An AHP-Based Evaluation Method for Vocational Teacher's Competency Standard

Dessy Seri Wahyuni, Ketut Agustini, and Gede Ariadi

***Abstract*—Teacher competency standards are the main guidelines for assessing the initial academic qualification of teachers. The basis for the assessment of teacher performance is the sustainable development of their professional career. This research reassesses teachers' competency standards in vocational high schools (VHSs) to sufficiently explain the competence in teaching tailored to the needs of the industrial world. This research aims at an assessment structure established on the Analytic Hierarchy Process (AHP) to assess such competency standards for VHS teachers steadily to assess such competency standards for VHS teachers. The assessment model is classified into four critical criteria, namely: 1) pedagogical competency, 2) professional competency, 3) vocational competency, and 4) technological competency. These criteria are further accumulated into 21 sub-criteria to gauge the efficacy of teacher competency standards. This finding shows that the pedagogical competencies are the most important in this research. Thus, this study's novelty is seen in developing two key aspects: a more detailed explanation of sub-competencies and competencies to enhance Indonesia's skilled teachers' competency levels.**

***Index Terms*—Teacher competency standard, pedagogical competency, professional competency, vocational competency, technological competency, analytic hierarchy process.**

I. Introduction

A country's life can be determined by developing its economy and its citizens' prosperity, which are significantly affected by the standard of vocational learning while attempting to facilitate the job prospects of competent workers in the business industry [1]. Vocational learning is a program of intended education linked explicitly to creating both waged and unwaged students or preparing for occupations requiring a bachelor's degree [2]. VHSs (Vocational High School) from Indonesia fulfil the demand and pressures of gradually multifaceted job capabilities, requiring that workers perform effectively and have the expertise to meet today's skill requirements. To maintain that vocational education is introduced following the national educational targets, technical teachers' competency requirements adapted to their preferences must be identified. Besides, teacher competence criteria are performance-based, identifying the knowledge, expertise, personal characteristics, and conduct required to implement appropriately in an institute and help achieve its strategic aims [3]. According to the Ministry of Education Regulation No 34, the Year 2018 regulates the national standard of teacher competency that the specifications include pedagogical, professional, interpersonal, and social aspects. On the other hand, VHS in Indonesia aims to create competent and absorbed graduates in the industrial world. However, statistical results show an increasing number of VHS graduates who do not find jobs [1]. Sandroto and Riyanti et al. [1] state that only 50% of VHS graduates are absorbed in the world of work, while around 1-2% are entrepreneurs, and the rest have not found a job.

In the current economic situation, employers are demanding enhanced capabilities that support systemic creativity needed even for moderate competitiveness, such as the deployment of interpersonal and intrapersonal behaviour [4]. Conversely, graduates are suitable for the workforce, their skills can be applied to an adjusting business climate, and their performance impacts emerge from an employability gap [2]. Scholars are discipline-specific experience and have inconvenient teaching skills [3]. On the contrary, employers were not informed to the higher education sector of their skills needs [3], and the firm has its obligation to tutor former students aimed at each segment [5].

The developed expertise requirements contain neither explicitly nor specifically required teacher competence based on the Ministerial Regulation of Education and Culture No 34, the Year 2018, especially regarding the mastery of vocational and Technology skills. Sub-competencies remain the same as those of VHS teachers, without being unique, from the present regulation's pedagogical side. The expectations of competent teacher skills should be responsive to labour demand based on employer requirements [6]. The current technical competence does not cover many core issues such as 1) mastery of practical skills in the field of vocational substance; 2) abilities relevant to professional courses; 3) the capability to continually improve current and work-related skills and knowledge; 4) the potential to create networks and to optimize collaborative partnerships to improve the standard of vocational training. It shows a practical gap between what is indicated in the regulations and what is expected in meeting the requirements in the field.

In previous studies, teachers provided subject content and were also trained to link relevant professional content and integrated it with real-life [7], making a significant contribution to learning outcomes and teaching outcomes [8]. Therefore, it is imperative to establish more precise, more explicit, and systematic (more comprehensive) qualification requirements related to the mastery of critical skills and teacher knowledge to revitalize VHS, increase professional teachers' excellence in vocational schools, and encourage quality of teaching and produce good graduates can be absorbed in the industrial world.

