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RELEVANCE ANALYSIS OF CIVIL ENGINEERING COMPETENCY ACCORDING TO THE CONSTRUCTION INDUSTRY NEEDS IN VOCATIONAL HIGH SCHOOL

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ABSTRACT
Abstract: Vocational High School (VHS) graduates as new workers are expected to be able to enter the workforce immediately after completing their education with the skills they have. But in reality, many graduates from vocational students do not work according to their field of expertise. This study aims to reveal competencies according to standards and needed by the construction industry and how much relevance is the level of competence in the curriculum and implemented in schools. The study was conducted in 15 construction industries with the characteristics of the respondents, namely directors, project and site managers, estimators, senior engineers and drafters, and architects. This research is a type of quantitative research using factor analysis with survey methods. The instrument, which consisted of 37 competency items, was validated using Exploratory Factor Analysis (EFA) techniques and the reliability was based on the Average Variance Extracted and Construct Reliability (CR) values. Overall, the competency instrument has met the Goodness of Fit (GoF) of construct validity and reliability. The results of the reseach reveal the level of relevance of civil engineering competencies based on three aspects, namely basic knowledge, work skills, and personal, obtaining results of 80.856% with relevant categories. These results are a reflection of the percentage of the construction service industry's needs for the competencies mastered by civil engineering graduates. This can be interpreted that the curriculum used in schools has taken into account the needs of the industry.

Keywords
Civil Engineering; Competency Relevance; Construction Industry; Vocational High Schools.

1. Introduction

The development of science, technology and information is very rapid which requires effective and efficient education (Heru et al., 2021; Kundu & Bej, 2021; Lai et al., 2021). The education is an effort to grow and develop the potentials possessed by students to become quality human resources (HR) (Ainslie & Huffman, 2019; Bakke, 2021; Luthfi et al., 2021; Sima et al., 2020). Competition makes the industry must have a strategy that can increase the competitiveness of the industry (Hariyanto et al., 2022; Olazaran et al., 2019). One thing that can be done is to improve the quality of HR. Improving the quality of HR is carried out by the industry making competency standards so that the industry can get workers according to the standards (Mingaleva & Vukovic, 2020; Widayanto et al., 2021).

Vocational High School (VHS) is education at the secondary level the development of students' abilities and work skills to do certain types of work (Daryono et al., 2021; Nurtanto et al., 2020). The competition in the VHS curriculum is structured according to the suitability and needs in industry (Imansari & Sutadji, 2017; Wheelahan, 2015) and takes into account the development of students and the suitability of the type of work, social environment, national development needs (Triyono et al., 2020; Yudiono, 2018), developments in science, technology and culture (Berestova et al., 2020). Completion or improvement of education, especially VHS as a form of harmonizing the development of the industry, science and technology (Beicht & Walden, 2019; Coetzer et al., 2020; Creed et al., 2020).

One of the visible problems is the limited employment opportunities due to the country's economic growth that has not met expectations, then the high unemployment rate for VHS students (Hofmann et al., 2021; Yudiono, 2018), especially civil engineering majors, indicates a competency gap between supply and demand (Daryono et al., 2021; Hariyanto et al., 2022; Olazaran et al., 2019). In addition, it is also related to the quality and relevance in the field of civil engineering between the workforce who graduated from VHS and the needs of the industry.

Observations and interviews were conducted in the department of civil engineering at SMK Negeri 2 Yogyakarta. This department learns about construction

work, especially in the implementation of building planning. But in reality, from the programs that have been implemented in the world of education, there are several problems encountered so that there is a mismatch between the education unit and the industrial construction. Such a curriculum is developed only from the school without involving industry to shape the material taught in the learning that will run. So that the lack of school relations with the world of work causes the absorption of graduates from VHS to work according to their fields to be low.

This is as the results of research conducted by Daryono et al. (2020) revealed that there is still a link and match gap between schools and industry so that it recommends several competencies that must be mastered by civil engineering graduates including personality competencies, basic knowledge, and work skills. Furthermore, research by Wijayanti & Jaedun (2019) revealed the development of civil engineering technology in the world of work, especially the industry which is recommended to be implemented in vocational high schools to improve technological competence and competence of local workers. In addition to competence and work skills to support graduate careers, research by Salehi et al. (2021) recommends the importance of soft skills in work, especially in communicationIn addition, it is also expected to have a willingness to cooperate with colleagues in order to achieve the goals of a job.

