IV/S1 graduates (6.61%), junior high school graduates (5.06%), and elementary school graduates and below (3.00%). A similar situation can be seen in rural areas, where the TPT for vocational school graduates is 7.04%, again the highest compared to other education levels, as shown in Figure 1. This fact points to a fundamental problem in the implementation of vocational education, particularly in terms of the suitability of graduates for the needs of the world of work.

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Tabel 25 Penduduk Berumur 15 Tahun ke Atas Menurut Pendidikan Tertinggi yang Ditamatkan dan Jenis Kegiatan Selama Seminggu Terakhir di Perkotaan, Februari 2025
Population 15 Years of Age and Over by Educational Attainment and Type of Activity During The Last Week in Urban Area, February 2025

Pendidikan Tertinggi yang Ditamatkan *Educational Attainment*	Angkatan Kerja/*Labour Force*			Bukan Angkatan Kerja *Not in Labour Force*	Jumlah Penduduk Berumur 15 Tahun ke Atas *Total Population 15 Years of Age and Over*	% Bekerja Terhadap Angkatan Kerja *% Working to Labour Force*	Tingkat Pengangguran Terbuka (TPT) *Unemployment Rate (%)*	Tingkat Partisipasi Angkatan Kerja (TPAK) *Labour Force Participation Rate (%)*
	Bekerja *Working*	Pengangguran[1] *Unemployment*[1]	Jumlah Angkatan Kerja *Total Labour Force*					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sekolah Dasar ke Bawah *Primary School and Below*	24.098.603	745.525	24.844.128	12.656.670	37.500.798	97,00	3,00	66,25
Sekolah Menengah Pertama *Junior High School*	14.284.727	761.603	15.046.330	12.296.397	27.342.727	94,94	5,06	55,03
Sekolah Menengah Atas *Senior High School*	19.453.853	1.486.892	20.940.745	9.019.843	29.960.588	92,90	7,10	69,89
Sekolah Menengah Kejuruan *Vocational High School*	13.859.621	1.260.540	15.120.161	3.609.269	18.729.430	91,66	8,34	80,73
Diploma I/II/III *Diploma I/II/III*	2.669.263	147.058	2.816.321	942.903	3.759.224	94,78	5,22	74,92
Diploma IV, S1,S2,S3 *Diploma IV, Bachelor, Master, Doctoral Degree*	11.543.091	817.099	12.360.190	2.575.821	14.936.011	93,39	6,61	82,75
Jumlah *Total*	85.909.158	5.218.717	91.127.875	41.100.903	132.228.778	94,27	5,73	68,92

Catatan/Notes :
[1]Lihat Penjelasan Tabel 19/*Look at Note on Table 19*

Tabel 26 Penduduk Berumur 15 Tahun ke Atas Menurut Pendidikan Tertinggi yang Ditamatkan dan Jenis Kegiatan Selama Seminggu Terakhir di Perdesaan, Februari 2025
Population 15 Years of Age and Over by Educational Attainment and Type of Activity During The Last Week in Rural Area, February 2025

Pendidikan Tertinggi yang Ditamatkan *Educational Attainment*	Angkatan Kerja/*Labour Force*			Bukan Angkatan Kerja *Not in Labour Force*	Jumlah Penduduk Berumur 15 Tahun ke Atas *Total Population 15 Years of Age and Over*	% Bekerja Terhadap Angkatan Kerja *% Working to Labour Force*	Tingkat Pengangguran Terbuka (TPT) *Unemployment Rate (%)*	Tingkat Partisipasi Angkatan Kerja (TPAK) *Labour Force Participation Rate (%)*
	Bekerja *Working*	Pengangguran[1] *Unemployment*[1]	Jumlah Angkatan Kerja *Total Labour Force*					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sekolah Dasar ke Bawah *Primary School and Below*	28.211.482	498.134	28.709.616	10.077.982	38.787.598	98,26	1,74	74,02
Sekolah Menengah Pertama *Junior High School*	11.671.853	417.584	12.089.437	7.408.048	19.497.485	96,55	3,45	62,01
Sekolah Menengah Atas *Senior High School*	10.623.107	552.001	11.175.108	3.450.991	14.626.099	95,06	4,94	76,41
Sekolah Menengah Kejuruan *Vocational High School*	4.858.260	367.977	5.226.237	1.033.610	6.259.847	92,96	7,04	83,49
Diploma I/II/III *Diploma I/II/III*	816.797	30.341	847.138	190.846	1.037.984	96,42	3,58	81,61
Diploma IV, S1,S2,S3 *Diploma IV, Bachelor, Master, Doctoral Degree*	3.680.523	193.553	3.874.076	474.130	4.348.206	95,00	5,00	89,10
Jumlah *Total*	59.862.022	2.059.590	61.921.612	22.635.607	84.557.219	96,67	3,33	73,23