Hence, the present study aims at a systematic method of

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Dessy Seri Wahyuni and Ketut Agustini are with the Department of Informatics and Engineering, Universitas Pendidikan Ganesha. Singaraja, Indonesia (e-mail: wahyuni.dsy@gmail.com, ketutagustini@undiksha.ac.id).

Gede Ariadi is with the Department of Management, University of Brawijaya, Malang, Indonesia (e-mail: ariadi.ratih@gmail.com).

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appraising the vocational teacher's competency standard applying the Analytic Hierarchy Process (AHP) decision model. Our methods and study findings provide consistent and comprehensive competencies for the teacher and teacher training institutions used to assess, provide instruction, and develop skills and know-how relevant to the workforce market's requirements. The suggested vocational teacher competence criteria may also be used as benchmarks for teacher performance assessments for their career promotion.

II. Literature Review

Competencies classify into two characterized: basic competency and distinction competency [9]. Basic competency is linked with the primary specific into job-related like pedagogy expertise and professional skill. On the contrary, distinction competency is the capabilities that create someone diverse from others, like vocational proficiency and technology ability. The author tries to explain that the importance of the assessment system involves the four types of competencies above. Assessment of pedagogy competency measures the knowledge and abilities of teachers for understanding in teaching approaches and coaching methods that VHS teacher is requested to have industry proficiency that can meet and associate between studying assigned in school and the industrial scope [10]. Subsequently, assessment of professional competency appraises the proficiency of substance knowledge, identifying how to educate this science and recognizing the teacher's responsibility in the educational structure [11]. Thus, assessment of vocational competency measures mastery in industrial scope and expertise in technical skills of teachers that foster students to train them obtaining their rightful places in the workstation [12]. Finally, assessment of technology competency appraises teachers' capability in applying and operating ICT for educating process, and evaluation [13].

Pedagogical competence refers to educational, teaching, and learning qualifications [14]. Sherlock and Perry et al. [15] stated the context of pedagogical capability in vocational learning such as a) the ability of teachers to confirm the equivalence of opportunity and create positive use of the assortment of student's qualification to enhance studying; b) the implementation of learning tailored to the potential of students in accommodating the abilities of each student; c) the capability to apply a variety of effective teaching methods in order to inspire and engage students as usual; d) capability to compose suitability, frequency and rigour evaluation (intellectual test, and psychometric test). These pedagogical competencies stand of the capacity to 1) identify professional education students' characteristics in relation to their ways of study, professional character, academic characteristics, physical and emotional ability, social background, preferences, potential and creativity [16]; 2) establish in line with the industrial setting of training [17]; 3) refine the application of studying concepts to the vocational [18]; 4) develop of a pre-test method to assess the standard of initial learning and skills of students [19]; 5) establish evaluation indicators for work education activities [20]-[22]; 6) recognize and implementing learning processes, concepts and the personality traits of the resources that are to be supplid [23]; (7) monitor and documenting learning results in particular on the parents [24]; 8) undertake reflective teaching steps to enhance the standard of practice and work training conducted [25]; 9) train activities for the provision of the training and work experience relevant to the business climate [26], [27]; 10) teach strategy techniques to vocational education customized to students' requirements [28]; 11) collaborate between teacher and student through mutually interactive in suitable manner [29].

Professional competence is the ability of teachers to master knowledge in the areas of knowledge and expertise that at minimum embraces proficiency of subject substance broadly and profoundly following the standard content of academic unit programs, subjects, and groups of subjects taught, and mastery of related models and techniques of systematic discipline. They are conceptually overshadowing or coherent with the education unit, subject matter, and group of subjects to be taught [30]-[32]. These professional competencies stand of the capacity to 1) provide specific input such as content which comprise chances to apply specific instructional strategies and to exemplify individually and collectively on their proficiencies [33]; 2) foster students' learning processes by profession-specific knowledge [32]; 3) to continue self-development for achieving career success [34].