To produce graduates who are professional and reliable to work in the construction industry, it is necessary to support the curriculum and competencies according to the standards and requirements needed in the industry (Daryono et al., 2020; Mingaleva & Vukovic, 2020; Olazaran et al., 2019). Some of these standards, for example, are content standards, graduate competency standards, and standards for the world of work. Through the curriculum developed, it is hoped that SMK can produce graduates who are professional and have competitive careers as workers in accordance with their fields of expertise.

The curriculum in schools has a character that leads to the formation of vocational competencies contained in productive programs that are reliable and work in accordance with their fields of expertise which are based on normative and adaptive scientific bases to support vocational competencies that must be achieved. It is imperative for each educational unit to improve the quality and design the best programs so that VHS graduates are able to compete in the world of work (Syauqi et al., 2020; Yudantoko, 2021).

Based on the description above, research on the relevance of the curriculum is very important to do to explore the competencies needed by the construction industry according to current standards. Through this research, it is hoped that schools and industry can find out how big the level of competency relevance in the civil engineering department is today. This research is expected to be able to provide an evaluation so as to produce input to produce a curriculum that is in accordance with industry needs so that it can increase the absorption capacity of civil engineering students.

2. Method

This research is a type of quantitative research using factor analysis with survey methods. The research was carried out by conducting a survey on the construction service industry regarding the competencies required by the construction service industry for graduates of VHS in the civil engineering department. The survey results are expected to provide indicators of competencies to be mastered by civil engineering graduates. The subjects in this study were 15 respondents from 15 business world/construction service industries in Yogyakarta.

Categorization of construction service companies based on the main field of work, namely the building sector and the civil building sector such as roads, bridges, factories/workshops. Furthermore, the classification based on the qualifications of the company consisting of B1 is a company that has a maximum value limit of 0 to 250 billion, M1 has a maximum value of one job 0 to 10 billion, and K1 has a maximum value limit of one job 0 to 1 billion. The list of companies is shown in Table 1.

Table 1. List of Construction Companies

No	Company Name	Profile of Employer	Qualification	Specific Sectors
1	PT. Proporsi	Director	B1	(1)
2	CV. Duta Anggita	Project Manager	M1	(1)
3	PT. Rimasyada	Estimator	M1	(1)
4	PT. Surya Praga	President Director	M1	(2)
5	CV. Archira	Architect	K1	(2)
6	PT. Arss Baru	President Director	M1	(2)
7	PT. Emka Architect	Senior Engineer	M1	(1)
8	PT. Ajisaka Nusa Ilmu	Project Manager	K1	(1)
9	PT. Tri Patra Konsultan	Senior Drafter/Detailer	K1	(2)
10	PT. Kalaprana Konsultan	Site Manager	K1	(1)
11	PT. Arsigraphi	Manager	K1	(2)
12	PT. Stapaka Reka Bangun Nusantara	General Manager	K1	(1)

No	Company Name	Profile of Employer	Qualification	Specific Sectors
13	PT. Laudza Engineer	General Manager	M1	(1)
14	CV. Karya Mandiri Sejahtera	Senior Drafter/Detailer	K1	(3)
15	CV. Multi Citra Graha	Senior Engineer	K1	(1)

(1) Buildings; (2) Roads/Bridges; (3) Factory/Workshop

The instrument is structured based on the basic competencies of the civil engineering department in VHS in the subject syllabus. The researcher gave a questionnaire to the company to provide answers and information from statements about the learning competencies taught in schools whether they were appropriate or needed additional competencies that were appropriate and needed in the construction industry. The indicators and instrument items are shown in Table 2.