Catatan/Notes :
[1]Lihat Penjelasan Tabel 19/*Look at Note on Table 19*

Fig 1. Comparison of the population aged 15 years and above according to the highest level of education completed and activities during the last week in urban and rural areas
Source: BPS Data (2025)

Various studies reveal that the high unemployment rate among vocational school graduates is influenced by the competency gap between what is learned in school and the actual demands of the industry (Agustian et al., 2024). This condition reflects that the implementation of learning and teachers' readiness in understanding industry dynamics is not yet fully optimal. Amidst the rapid development of the Industry 4.0 era, which demands rapid adaptation to technological changes, the quality of teachers is a major determinant of the success of efforts to align (*link and match)* schools with the business world and industry (DUDI) (Disas, 2018) .

The Industry 4.0 era has brought significant changes to the structure of labor needs, marked by the emergence of automation, *the Internet of Things* (IoT), big data, and artificial intelligence. Schwab (2017) states that this era requires graduates who possess *problem-solving* skills, digital literacy, collaborative abilities, and flexibility in facing new technologies. With increasingly complex demands, the role of teachers is no longer limited to delivering material, but has become that of facilitators who connect school knowledge with industrial practice. Sudira (2018), emphasizes that vocational teachers must understand the latest industrial technology, work competency standards, and production-based pedagogical strategies. Thus, teacher competencies should cover pedagogical, technical, digital, and collaborative aspects.

On the other hand, teachers' ability to meet these demands is still uneven across all educational units. According to Hartanto et al., (2019) , some vocational teachers are not yet ready to face technological changes due to limited training related to digitization and industrial technology. This challenge is even greater in schools located in rural areas, where learning facilities, digital devices, and access to training are often limited. Kulsum (2020) adds that there are disparities in the quality of vocational education between

regions, where some vocational schools in less developed areas face limitations in facilities and human resources, which have an impact on teachers' readiness to meet the demands of industrial work.

Given these conditions, systemic efforts are needed to bridge the gap between teachers' abilities and industry needs. In this context, the *link and match* program developed by the government is one of the main strategies to improve the relevance of vocational education. This program includes industry-based curriculum alignment, the involvement of DUDI in training, and partnerships in graduate recruitment (Iskandar, 2022). However, several studies show that teachers' understanding of the technical implementation *of link and match* still varies and has not been fully internalized in learning practices (Ahmanda et al., 2021). This shows that the success of school alignment with industry is greatly influenced by the readiness and competence of teachers. In addition to challenges from the industry side, post-pandemic digital developments have also expanded the demands on teacher competence. Technology-based learning, the use of *Learning Management Systems* (LMS), digital simulations, and computer devices are now basic requirements in vocational teaching. Rohmah (2019) found that teachers with good digital literacy can adapt more quickly and produce more innovative learning. Conversely, teachers with limited digital literacy experience obstacles in developing learning that is relevant to modern industry needs, especially in areas with low technology access.