Vocational competence is the skills to be learned to achieve required qualified duties [35]. It is linked to competence in job focus and practical skills. These vocational competencies stand of the capacity to 1) provide tacit knowledge connected to the work which increased as an outcome of the experimental acquiring of accomplishment a specific task [36]; 2) create a link between the world of education and work also to be set as the de facto benchmark by any ongoing efforts to enhance entrepreneurial studying [37]; 3) share and interact amid job-related intellect (employed expertise) and condition (chance to understand in the situational atmosphere such as manufacturing scenery and factory) [38], [39].

Finally, Caena [10] states the essential support areas of VHS teachers' competence as functioning with technology. Vocational teachers can use and utilize ICT (Information Communication Technology) for supporting instruction features. It can apply and operate ICT to enrich studying and instructing in the classroom and workshop. ICT significantly impacts increasing learners' innovation and motivation [40], improving education and training in vocational teaching [41]. For instance, in design, local area networks (LAN) may use network service administrator applications to improve and generate the scheme and fault testing by giving the signed tag of error previously realized in the LAN. These technological competencies stand of the capacity to 1) provides more chances for educators and learners to effort improved in an international digital era [42]; 2) establish a society that wishes an altered, technologically mediated link between instructor and student [43]; 3) design spreadsheets, entry handout, give the comprehensive test, analyzing the learner's result studying [44], [45]; 4) optimize technology role for supporting professional development [46]. Fig. 1 demonstrates the initial aspect structure of the analysis. This investigation sought to reevaluate the current VHS teacher competency level in the regulatory oversight and thoroughly

studied the professionals' parameters in increasing industrial requirements.

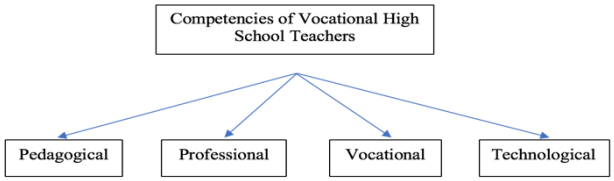

Fig. 1. Initial construct of vocational teachers.

The criteria and sub criteria discussed in the previous research can be seen in Table I. The tables below display the four factors of VHS teachers' competencies as obtained by comprehensive literature:

TABLE I: THE CRITERIA COMPETENCIES OF VOCATIONAL TEACHER

No	Criteria Competencies	Sub-criteria Competency
1	Pedagogical [14], [15]	1.1 Students' characteristic [16] 1.2 Teaching strategy [28] 1.3 Industry Collaboration on curriculum [23] 1.4 Learning environment [17] 1.5 Teaching, learning, and practicing [26], [27] 1.6 Guiding and mentoring of student activity [18] 1.7 Facilitating of student's development continually [19] 1.8 Communication in good manner [29] 1.9 Assessment technique [20]–[22] 1.10 Reflective actions [25] 1.11 Administrative teaching process [24]
2	Professional [30]–[32]	2.1 Content Knowledge [33] 2.2 Application of content [32], [47] 2.3 Continuous self-development [48]
3	Vocational [35]	3.1 Vocational Knowledge and skills [36] 3.2 Entrepreneurship [37] 3.3 Networking and Collaboration [38], [39]
4	Technological [10]	4.1 ICT for learning instruction [42] 4.2 ICT for communication [43] 4.3 ICT for evaluation and assessment [44] 4.4 ICT for continuous development [46]

III. RESEARCH METHODOLOGY

A. Sampling

In this research, an observation was conducted to evaluate the current teacher competency level in VHSs located in Bali, Indonesia. Questionnaires were issued to the respondents that involved two the good experiences of VHS principals, three academics, and an expert from industry who are the experts in this study. There was a total of six questionnaires experts disseminated gathered by them. The information obtained by the survey was employed for implementing AHP and for weight consideration in order to recheck variables based on findings. Therefore, six questionnaires were distributed in this study, so six answers were received. In this stage, the response rate is therefore 100%.

