Competency of surveyor in civil engineering

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Abstract. The purpose of this study is to analyse the competency of the surveyor in civil engineering based on Indonesian National Work Competency Standards. This research uses a descriptive qualitative approach with content analysis design. This research was conducted in three Vocational High Schools (VHS) construction and property engineering expertise programs in Jakarta. The results showed there were 28 competencies of the measurers with the content of knowledge, skills and work attitudes based on the Indonesian National Work Competency Standards.

1. Introduction

In fulfilling work competencies in the field of construction, Law No. 2 of 2017 concerning Construction Services states that each construction worker is required to have a Work Competency Certificate stipulated in an Indonesian National Work Competency Standards in accordance with each work position. Indonesian National Work Competency is a formulation of work capabilities that includes aspects of knowledge, skills, and expertise as well as work attitudes that are relevant to the implementation of the assigned tasks and conditions of office [1].

In the world of construction there are several areas of performance needed, such as land surveyors (surveyors) which needed in building construction, bridge construction, or dam construction. A land surveyor job is to determine the physical and topographic characteristic of lands and also to establish the facts as to the boundary position on the ground [2]. Land measurements in building construction work are carried out with a view to getting a shadow about the state of a field or area where a building / construction will be erected.

Based on the Indonesian National Work Competency Standards, surveyors included in the third level, that can be filled by high school graduates such as vocational high school (VHS) [3]. Labor providers require VHS graduates to master the skills needed in the construction industry because there is a demand for competent workforce quality in the construction industry [4–6]. Competence mastery in vocational students is the initial assets and becomes fundamental assets that must be mastered by vocational students in their role as prospective construction workers [7,8]. So that competency mastery can be done by developing competencies in VHS that are in accordance with industry needs (or construction sector) [9–11].
In addition, workers in the construction sector must have certification in accordance with Indonesian National Work Competency Standards. Therefore, the application of Indonesian National Work Competency Standards in schools is expected to be one of the efforts in improving the quality of VHS graduates’ competency in Indonesia Below this is the Competency Unit of the surveyors based on Indonesian National Work Competency Standards.

| No. | Unit code                  | Competency unit                                      |
|-----|----------------------------|-----------------------------------------------------|
| 1.  | M.711000.001.01            | Implementation of Health, Work Safety, and Environment (HSE) |
| 2.  | M.711000.002.01            | Communication in the Measurement Process            |
| 3.  | M.711000.003.01            | Perform Measurement Preparations                    |
| 4.  | M.711000.004.01            | Operate Measurement Equipment                       |
| 5.  | M.711000.005.01            | Situation Mapping                                   |
| 6.  | M.711000.006.01            | Stake Out Measurement                               |
| 7.  | M.711000.007.01            | Evaluate the Results of Measurement Work            |
| 8.  | M.711000.008.01            | Make a Measurement Report                           |

Source: Indonesian national work competency standards no. 49 of 2015.

2. Methods
This study uses a descriptive qualitative approach with a content analysis and research design by comparing competency elements in the Indonesian National Work Competency Standards with basic competencies in the school curriculum, especially in the field of land surveys.

3. Results and discussion
Based on the results of the equation between the Indonesian National Work Competency Standard surveyor competency elements and the Basic Competency Curriculum for Vocational Building Engineering there are 8 competency units that analyzed as follows.

3.1. Competences on implementation of Health, Work Safety, and Environment (HSE)

| Code  | Competence elements                                                                 | Basic competency                                                                 |
|-------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| 001.01| Identification of hazards and risks of the work site                                 | 3.2 Application of the Health, Work Safety, and Environment (HSE) procedure     |
|       |                                                                                     | 4.2 Implementation of the Health, Work Safety, and Environment (HSE) procedure  |
| 001.02| Prepare Health, Work Safety, and Environment (HSE) equipment and supplies            | 3.2 Application of the Health, Work Safety, and Environment (HSE) procedure     |
|       |                                                                                     | 4.2 Implementation of the Health, Work Safety, and Environment (HSE) procedure  |
| 001.03| Use personal protective equipment and health protective equipment in accordance with HSE standards | 3.2 Application of the Health, Work Safety, and Environment (HSE) procedure     |
|       |                                                                                     | 4.2 Implementation of the Health, Work Safety, and Environment (HSE) procedure  |
| 001.04| Check and maintain Personal Protective Equipment and Health Protective Equipment in accordance with standard operating procedures (SOP) | 3.2 Application of the Health, Work Safety, and Environment (HSE) procedure     |
|       |                                                                                     | 4.2 Implementation of the Health, Work Safety, and Environment (HSE) procedure  |
Table 2 shows that there are 4 elements of competences on Implementation of Health, Work Safety, and Environment (HSE). However, this competency does not explain the details of competencies such as Indonesian National Work Competency Standards. Competence with code 001.01 in the table, in line with research in the journal [12–14]. Competences with codes 001.02 and 001.03 in the table, in line with research in the journal [13]. Lastly, competence with code 001.04 in the table, in line with research in the journal [12,13].