Given the complexity of these challenges, improving teacher professionalism is an urgent need. Effective professional development, according to Darling-hammond (2017), must be continuous, needs-based, and provide opportunities for relevant hands-on practice. For vocational school teachers, the ideal form of professional development includes internships in industry, technical training, strengthening digital competencies, and the ability to design project-based and production-based learning. Internal school factors also influence the development of teacher competencies. Wahidin & Efendi (2025), show that school leadership support, teacher collaboration, and an innovative climate are crucial to the success of teacher competency improvement. Schools in urban areas generally have broader access to industry, while schools in rural areas tend to face structural limitations that hinder competency renewal.

Based on these issues, this study aims to analyze the readiness and professional development needs of vocational school teachers in facing the implementation of link and match in the Industry 4.0 era. This study seeks to: (1) identify the level of readiness of vocational school teachers in supporting the implementation of link and match; (2) analyze the professional development needs of teachers in the current digital and industrial era; and (3) compare the readiness and needs of teachers between schools in urban and rural areas. The results of this study are expected to provide strategic recommendations for educational institutions, local governments, and industries in designing effective, relevant, and contextual professional development programs for teachers, so that vocational education can produce graduates who are truly ready to work and in line with industry demands.

2. RESEARCH METHOD

A. Research Design

This study uses a descriptive qualitative approach that aims to describe in depth the readiness and needs of vocational school teachers' professional development in facing the implementation of *link and match* in the Industry 4.0 era. This approach was chosen because it allows researchers to understand teachers' experiences, perceptions, and needs directly based on the narratives they convey. Descriptive qualitative research is also appropriate when the research objective is not to construct new theories, but rather to understand phenomena in a naturalistic and contextual manner.

The research location was in North Sumatra Province, involving five schools, consisting of four schools in urban areas and one school in a rural area. The schools located in urban areas included SMKN 7 Medan, SMKS Multi Karya Medan, SMKS Gema Buwana, and SMKS Tritech Informatika Medan, each involving one productive vocational teacher as an informant. Meanwhile, the rural area was represented by SMK Swasta Karya Bhakti, involving six productive teachers. Informants were selected using purposive sampling, considering that productive teachers have direct understanding of vocational learning and are

connected to industry needs. This purposive approach ensured that data was obtained from individuals who truly understood the vocational context and link and match.

B. Data Collection Techniques

Data collection was conducted using written interviews, namely interviews carried out indirectly through online forms and written communication. This technique was chosen to provide flexibility in terms of time for teachers to provide in-depth and reflective answers, as well as to take into account the geographical conditions and varying workloads of teachers. The written interviews contained open-ended questions that explored:

1. Teachers' understanding of the concept of link and match,
2. Teachers' readiness in terms of pedagogy, digital competence, and vocational skills,
3. Teachers' experiences in collaborating with DUDI,
4. Challenges in implementing learning that is relevant to industry needs, and
5. The forms of support and professional development needs required.

If there is information that is unclear or requires further elaboration, the researcher conducts follow-up interviews in writing through private messages to clarify or elaborate on the answers.

C. Data Analysis Techniques

The data were analyzed using qualitative content analysis following the approach of Elo & Kyngäs, (2007). This approach consists of three main stages: *preparation*, *organizing*, and *reporting*.

a. Preparation Stage

In this stage, the researcher repeatedly reads all interview data to gain a comprehensive understanding. The researcher then determines the unit of analysis in the form of relevant answer fragments for the research objectives.

b. Organizing Stage

This stage involves several systematic steps:

1. Open coding: Researchers assign initial codes to text segments that contain important meanings, such as those related to digital readiness, vocational competencies, facility barriers, or training needs.
2. Categorization: Codes with similar meanings are grouped into larger categories.
3. Abstraction: These categories are then synthesized into main themes that describe patterns in the teachers' responses.

c. Reporting Stage

Findings are presented in the form of descriptive narratives that describe themes, categories, and representative quotes from teachers. Reporting is done comparatively between urban and rural teachers so that differences in regional contexts can be clearly seen.