B. Analytic Hierarchy Process (AHP)

AHP is a comparative valuation theory by measuring the priority scale of comparing intangible objects from the pair ratio matrix based on human judgment. Subjective value interpretation is put into the form of a 9-point scale where the empirical fundamentals are put forward by [49]. The AHP eigenvector technique processes these importance loads from a single or collection applying their psychometric scale for formulating the requisite pairwise assessments. For instance, these pairwise judgments exemplify the ratio of loads and exact the relative significance, fondness, or supremacy of one part throughout another regarding a shared goal or criteria. Furthermore, it processes the steadiness of one's judgments by cross-validating fit, which gauge is tracked.

This method has been broadly applied and developed to multi-criteria decision-making problems to find a combination significance vector in a tiered structure. Hierarchical configurations are used to bridge complex problem solving into sub-problems that can be resolved quickly and steadily by the person's opinion; it also delivers a context for integrating various sub-problem outcomes into coherent solutions to the whole problem task. Generally, a decision construction consists of three key aspects: objectives, standards, and decision options [50]. The objectives of the AHP decision problem are established at the maximum level of the order. The criteria and sub-criteria are based on the intermediate level structure. Finally, the decision options are discovered at the base of the order. Thus, AHP delivers a computational context incorporating all local importance reckonings from every paired comparison into a holistic decision framework.

One of the capabilities of AHP is merging numerical data from pre-identified informants or past data and qualitative data from the decision of a group of professionals or specialists. The findings on AHP have also been allocated with data ambiguity across fuzzy set model [51], and interval study [52]. Purposely, the fuzzy AHP method affects education merged with other numerical methods to abstract in individual decision-making in accomplishing the preferred aims. The AHP alternatives manage norms from the fuzzy set concept that suggests a numerical theory to estimate individual perception. Thus, in this research, an assessment structure built on AHP is suggested to analytically reevaluate the current VHS teacher competency level in keeping with the increasing industrial requirements prejudiced by the comparative significance of each criterion for a vocational teacher's competency standard. Once all criteria have been identified, the structure of the vocational teacher's competency standard was identified, as is shown in Fig. 2.

Processing of AHP data involves four essential steps that are:

Step one: developing the hierarchical structure

This study's aim is in sync with the hierarchical structure based on several criteria that have been discussed in previous research. It seeks to reidentify the best competent teacher skills. The hierarchy relies on the structure's complexity. This study overlays two stages: tier 1 comprises pedagogical, professional, vocational, and technological criteria, and tier 2 includes 21 sub-criteria of identity possible. The highest capabilities are categorized into Tier 1 and 2 in this study.

Step two: Putting up the pairwise relative matrixes across the survey

The survey questionnaire was used to obtain the comparison results of each construction pair expertly in proficient pairwise, applying a 9-level assessment scale [53].

Step three: Discovering the eigenvalues and eigenvectors

The stage is taken in compliance with the rule [33]. It was rendered by entering in the second step comparing each

variable in pairs and generating a relative weight value at stages 1 and 2. The pairwise matrix is shown further down. W = (W1, W2, ..., Wn) T, as the vector W and n are the numbers of components.

$$\begin{bmatrix} \frac{W1}{W1} & \cdots & \frac{W1}{Wn} \\ \vdots & \ddots & \vdots \\ \frac{Wn}{W1} & \cdots & \frac{Wn}{Wn} \end{bmatrix} \times \begin{bmatrix} W1 \\ \vdots \\ Wn \end{bmatrix} \quad (1)$$

n and *W* in (1) in the matrix are entitled the eigenvalue and the right eigenvector of matrix A. Then, the experimental matrix A comprises discrepancies. The approximation of W (symbolized as $\overline{w}$) can be taken likeness to (1)

$$\bar{A} \text{ x } \overline{w} = \lambda_{max} \text{ x } \overline{w}$$

$\bar{A}$ is the pairwise judgment observed matrix, λ_{max} is the biggest eigenvalue of, $\bar{A}$ and $\overline{w}$ is its accurate eigenvector.