3.2. Competences on communication in the measurement process

**Table 3.** Competences on communication in the measurement process and its basic competence in VHS.

| Code   | Competence element                                      | Basic competency |
|--------|---------------------------------------------------------|------------------|
| 002.01 | Recognize the communication system of measurement      | -                |
| 002.02 | Prepare communication equipment in measurement         | -                |
| 002.03 | Use communication equipment in measurements             | -                |

Table 3 shows that there are 3 elements of competence on Communication in the Measurement Process, but the basic competence is not explicitly explained in the basic competency. Thus it can be concluded that the basic competencies in vocational schools are not yet in accordance with the competencies of the Indonesian National Work Competency Standards. While communication skills for the surveyor are needed to support coordination with other parties in the construction process. In addition, communication skills are needed for future career paths [15].

3.3. Competences on perform measurement preparations

**Table 4.** Competences of perform measurement preparation and its basic competence in VHS.

| Code   | Competence element                                      | Basic competency                                      |
|--------|---------------------------------------------------------|-------------------------------------------------------|
| 003.01 | Conduct an initial review (orientation) of the field    | 3.4 Implement simple survey and mapping work procedures. |
|        |                                                         | 4.4 Carry out simple survey and mapping work.          |
| 003.02 | Prepare a daily schedule and weekly schedule based on the master schedule | 3.1 Applying the principles of land measurement techniques. |
|        |                                                         | 4.1 Carry out measurements in accordance with the principles of land measurement. |
| 003.03 | Prepare measurement equipment and assistive devices     | 3.3 Implement operating procedures for types of survey and mapping equipment. |
|        |                                                         | 4.3 Operate survey and mapping equipment.              |

Table 4 above shows that there are 3 elements of Competence on Perform Measurement Preparations. Based on the table 4, Competencies in conducting measurement preparation have been fulfilled, and 5 basic competencies in Vocational High Schools (VHS) also have been applied. The competency element in the measurement preparation work stipulated in the Indonesian National Work Competency Standards is more directed to administrative preparation [16]. The basic competencies listed in the VHS curriculum lead to technical preparation. Therefore, the measurement preparations set out in the Indonesian National Work Competency Standards and VHS curricula are complementary. Competences with codes 003.02 and 003.03 in the table, in line with research in journal [4].
3.4. Competences on operate measurement equipment

Table 5. Competences on operate measurement equipment and its basic competency in VHS.

| Code   | Competence element                                                                 | Basic competency                                                                 |
|--------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| 004.01 | Identify measurement equipment that will be used based on the type of work          | 3.3 Implement operating procedures for types of survey and mapping equipment.     |
| 004.02 | Recognize all parts of the equipment and each function                             | 3.3 Operate survey and mapping equipment.                                        |
| 004.03 | Validate all measuring equipment for the appropriateness of the equipment to be used | 3.6 Implement operating procedures for types of survey and mapping equipment.     |
|        |                                                                                    | 4.6. Operate survey and mapping equipment.                                       |
| 004.04 | Conduct measurement equipment correction from errors when validating measurement equipment | 3.6 Apply maintenance techniques and optical type checking.                        |
|        |                                                                                    | 4.6 Perform maintenance and checking of optical type devices.                     |
| 004.05 | Report the measurement equipment calibration conditions                             | 3.6 Apply maintenance techniques and optical type checking.                        |
|        |                                                                                    | 4.6 Perform maintenance and checking of optical type devices.                     |
| 004.06 | Perform maintenance of measurement equipment and accessories                        | 3.6 Apply maintenance techniques and optical type checking.                        |
|        |                                                                                    | 4.6. Perform maintenance and checking of optical type devices.                     |

Table 5 shows that there are 6 elements of Operate Measurement Equipment competences. These competences are important, because level 2 surveyors must be mastered the measurement equipment correctly and appropriately. In order to operate measurement equipment, surveyors need to master a number of commonly used measuring devices, such as: water pass, theodolite (digital and manual), and the total station. Competences with codes 004.01 through 004.05 in the table, are in line with research in the journal [4].