D. Data Validity

Data validity in this study was maintained through two main techniques. First, the researchers applied *member checking*, which involved asking participants to re-verify the researchers' summary interpretations to ensure that the meanings produced were truly in line with their intentions. This step is in line with the views of Lincoln and Guba (1985, in Nirmala et al., 2025), who state that *member checking* is the most important procedure in ensuring the credibility of qualitative findings because it allows participants to correct or reinforce the researcher's interpretation. Second, researchers strengthen data reliability through *audit trails,* which are systematic records of the entire research process, from data collection, coding, and analysis to the interpretation of findings. This technique helps ensure that every analytical decision is based on logical and traceable steps. Maxwell (2013), explains that audit trails enable researchers to build transparency in the research process so that decisions made are not arbitrary and are scientifically accountable. The combination of these two techniques ensures that the analysis process is consistent, transparent, and credible, so that the research findings truly represent the experiences and needs of teachers in the research context.

3. RESULTS AND DISCUSSION

This section presents the research findings based on a qualitative content analysis of written interviews involving vocational school teachers in the city of Medan and rural schools. These findings use an analytical framework that refers to five main aspects of the interviews, namely (1) understanding of the link and match concept, (2) pedagogical readiness, digital competence, and vocational skills, (3) experience of collaboration with the business and industrial world (DUDI), (4) obstacles to professional development, and (5) training support and needs. The discussion also compares the conditions of teachers in urban and rural areas and relates them to relevant literature.

A. Teachers' Understanding of the Link and Match Concept

In general, teachers from both regions showed a similar understanding of the link and match concept, namely the importance of aligning vocational school learning with the real needs of the world of work. Teachers in the city of Medan tended to understand this concept as a strategy that must be implemented directly in learning practices. For example, a teacher from SMK Multi Karya said that link and match means that learning must be based on workplace competencies and not stop at theory. Other teachers mentioned that link and match requires teachers to design teaching materials that are relevant to industry trends so that graduates have high job readiness. This more technical understanding shows that urban teachers see link and match as an operational framework that guides the preparation of learning materials, methods, and evaluation. This is in line with the explanation in , which states that teachers' understanding of the link and match concept greatly determines the depth of vocational curriculum implementation, including the integration of competencies required by industry and the adjustment of project-based and practice-based learning approaches. Research by Dewi et al (2024), also shows that teachers with a technical understanding of the industrial curriculum are better able to design project-based learning that is relevant to work demands, thereby increasing students' readiness to enter the industrial world.

On the other hand, teachers from rural areas also understand link and match, but their understanding is more general. Answers such as "preparing students for work" or "aligning education with the industrial world" show that their understanding is at a basic level, not yet touching on technical aspects such as industrial partnerships, competency-based demand analysis, or the development of industry-based curricula. This understanding is normative in that it recognizes the importance of link and match, but lacks knowledge of how the concept is translated into concrete teaching practices. This finding is in line with the study Prima et al. (2025), which shows that schools in rural areas have an information gap regarding the technical implementation of industry partnerships, including a lack of exposure to the latest industry standards, digital learning tools, and collaborative practices such as teaching factories or industrial apprenticeships for teachers. Additionally, research by Sutomo & Siregar (2022) explains that teachers in remote areas tend to only master the basic concepts of curriculum alignment and have minimal implementation experience due to a lack of exposure to industrial technology and professional development workshops.

This difference in the depth of understanding is greatly influenced by geographical context and access to training. Teachers in urban areas tend to be more frequently involved in industry-organized training, vocational seminars, and in-house training activities that discuss curriculum integration with industry needs. According to Waren & Prasojo (2024), the intensity with which teachers participate in industry training greatly affects the quality of their understanding of the latest competency standards, including aspects of work process digitalization. Meanwhile, teachers in remote areas have limited access to training, either due to location, weak digital facilities, or a lack of networking with industry, so their understanding rarely develops in an applied direction. This is in line with the opinion of P. A. Putra (2024), which emphasizes that the level of teachers' understanding of educational policy concepts is greatly influenced by the intensity of their exposure to practical implementation in the field. According to Vania et al (2021), teachers in remote areas have limited access to curriculum updates, so their understanding is static and does not develop in line with industry dynamics