Step four: accumulating the relative loads

Diverse echelons acquired in phase three are merged to yield a vector of multiple loads aiding as a varying degree for VHS teacher skill in accomplishing the supreme overall goal of this study. To certify the study's reliability, the Consistency Index (CI), the first sign of the exactness of pairwise comparison, is created. The method to determine the indicator is obtainable underneath.

$$CI = \frac{\lambda_{max-n}}{n-1}$$

Thus, the consistency ratio (CR) is estimated for more analysis, whereas ACI is the average index of randomly created weights [20]:

$$CR = \frac{CI}{ACI} \text{ x } 100\%$$

According to [54], the consistency indicator is tolerable if the CR rate < 0.1. Conversely, the paired comparison must be repetitive. Ishizaka and Labib [55] state that Expert Choice software creates improved outcomes than the others. So, this research applies Expert Choice V.11 for the data examination.

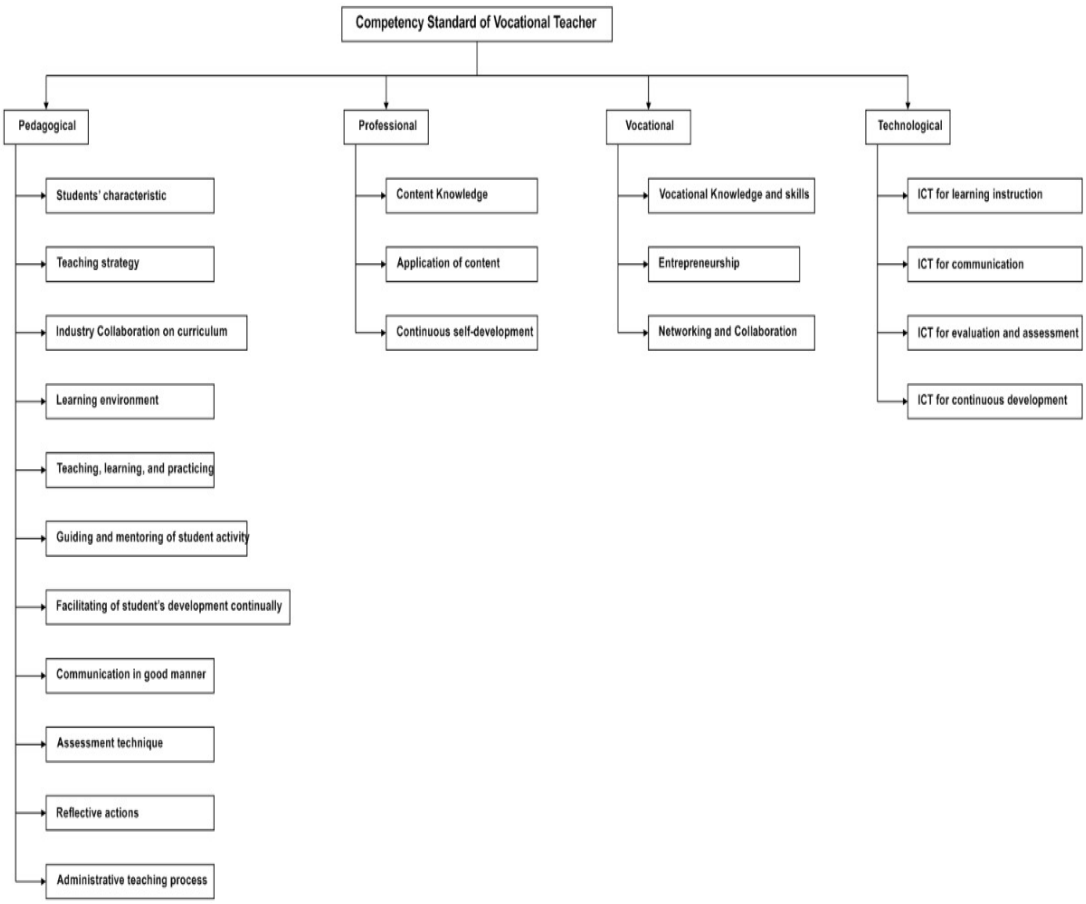

Fig. 2. AHP model for evaluating the competences of vocational teachers.