Table 2. Aspects of Competence for Graduates of Civil Engineering Students

Aspect of Competency	Indicator	Item	Code
Basic Knowledge (BK)	Health, safety and the environment	1, 2	BK (1,2)
	Read working drawings and make plans for working conditions	3, 4	BK (3,4)
	Able to use computer applications to complete tasks	5, 6	BK (5,6)
Work Skills (WS)	Able to carry out work	7 – 19	WS (1-13)
	Able to estimate	20 - 24	WS (14-18)
	Able to evaluate & make reports on work results	25, 26, 27	WS (19-21)
Personal (PS)	Confident, willing to learn, and able to work under pressure	28 - 32	PS (1-5)
	Take responsibility and prioritize work	33 - 35	PS (6-8)
	Able to communicate and work in groups	36, 37	PS (9-10)

Furthermore, the percentage value is interpreted using the average percentage conversion based on the determination of the scale range by calculating the number of ideal scores for each item. The interpretation of the results of the percentage of competency items is stated to be relevant, namely if each item gets a minimum percentage of >62.5% (Rahmatunisa et al., 2022). The interpretation of the data is shown in Table 29.

Table 3. Interpretation of Competence Relevance Data

No	Interval			Category
1	81.25%	< X ≤	100%	Very Relevant
2	62.50%	< X ≤	81.25%	Relevant
3	43.75%	< X ≤	62.50%	Quite Relevant
4		≤ 43.75%		Less Relevant

3. Results and Discussion

Before further analysis was carried out to calculate the level of relevance of each competency item, the research instrument was tested for validity and estimated reliability. The instrument validity test uses construct validity with a factor analysis technique, namely Exploratory Factor Analysis (EFA) (Boonk et al., 2020; Hazriyanto et al., 2019). Meanwhile, the estimation of instrument reliability is based on the Cronbach Alpha (CA >0.70), AVE (>0.50) and CR (>0.70) (Nashir & Mustapha, 2020; Simangunsong, 2019; Yudong et al., 2020).

Befor the EFA test, it is necessary to measure the value of skewness and kurtosis to determine the normality of the research data. The threshold value for skewness and kurtosis is between -1.96 to +1.96 if the data is said to be normally distributed (Hidayat et al., 2018; Kaiser et al., 2020; ShayesteFar, 2020). The EFA test is based on the communalities table, loading factor, and total variance explained. The communalities table shows the effective contribution of each item to the formed factors. In this case the communalities values range from 0.5 to 1.0 (Reynolds & Candee, 2019; Saifurrahman et al., 2021). The loading factor value shows the magnitude of the correlation of each variable in the formed factor. Factor loading values ranged from 0.40 to 1.00 (Gunuc, 2015; Pala & Erdem, 2020; Reynolds & Candee). The results of the EFA test are shown in Table 4.

Table 4. Testing Data Normality and Validity of Competency Items

Kode	Descriptive Statistics		Commu-nalities	Factor Loading	Kode	Descriptive Statistics		Commu-nalities	Factor Loading
	Skewness	Kurtosis				Skewness	Kurtosis		
BK1	-0.383	-1.117	0.886	0.800	WS14	-0.841	-0.470	0.948	0.709
BK2	-0.004	0.537	0.889	0.628	WS15	-0.547	-0.385	0.977	0.766
BK3	-0.788	-1.615	0.953	0.846	WS16	-0.312	-0.404	0.966	0.585
BK4	-0.112	0.378	0.783	0.424	WS17	-1.085	0.398	0.976	0.687
BK5	-0.841	-0.470	0.964	0.792	WS18	-0.802	-0.127	0.926	0.538
BK6	-1.085	0.398	0.941	0.913	WS19	-0.312	-0.404	0.895	0.489

Kode	Descriptive Statistics		Commu-nalities	Factor Loading	Kode	Descriptive Statistics		Commu-nalities	Factor Loading
	Skewness	Kurtosis				Skewness	Kurtosis		
WS1	-0.282	1.401	0.906	0.826	WS20	-0.547	-0.385	0.962	0.861
WS2	0.000	-1.615	0.973	0.820	WS21	-0.802	-0.127	0.967	0.907
WS3	0.312	-0.404	0.953	0.544	PS1	-1.085	0.398	0.889	0.678
WS4	0.433	-0.669	0.956	0.511	PS2	-0.788	-1.615	0.946	0.864
WS5	-0.227	-0.970	0.922	0.884	PS3	-1.672	0.897	0.972	0.879
WS6	0.128	-1.348	0.977	0.612	PS4	-0.788	-1.615	0.935	0.619
WS7	0.312	-0.404	0.987	0.958	PS5	-0.788	-1.615	0.942	0.831
WS8	0.312	-0.404	0.987	0.958	PS6	-1.074	-0.106	0.963	0.617
WS9	0.000	-0.179	0.979	0.471	PS7	-0.312	-0.404	0.925	0.861
WS10	0.383	-1.117	0.954	0.729	PS8	-0.802	-0.127	0.983	0.842
WS11	0.628	-0.654	0.939	0.867	PS9	-0.433	-0.669	0.963	0.688
WS12	0.547	-0.385	0.975	0.907	PS10	-1.176	-0.734	0.720	0.637
WS13	-0.802	-0.127	0.971	0.422					