This difference has a direct impact on the readiness to implement link and match. Urban teachers tend to be able to relate this concept to technology-based teaching practices, digital competency integration, and contextual learning that resembles the work environment. Meanwhile, rural teachers, despite understanding

the urgency of link and match, tend to lack implementation guidelines or facility support to apply this concept optimally. This is reinforced by the findings of Iskandar (2022), who state that limitations in digital devices, a lack of industry partnerships, and insufficient ongoing training prevent teachers from translating the link and match concept into learning practices. Thus, it can be concluded that a more technical and operational understanding of link and match is found among urban teachers, while rural teachers tend to have a basic conceptual understanding but are hampered by systemic limitations in implementing it.

B. Teacher Readiness in Pedagogy, Digital Competence, and Vocational Skills

The results of the study show that there are significant differences between the readiness of vocational school teachers in cities and teachers in rural areas in facing the demands of learning in the Industry 4.0 era. Teachers in cities generally show higher readiness in terms of pedagogy, digital technology integration, and strengthening vocational skills. All teachers from this region stated that they were ready or very ready, and this readiness was reflected in the concrete practices they mentioned. Teachers at SMK Gema Buwana, for example, emphasized the importance of developing digital competencies through the use of online learning technologies and strengthening 21st-century skills. Teachers from SMK Multi Karya also described the use of digital tools, business simulations, and collaborative platforms as part of their teaching strategies. These practices show that city teachers not only understand the demands of Industry 4.0 theoretically but have also begun to integrate technology and modern learning approaches into their teaching activities. These findings are in line with the research Prima et al. (2025), which shows that vocational school teachers in urban areas have greater access to ICT facilities, digital training, and industry networks, resulting in a higher level of readiness compared to teachers in rural areas. Research by Zhou et al. (2022), that teachers who regularly attend technology training and vocational workshops have better abilities in designing digital learning and implementing project-based methods that are in line with industry characteristics.

In contrast, teachers in rural areas such as SMK Karya Bhakti show more declarative than practical readiness. They claim to be ready to face the demands of Industry 4.0, but this is not followed by concrete experience in implementing technology or digital learning approaches. Some teachers admit that this readiness is more of a moral commitment than technical readiness. Structural barriers such as limited internet access, lack of digital devices, and minimal training are the main factors hindering their readiness. One teacher emphasized that unstable internet access makes it difficult for them to participate in online training or integrate technology into learning. This condition is in line with the findings of Nashrullah et al (2025), which explains that teachers in remote areas generally face a large digital divide, both in terms of infrastructure and opportunities for competency development, so that the 4.0 learning transformation is not running evenly. A similar point is made by Ubihatun et al (2024), who state that limited access to technology in remote schools is a major obstacle to the integration of ICT and digital-based evaluation in vocational learning.

The readiness gap between these two regions reflects not only differences in facilities but also differences in exposure to the industrial world and pedagogical innovation. Teachers in cities more often participate in training, seminars, or industrial internships that provide direct experience of work practices and current competency requirements. This enables them to design learning that is more relevant to industry standards. Meanwhile, rural teachers have very few opportunities to do the same, so their knowledge of industry demands and digital learning tends to be conceptual. According to Hafid et al. (2025), teacher involvement in industry partnerships is an important factor that determines their ability to implement learning based on the needs of the workforce.

Thus, the difference in the readiness of urban and rural teachers in facing learning in the Industry 4.0 era is not only related to individual abilities but also reflects systemic gaps in access to training, digital infrastructure, and collaboration with the industrial world. This condition reinforces the urgency of more inclusive and locally-based professional development programs, so that teachers in rural areas have the same opportunity to improve their readiness to face the transformation of vocational education. Professional development programs that are adaptive to the local context are key to overcoming the quality gap between teachers in different regions (Setiawan & Supriyanto, 2024).