IV. Results

The evaluation of expertise requirements was established after a thorough survey and consultations with some specialists. The empirical findings indicate that pedagogical, professional, vocational, and technological competencies are regarded as essential skills for qualified teachers. Thus, this study's novelty is seen in developing two key aspects: a more detailed explanation of sub-competencies and competencies to enhance Indonesia's skilled teachers' competency levels.

Moreover, this framework offers a more detailed and systematic (including vocational experience and technological expertise) study on VHS teachers' abilities, which is not explicitly specified in the regulation. This study provided a more systematic specification of criteria of

competence. The subsequent are some alternate skills, including the vocational and technological dimensions. There are three vocational competencies, specifically: 1) vocational Knowledge and skills; 2) entrepreneurship; 3) networking and collaboration. Moreover, particular technological competencies that VHS teachers should possess in this respect are 1) ICT for learning instruction; 2) ICT for communication; 3) ICT for evaluation and assessment; 4) ICT for continuous development.

The AHP was employed to acquire weight, criteria and sub criteria in each dimension established on the perceptions of the expert. Consecutively 1) pedagogical (0.435), 2) vocational (0.328), 3) professional (0.163) and 4) technological aspects (0.074), respectively, are the most significant factors reported. First the core pedagogical skills include: 1) ability to teach, learn and practice (0,137); 2) Teaching strategy (0,128); 3) ability to facilitate of student's development continually (0,124); 4) ability to create a learning atmosphere (0,095); 5) assessment technique (0,089); 6) ability to acquire industry needs into curriculum; (0.087); 7) capability to provide reflective actions (0.083); 8) capability to guide and mentor of student activity (0.075); 9) communication in good manner (0.067); 10) capability to recognize student characteristics (0.065); and 11) administrative teaching process (0.050).

TABLE II: WEIGHT ALLOCATING OF VOCATIONAL TEACHER COMPETENCY — OUTCOMES ACQUIRED BY THE AHP

Criteria	Sub-Criteria	Weight	Ranking
Pedagogical (0.435)	Teaching, learning, and practicing	0.137	1
	Teaching strategy	0.128	2
	Facilitating of student's development continually	0.124	3
	Learning environment	0.095	4
	Assessment technique	0.089	5
	Industry Collaboration on curriculum	0.087	6
	Reflective actions	0.083	7
	Guiding and mentoring of student activity	0.075	8
	Communication in good manner	0.067	9
	Student's characteristics	0.065	10
	Administrative teaching process	0.050	11
Vocational (0.328)	Vocational learning	0.516	1
	Relation and partnership	0.289	2
	Entrepreneur	0.195	3
Professional (0.163)	Application of contents	0.421	1
	Content knowledge	0.334	2
	Continuous self-development	0.245	3
Technological (0.074)	ICT for learning instruction	0.579	1
	ICT for continuous development	0.229	2
	ICT for evaluation and assessment	0.152	3
	ICT for communication	0.040	4

The second rank of critical sub-criteria in the vocational criteria is 1) to provide tacit vocational experience related to the occupation (0.516); 2) to acquire in the workplace atmosphere such as industry situation (0.289); and 3) to foster entrepreneurial learning by collaborating with industry (0.195). Then, the third rank is the professional aspect that is 1) to provide specific input such as content reflecting teacher experience (0.421); 2) to foster students' learning processes by profession-specific knowledge (0.334); and 3) to continue self-development for achieving career success (0.245). Then lastly, the competencies in the technological aspect are 1) to provide more chances for educators and learners to effort well through IT infrastructure (0.579); 2) to optimize technology role for supporting professional improvement (0.229); 3) to create worksheets and, to analyze the student's result learning by IS capability (0.152), and 4) to establish an interaction society by technologically mediated relation between teacher and learner (0.040).