All of the competency items have met the criteria for normal data in the skewness range of -1.672 to 0.628, and kurtosis -1.615 to 1.401. This communalities value indicates that each of the 37 competency items is able to provide an effective contribution of >50% in explaining the competencies needed by the construction industry because the extraction value is >0.50. The factor loading value shows the correlation between each competency item required by the construction industry. Because all factor loading values are >0.40, each item has a correlation with other competencies. The next output is the total variance explained value is shown in Table 5 and Figure 1.

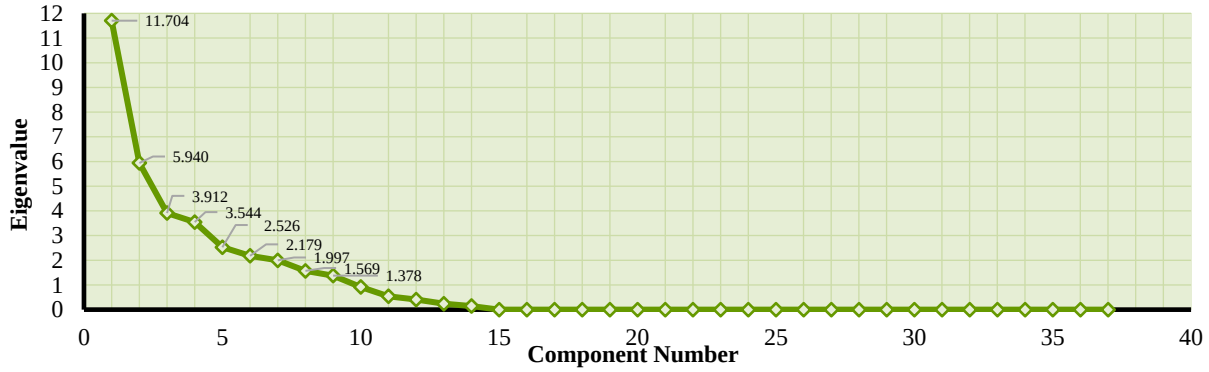

Figure 1. A Scree Plot of Eigenvalue on the Measurement of Civil Engineering Competencies

Table 5. Results of Total Variance Explained in EFA Analysis

Aspects	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cum %	Total	% of Variance	Cum %	Total	% of Variance	Cum %
1	11.704	31.631	31.631	11.704	31.631	31.631	6.984	18.877	18.877
2	5.940	16.053	47.684	5.940	16.053	47.684	6.024	16.280	35.157
3	3.912	10.573	58.257	3.912	10.573	58.257	5.482	14.817	49.974
4	3.544	9.578	67.835	3.544	9.578	67.835	2.888	7.805	57.780
5	2.526	6.828	74.663	2.526	6.828	74.663	2.747	7.426	65.205
6	2.179	5.891	80.554	2.179	5.891	80.554	2.729	7.375	72.581
7	1.997	5.397	85.950	1.997	5.397	85.950	2.712	7.331	79.911
8	1.569	4.242	90.192	1.569	4.242	90.192	2.703	7.305	87.216
9	1.378	3.725	93.917	1.378	3.725	93.917	2.479	6.701	93.917

Extraction Method: Principal Component Analysis.