C. Experience of Collaboration with the Business and Industrial World (DUDI)

The research results show a very significant difference between vocational school teachers in urban and rural areas in terms of their experience and involvement with the business and industrial world (DUDI). This gap is evident in the types of training they have participated in, the intensity of cooperation, and the level of teachers' understanding of the competency requirements relevant to the world of work.

In urban areas, some teachers have had real experience in collaborating with DUDI, either through training or internships. Two of the four urban teachers have participated in industry-based training: teachers from SMKS Gema Buwana participated in Digital-Based Deep Learning for Education training, a collaboration between Google for Education and the Ministry of Education, while teachers from SMKN 7 Medan participated in the OTKP Upskilling–Reskilling program and a one-month internship at the Horison Lampung Hotel. In addition to participating in training, city teachers also have experience in assisting students with work placements, communicating with industry partners, and understanding the competency standards required by companies. This kind of direct experience provides its own advantages, as teachers can translate real work practices into classroom learning. This is in line with the findings of Arinaitwe (2021) study, which explains that teachers in urban areas have greater opportunities for industry collaboration, so their exposure to work culture and industry standards is much stronger than that of teachers in rural areas. The intensity of teacher interaction with industry significantly improves teachers' ability to adapt the curriculum, especially in terms of updating vocational learning materials and methods based on industry needs (Syarif & Janata, 2024).

In contrast to these conditions, teachers from rural areas face significant limitations. All six teachers admitted that they had never participated in industry-based training, whether in the form of workshops, internships, or industry certification. Their involvement with DUDI was largely limited to the administrative process of PKL, such as arranging student practice locations or conducting routine monitoring without technical assistance or opportunities for direct teacher competency development from the industry. Some teachers also mentioned geographical and infrastructure barriers, such as unstable internet access, which prevented them from participating in online training, which is increasingly being provided by various institutions. This condition is in line with the findings of Prima et al (2025), which states that the disparity in the quality of vocational education between cities and villages is partly due to the limited access of teachers in rural areas to training and industry partnerships.

This lack of practical experience impacts the ability of teachers in rural areas to translate industry demands into learning. Although their understanding of link and match is conceptually sound, the absence of direct experience with the world of work makes it difficult for teachers to update their vocational learning strategies in a relevant manner. This reinforces the view that teacher collaboration with industry is a crucial component of vocational education, as it enables teachers to update their industry knowledge, understand the latest technological developments, and ensure that learning materials remain aligned with the needs of the job market (Hafid et al., 2025). In addition, according to Zhang (2025), teachers who have never been involved in industrial practice tend to maintain traditional learning patterns even though the curriculum demands project-based learning, technology, and real-world work simulations.

Thus, the data shows that urban teachers have advantages in terms of exposure, networking, and direct experience with industry, while rural teachers face structural limitations that hinder their involvement. These findings indicate that the disparity in the quality of teachers' collaborative experiences with industry is not only an individual issue, but also a structural problem related to access, location, and system support. Therefore, affirmative policies and more inclusive industry partnership strategies are needed so that teachers in rural areas can have the same professional development opportunities as teachers in urban areas.

D. Barriers to Implementing Industry-Relevant Learning

The research findings show that the obstacles experienced by vocational school teachers in participating in training and professional development programs are greatly influenced by the geographical context, with clear differences between teachers in urban and rural areas. Although both groups of teachers face challenges, the nature of the obstacles is different: urban teachers face more technical and administrative obstacles, while rural teachers face more complex and fundamental structural obstacles.