V. DISCUSSIONS

Findings have shown that the pedagogical competencies are the most important in this study, confirming findings Lauermann & König [26] and Wahyuni *et al.* [56]. The essential sub-criteria that VHS teachers must have to contribute to pedagogical competencies are teaching, learning, and practising. VHS teachers have a formal acquaintance of operating and applying studying resources and media that support student characters. When a teacher has mastery of sub-criteria teaching, learning, and practising, ideally it must fulfil efficient and effectual instructing and learning; prolific, applied job; protection standard in the laboratory; resources and instructional learning media; flexible and perform judgment in teaching, learning, and training activity [57]. For example, teachers implement learning media in teaching, such as packet tracer software to simulate the topology area networking and explore learning sources. In this competency criteria, VHS educators are essential to develop role models in actual practice.

Furthermore, another finding is that the vocational competencies are the second important in this study, which confirms Köpsén [12] and Bacigalupo *et al.*[37]. The essential sub-criteria that VHS teachers must have to contribute to vocational competencies are vocational knowledge and skills because VHS teachers prepare to teach assignments so that their students can use them in the world of work. Ideally, when a teacher has mastery of sub-criteria vocational knowledge and skills, it must accomplish occupied acquaintance, practical abilities, and career progress advising. For instance, the VHS teachers express stories and deliver students illustrations of how to speak and turn in the students' forthcoming workshop and prospect exercise of job. This drill is related to the vocational teachers' sharing of proficiency and expertise with the pupils. In addition, vocational frameworks in disciplinary methods suggest how vocational pupils should impress, view, and achieve and what principles and attitudes they should comprise.

Moreover, another finding is that the professional competencies are the third important in this study, which confirms Instefjord & Munthe [31] and Kunter *et al.* [32]. The essential sub-criteria that VHS teachers must have to contribute to professional competencies is the application of content. VHS teachers must improve oriented, linked, and incorporated substance with business scope; improve development and relevance to an industry context. When a teacher has mastery of the sub-criteria application of content, ideally, it must cooperate for conducting curriculum sharing

between VHS and industry [58], [59]. For instance, the partnership provides mutual benefits for VHS and industries to improve the quality of curriculum information, accuracy of order specification worker needs, and joint planning for production prototypes through more responsiveness to consumer requirements [60], [61]. In addition, the graduates' outcomes and industry partners must work together to facilitate positive organizational performance through an integrated education process.

Finally, another finding is that the technological competencies are the fourth important in this study, which confirms Lawrence & Tar [42] and Lucas *et al.* [44]. The essential sub-criteria that VHS teachers must contribute to technological competencies is the ICT for learning instruction. VHS teachers must utilize and display assisting software during the work progression and work exercise directly [62], [63]. Supportive software such as network system analysis can be applied to deliver a prolific, efficacy and effectual learning process. When VHS teacher has mastery of the sub-criteria ICT for learning instruction, it will ideally aid learners and educators who can study more flexibly. ICT permits everyone to get data and education matters wherever and anytime. For example, software implementation in network system connection supports pupils' recognizing of the network resilience system. So, VHS teachers can implement ICT to streamline their instruction and create it more straightforward for their learners to study better.

VI. Implications

Theoretically, this study supports the AHP results that show the essential competency of VHS teachers are pedagogical competencies by teaching, learning, and practising. The higher the level of teacher knowledge, the higher the standard of teaching competence; experienced teacher knowledge is more likely to be based on practical experience and theoretical knowledge. The vocational and technological competencies represent VHS teachers' new criteria that fulfil the practical gap of the relationship between what is stated in the regulations and what is expected to meet the needs in the field. Another interesting finding is that the weight of vocational competence is greater than the weight of professional competence. According to the minister of education regulation, one of the main aspects of the VHS teacher competency standard is professional competence. VHS teachers' primary competency is the vocational aspect because it can be absorbed to achieve required job-related duties and technical skills.

From a practical perspective, the findings significantly impact VHS principals, teachers, and government agencies. First, the analytical outcomes will advise VHS teachers' assessment based on their competency requirements. Second, the proficiency criteria in its research are set in the direction from the most significant to the most minor significant to help VHSs principal evaluate the current VHS teacher competency level. Third, providing input for the government to add vocational and technological competencies is the central aspect of assessing competency standards, primarily vocational teachers.