The total variance explained is the percentage of variance in the measuring construct that can be explained by each item of competence. The competency, which consists of 37 items, is categorized into 9 components as contained in the 9 indicators in the research instrument. From the initial eigenvalues column in the cumulative sub-column, it can be seen that reducing 37 items to 1 factor can explain 31.631% of the variance, reducing to 2 factors explains 47.684% of the variance, and reducing to 9 factors can explain 93.917% of the competencies needed by the construction industry. The results of the instrument reliability test are shown in Table 6.

Table 6. Results of Construct Reliability on Competency Items

Aspect of Competency	Total Items	CA >0.70	AVE >0.50	CR >0.70
Basic Knowledge (BK)	6		0.542	0.865
Work Skills (WS)	21	0.916	0.543	0.959
Personallty (PS)	10		0.576	0.930

Overall, the instrument items consisting of 37 competencies have a good reliability value based on Cronbach's Alpha value of 0.916 (>0.70). The cut-off value for the recommended AVE test is >0.50. The AVE value indicates that the variance of the indicators extracted by the latent construct is greater than the error variance. The calculation results show that the AVE value of each competency aspect is 0.542; 0.543; and 0.576. So that 37 items of reliable competence converge to determine the competencies.

Then the value of construct reliability is intended to measure a variable that has good composite reliability on all items of competence. The construct reliability test value is accepted if the value is >0.70. The calculation results show that the CR value of each competency aspect is 0.865; 0.959; and 0.930. The value of construct reliability of the three aspects of competence is >0.7, so the items of competence have good internal consistency.

This study focuses on the competencies contained in the learning outcomes of the VHS curriculum in the civil engineering department with the problem being studied is the relevance of the competencies provided in schools to those required by the construction service industry. Based on data collection that has been carried out at the construction service company where the graduate works, data is obtained regarding the competencies required by the construction service industry. Data collection was carried out using closed questionnaires containing data on learning achievement competencies for civil engineering graduates.

After testing the validity and reliability of the instrument against 37 appropriate competency items, then the percentage relevance of competence is calculated based on an assessment by engineering experts in the field of building construction in 15 construction service companies. From the data that has been obtained as described in the data description, then the data is calculated using the formula for calculating the level of relevance to the needs of the construction service industry. The results of measuring the relevance of competence are shown in Figures 2 to 4.

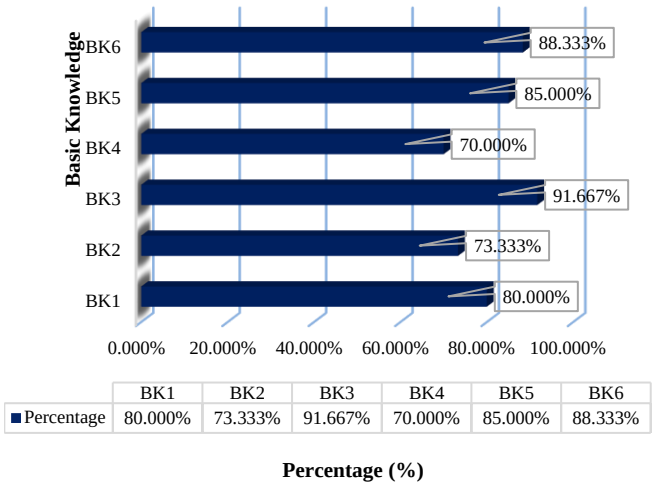

Figure 2. The Relevance Level of Basic Knowledge (BK)

The Basic Knowledge (BK) aspect in shows the results of the analysis of the relevance level of the basic knowledge aspect consisting of 6 competency items in the VHS curriculum at the civil engineering department. Where the results are very relevant of the construction industry with an average percentage of 81,389%. In general, the basic knowledge aspect is dominated by the competence to be able to read and understand working drawings (BK3) which has a high level of relevance (91.667%). Furthermore, there are three competencies in the relevant category (≤81.25%) namely understanding the Work Plan and Conditions for building construction work (BK4), being able to carry out building construction work with an environmental perspective (BK2), and being able to carry out K3 procedures in the implementation of building construction work (BK1).