Teachers from Medan described obstacles that tended to stem from workloads and time management. They mentioned difficulties in dividing their time between teaching duties, school administration, and attending training, especially when training schedules took place during working hours or required additional preparation. In addition, although technological facilities in cities are relatively adequate, some teachers still feel that certain limitations hinder their ability to participate in online training. However, they generally still have the opportunity and access to participate in industry training and digital training. This condition is in line with the findings of Fatmawati et al (2024), which explains that teachers in urban areas are often burdened with high administrative tasks, making it difficult for them to focus on professional development, even though infrastructure access and training opportunities are much better than in non-urban areas. Furthermore, according to Osman et al (2024), the administrative workload is a significant barrier to urban teachers' participation in vocational training, as teachers' time is more consumed by managing educational documents than by learning innovation.

In contrast, teachers from SMK Karya Bhakti in rural areas face structural barriers that are far more serious. All teachers admitted that they had never received training from industry because it was not available in their area. Barriers such as poor internet access make online training, which is now a popular national alternative, almost impossible to participate in optimally. High training costs, lack of logistical support from schools, and limited information about training further narrow their opportunities to develop professional competencies. Some teachers even stated that training relevant to their field of expertise is rarely held in the surrounding area, so they have no systematic path for competency development.These findings are in line with the research D. A. P. Dewi et al (2025), which states that teachers in rural areas generally experience: (1) limited facilities and infrastructure, (2) limited access to professional training, and (3) a lack of industry networks. As a result, the competency gap between teachers in urban and rural areas is widening because rural teachers not only lack training opportunities but also do not have a supportive environment to develop their competencies continuously.

This gap has serious consequences for the ability of rural teachers to keep up with developments in industry and learning technology. The lack of training not only results in a lack of industry-based pedagogical competencies, but also hinders the formation of a culture of innovation in schools. Research by Putra (2025) shows that without the support of a conducive environment, such as stable internet access, the presence of industry partners, and the availability of technical workshops, teachers in disadvantaged areas will continue to lag behind in the adoption of learning technology and vocational competency development. As a result, the competency gap between urban and rural teachers continues to widen, as rural teachers not only lack training opportunities but also do not have a supportive ecosystem for continuous development.

Given these conditions, it can be concluded that the obstacles faced by urban and rural teachers are substantially different. Urban teachers face organizational and administrative obstacles, while rural teachers face systemic obstacles related to infrastructure, industry access, and the social environment of education. This gap indicates that teacher professional development programs must consider the geographical context, provide affirmation for rural schools, and ensure more equitable access to training to reduce disparities in vocational teacher competencies. The equitable distribution of vocational teacher training must integrate a region-based approach so as not to widen the gap in education quality between urban centers and remote areas (Muharam et al., 2025).

E. School Support and Professional Development Needs

Research findings show that school support for improving teacher competency is greatly influenced by geographical conditions and resource availability. Teachers from Medan City generally feel that they receive more concrete and structured support. They explain that schools give them permission to attend training, provide facilities for in-house training activities, and encourage teachers to innovate in learning. Some schools even routinely hold internal training and facilitate teachers to attend industry-based external training. This relatively strong support shows that urban schools generally have better institutional capacity to develop teacher competency, in line with the findings of , that schools in urban areas tend to have stronger

quality management and network access so that teacher competency improvement programs can be implemented more systematically.

In contrast, support from schools in rural areas is more normative or declarative in nature. Teachers at SMK Karya Bhakti acknowledged that the school "supports" competency improvement, but this support has not been realized in the form of concrete training programs, the provision of digital devices, or adequate network access. Some teachers even mentioned that the school had never held training in collaboration with industry or internal training related to industry-based learning. This condition illustrates the structural limitations of rural schools in providing an environment that allows teachers to develop their competencies. This is in line with the research Ritonga et al (2025), which shows that schools in rural areas often lack sufficient organizational resources to support teacher professionalism in a sustainable manner.

This difference in school support has a direct impact on teachers' professional development needs. Teachers from urban areas generally emphasize the need for applied and industry-oriented training, such as industrial internships, digital marketing training, teaching factories (TEFA), project-based learning, and strengthening digital competencies in line with technological developments. These training choices indicate that urban teachers have a higher level of readiness and expectations for digital and industry-based learning, while also illustrating their need to keep up with current industry trends.