VII. Conclusion

This research implied that the VHS teacher competencies could be categorized in the four main criteria, namely: pedagogical, vocational, professional, and technological dimensions, through AHP analysis to measure systematic structure for the level of vocational teacher competency. These criteria are thus more declassified into 21 sub-criteria's which were represented in the assessment questionnaires. The comparative significance of this sub-criteria was measured applying AHP by the predilections and expectancies of the experts. Commencing these rankings and loads was calculated and applied as a metric to encourage decision-making. Their assessments can be implemented for delivering an instrument for teacher benchmarking performance, teaching performance evaluation, and developing needs analysis for the vocational teacher training program.

There are limitations in this analysis that suggest some future research directions. First, the competency teachers are identified by the small sample of VHS teachers from only one province in Indonesia. Then the subsequent research should involve a sample of VHS teachers from other provinces or countries. Second, the expert sample has a background in computer and network programs, so that future research is expected to come from the various expertise programs.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Dessy Seri Wahyuni conducted the conceptualization of research, analyzed data, methodology, wrote original draft and software; Ketut Agustini conducted formal analysis, investigation, and project administration; Gede Ariadi wrote, reviewed, and edited the paper; all authors had approved the final version.

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Dessy Seri Wahyuni was born in Singaraja city, Bali in 1985. She received her doctoral degree in vocational education from Yogyakarta State University and Technische Universitä Dresden, in 2019.

She is a lecturer and researcher of Informatics and Education Department, Graduate Program, Ganesha University of Education. She has experience as research leader of "Vocational Teacher Competencies in Vocational High School".

Her teaching and research focus is related with the curriculum development, strategic collaboration of vocational education. She is actively publishing some articles. One of the articles that being published is The Effect of Agility and Product Innovation Efficacy in Indonesia. She is actively participating in certain professional societies, such as ADGVI and APTIKOM.

Ketut Agustini was born on August, 1974 in Singaraja city. She received her doctoral degree in education technology from Jakarta State University, Jakarta in 2014. She is Vice dean for academic affairs, Faculty of Engineering and Vocational, Ganesha Uniersity of Education, Bali. She is also lecturer at Informatics Engineering Education Department, Undergraduate Program, and Instructional Technology Department Graduate Program, Ganesha Uniersity of Education, Bali.

She is actively publishing some books and articles. One of the books is Book Chapter: Educational Technology to Improve Quality and Access on a Global Scale, published by Springer Nature, Switzerland in January 2018. One of her articles that being published are Flipped Learning for 21st Century Competence Development: The Systematic Literature Review, published in Proceedings of the 5th Asian Education Symposium 2020 (AES 2020), Evaluation of the Teachers' Acceptance to E-Report Card Applications with the Hot-Fit Model Approach, published in International Journal of Instruction, 2020. Then, article entitled Project Based E-Learning and Academic Procrastination of Students in Learning Chemistry, published in International Journal of Instruction, 2021

She actively participates in certain professional societies, such as IPTPI, ADGVI (as the secretary in Bali region), APTIKOM, and APS-TPI. She is awarded in her publication entitled Implementation of Augmented Reality Subak Network System as a Support System for Cultural Tourism Electronic Performance at the Subak Museum Tabanan-Bali funded by the DRPM Decentralization Research, 2021. Moreover, she also funded by postgraduate grant team Undiksha in her research entitled Development of Adaptive eLearning (AdeLe) oriented to Triple Characteristic Model in Vocational High School (as the Leader) in 2017 and 2018. Based on her publications, she is listed in Scopus which can be accessed on https://www.scopus.com/authid/detail.uri?authorId=57201396587.

Gede Ariadi was born in Jakarta in 1984. He is a consultant on several firms that move in education, operation management and vocational technology. He earned the doctoral degree in Brawijaya University of Management in 2021. His recent research interests include vocational industry educational management and learning technology.