Several items of competence on aspects of basic knowledge resemble and agree with the results of research conducted by Daryono et al. (2020) and Wijayanti & Jaedun (2019). The competence of being able to carry out K3 procedures in the implementation of building construction work (BK1) has a relevant category, but research by Daryono et al. (2020) is in a very relevant category. This is not too significant difference in the results of categorization in the level of need by construction industry standards, so it can be implemented in schools. In contrast to research by Wijayanti & Jaedun (2019), the results are quite relevant to the basic knowledge aspect. This study recommends that this basic knowledge is needed by graduate standards to be able to work in workplaces such as the

construction industry. Competencies that must be mastered by students include understanding the Work Plan and Conditions for building construction work (BK4), being able to use AutoCAD and Sketch Up application programs for work to make working drawings (BK5), being able to use Excel application programs to costs estimation (BK6), able to carry out building construction work (BK2), and working drawings (BK3).

The Work Skills (WS) aspect in Figure 3 shows the results of the analysis of the level of competence relevance of the work skills aspect which consists of 21 items of competence in the VHS curriculum in the civil engineering department. Where the results are in the category relevant to the needs of the construction service industry with an average of 76.825%. In general, the aspect of work skills is dominated by competencies that get 86.667%, namely being able to draw building interior designs (WS13), being able to calculate the estimated cost of implementing building construction work (WS18), making time schedules and S curves for the implementation of building construction work (WS21). Furthermore, there are three competencies in the relevant category (≤81.25%) with the acquisition of 65.00%, namely making technical documents for bridge construction work (WS12).

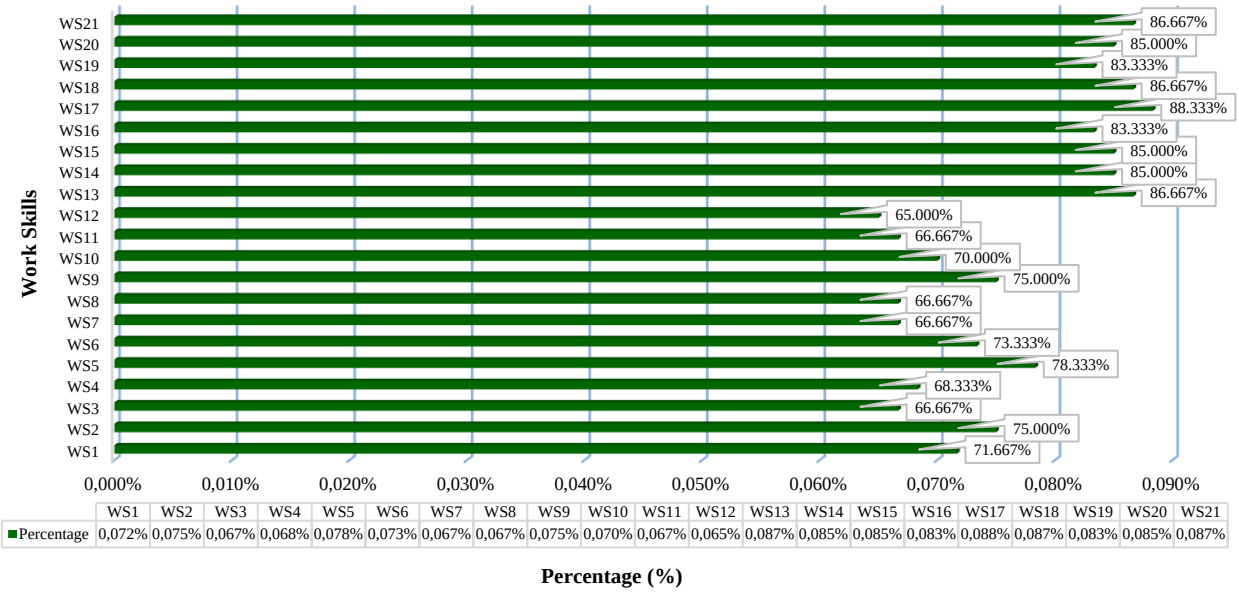

Figure 3. The Relevance Level of Work Skills (WS)

The Personality (PS) aspect in Figure 4 shows the results of the analysis of the level of relevance of the basic knowledge aspect of competence which consists of 10 competency items in the VHS curriculum at the civil engineering department. Where the results are very relevant to the needs of the construction service industry with an average percentage of 89.000%. In general, the personality aspect is dominated by competence having the willingness to cooperate with colleagues in order to achieve project goals (PS10) with 93.333% gains. In this aspect of the assessment, there are competency items according to the recommendations from research results by Camarillo et al. (2020) and Saleh et al. (2019) that some of the determinants for improving personal work skills are the need for good communication. The results of the competency relevance analysis on the indicator of having high self-confidence in communicating have met the category very relevant to the needs of the industry.