On the other hand, rural teachers also have high training needs, which are even more complex in some aspects. They mentioned the need for training in artificial intelligence (AI) integration, industry-based curriculum, digital competency certification, TEFA, and entrepreneurship. However, despite their high aspirations, access to such training is very limited. This situation reveals an aspiration gap and an opportunity gap, as stated by Hamidi et al (2015), that teachers in rural areas often have strong motivation to develop, but are hampered by limitations in infrastructure, access to training, and institutional support.

Thus, it can be concluded that the most striking difference is not only in the type of training needs, but also in access to professional development opportunities. Urban teachers have more opportunities to develop competencies in line with industry needs, while rural teachers tend to only be able to express their aspirations without adequate systemic support to realize them. This highlights the importance of affirmative policies and the provision of equitable access to training so that the competency gap between vocational teachers in different regions does not widen further.

F. Comparison of Readiness and Needs between Urban and Rural Teachers

To further understand how the conditions of vocational school teachers in urban and rural areas affect their readiness to implement link and match in the Industry 4.0 era, a more systematic mapping is needed. Based on the analysis of interview results, there are a number of fundamental differences between the two groups of teachers, in terms of readiness, experience, obstacles, and professional development needs. This comparison helps to reveal the structural and contextual factors that shape teachers' capacity to meet the demands of modern vocational education. In summary, the comparison is presented in Table 4.6 below:

Table 1.
Comparison of Readiness and Needs of Urban and Rural Vocational School Teachers

1. Aspect	Urban Teachers	Rural Teachers	Key Differences
1. Teaching Readiness	Already using technology, digital methods, and project-based assignments	Have a basic understanding of the concepts but are not yet able to implement the technology.	Urban areas are more prepared in practice; rural areas are still in the conceptual stage.
2. Access to Training and Industry	Have participated in industry training and internships.	No industry training; only administrative matters related to PKL.	Cities have much greater access.
3. Obstacles	Limited time and many administrative tasks.	Weak internet, inadequate facilities,	Inland obstacles are more severe and fundamental.

		and difficult access to training.	
4. Training Needs	Technology, digital, and project-based learning training.	Industrial training, basic technology, and curriculum alignment.	The needs are the same, but opportunities in rural areas are fewer.
5. School Support	There is support for facilities and internal training.	Support is still limited; digital facilities are minimal.	Urban support is stronger.

4. CONCLUSION

This study shows that there is a clear gap between vocational school teachers in urban and rural areas in facing the implementation of link and match in the Industry 4.0 era. Urban teachers have a more technical and operational understanding of link and match and demonstrate implementation readiness through the use of technology, digital simulations, and project-based learning. Meanwhile, rural teachers generally have a conceptual understanding that is still general in nature and are unable to apply industry-based learning strategies in a concrete manner.

This difference is also evident in their experience of collaboration with the business and industrial world (DUDI). Urban teachers have broader access to industrial training, internships, and cooperation with industry partners, while rural teachers have almost no such experience due to infrastructure and geographical access limitations. The obstacles faced by rural teachers are more structural in nature, such as poor internet connectivity, lack of digital facilities, and absence of industrial training, unlike the obstacles faced by urban teachers, which are more related to workload and time management.

School support also reinforces this gap. Urban schools are able to provide internal training, learning facilities, and clear training permits, while rural schools only provide normative support without concrete programs. Both groups of teachers actually have similar professional development needs, such as industrial training, digital competencies, TEFA, and industry-based curricula. However, rural teachers have limited opportunities to realize these needs.

Overall, this study confirms that the readiness and needs of vocational school teachers are greatly influenced by regional context, access to facilities, institutional support, and training opportunities. To reduce the competency gap among vocational teachers, affirmative policies are needed to provide access to industry training, strengthen digital infrastructure, and provide equal institutional support for schools in rural areas. These efforts are crucial to ensure optimal implementation of the link and match program and better prepare vocational school graduates to meet the demands of the workforce.

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