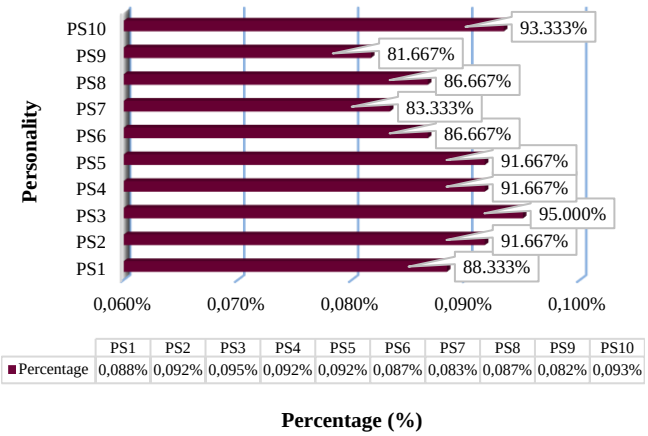

Figure 4. The Relevance Level of Personality (PS)

Furthermore, the competence to easily adapt to the work environment has a level of competency relevance. This is in accordance by Saleh et al. (2019) and Surya & Mulyanti (2020) which concluded that rapid adjustment will help someone in working professionally. Furthermore, competence has the willingness to learn new things related to the work carried out in

accordance with research recommendations by Nurtanto et al. (2020) and Olazaran et al. (2019) that to support work competence also consider creativity and innovation within a person. Therefore, this competence is categorized as very relevant.

The overall competency of graduates in the VHS curriculum at the civil engineering department obtained 80.856% results with relevant categories. Analysis of the data obtained from the average of all aspects of the competency level of relevance, namely aspects of basic knowledge, work skills, and personality. From the average value, it can be interpreted in the category relevant to the needs of the construction industry. These results are a reflection of the percentage of needs of all construction companies to the competency standards of graduates for the civil engineering department in VHS. This can be interpreted that the curriculum used in schools has taken into account the needs of the industry.

It is recommended that the construction industry in the field of implementation participate in paying attention to the learning process in civil engineering vocational schools so that later the competencies taught in the field of implementation. Participate in educating or teaching the competencies industry in the field of implementation when students carry out Industrial Work Practices in the construction industry in the field of implementation so that they can complement each other. In addition, support from the industry of implementation is also very much needed by schools, this is because the latest learning tools and facilities are still limited according to technological developments in the construction industry.

For schools, especially civil engineering vocational schools, the competencies that are taught in schools and are found to be less needed or not needed with the needs of the construction industry in the field of implementation need to be reconsidered by vocational education teachers regarding their implementation. If necessary, these competencies are eliminated or the number of hours reduced so that school hours are not too crowded and can teach other competencies that are more in the field of implementation. Competencies that already have a very high level of need should be further developed both regarding their content and how to convey them. The competency requirements suggested by the construction industry and have not been taught in schools should be taught to match those required by the construction industry and those taught in schools.

4. Conclusion

Based on the results of the research obtained, it can be stated that the competencies that are categorized as quite relevant by the construction service industry need to develop and evaluate competencies that are applied in schools and which should be taught in schools. Competencies that already have a very relevant level of need should be further developed both in terms of their content and the scope of deepening practice material. Because the competency requirements suggested by the industry should be prioritized to be implemented in VHS effectively and efficiently.

Furthermore, support from the construction industry is very much needed by VHS, especially the civil engineering department. This is because the latest learning tools and facilities are still limited in accordance with technological developments in the industry or the world of work. The industry is also expected to be able to teach the competencies needed when students do internships in the world of work so that they can complement each other. So that it can improve the competence of graduates so that more civil engineering students are absorbed to work according to their fields in the world of work in the construction industry.

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