3.5. Competences on situational mapping

Table 6. Competence on situational mapping and its basic competency in VHS.

| Code   | Competence element                                                                 | Basic competency                                                                 |
|--------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| 005.01 | Take measurements of the horizontal base framework (polygon)                       | 3.5 Apply the operation techniques of flat leveling (leveling) and spacing (theodolite). |
|        |                                                                                    | 4.5 Carry out measurements with flat-level devices (leveling) and space-sink devices (theodolites). |
| 005.02 | Take measurement of the vertical base framework (height difference)                | 3.5 Apply the operation techniques of flat leveling (leveling) and spacing (theodolite). |
|        |                                                                                    | 4.5 Carry out measurements with flat-level devices (leveling) and space-sink devices (theodolites). |
| 005.03 | Take detailed measurements of the situation                                         | 3.5 Apply the operation techniques of flat leveling (leveling) and spacing (theodolite). |
|        |                                                                                    | 4.5 Carry out measurements with flat-level devices (leveling) and space-sink devices (theodolites). |
Table 6 shows that there are 3 elements of Situational Mapping competences. This situation mapping work is very important because graduates are required to have practical abilities in positioning and mapping surveys. Competences with codes 005.01 through 005.03 in the table, are in line with research in the journal [4].

3.6. Competences on stake out measurement

| Code   | Competence element                        | Basic competence                                      |
|--------|-------------------------------------------|-------------------------------------------------------|
| 006.01 | Study the implementation drawings related to stake out | 3.8 Apply measurement and staking out techniques. 4.8 Carry out staking out techniques. |
| 006.02 | Carry out stake out measurements          | 3.8 Apply measurement and staking out techniques. 4.8 Carry out staking out techniques. |
| 006.03 | Check the results of stake out measurements | 3.8 Apply measurement and staking out techniques. 4.8 Carry out staking out techniques. |

Table 7 shows that there are 3 elements of Stake Out Measurement Competences. Pegging / Stake out is moving or transferring the points that exist in the space planning map (earth surface). In the case of stake out measurement work, the surveyor needs to adjust the equipment to be used. Competence with code 006.01 in the table, in line with research in the journal [4,17]. Furthermore, competence with code 006.03 in the table, in line with research in the journal [4].

3.7. Competences on evaluate the results of measurement work

| Code   | Competence element                        | Basic competence                                      |
|--------|-------------------------------------------|-------------------------------------------------------|
| 007.01 | Study the results of previous measurements | 3.9 Analyzing measurement data. 4.9 Make a report on measurement results. |
| 007.02 | Carry out evaluation of measurement results | 3.10 Evaluate measurement results in the form of working drawings for construction work 4.10 Make corrections to the results of measurements in the form of working drawings for construction work. |
| 007.03 | Revise deviations that occur              | 3.10 Evaluate measurement results in the form of working drawings for construction work 4.10 Make corrections to the results of measurements in the form of working drawings for construction work. |

Table 8 above shows that there are 3 elements of Evaluate the Results of Measurement Work Competences and 6 Basic Competences in VHS. That means that the competences on Evaluate the Results of Measurement Work has been fulfilled [18]. Competences with codes 007.01 through 007.03 in the table, in line with research in the journal [4].
3.8. Competences on make a measurement report

Table 9. Make a measurement report unit and basic competence in SMK.

| Code  | Competence element                      | Basic competence                         |
|-------|-----------------------------------------|------------------------------------------|
| 008.01 | Prepare the work of making reports on the measurement results | 3.9 Analyzing measurement data. 4.9 Make a report on Measurement results. |
| 008.02 | Make a measurement equipment report and its completeness | 3.9 Analyzing measurement data. 4.9 Make a report on Measurement results. |
| 008.03 | Make a report on the results of measurement work | 3.9 Analyzing measurement data. 4.9 Make a report on Measurement results. |

In table 9 above shows that there are 3 elements of Competence on Make Measurement Reports. These competences are important because the report that made will be used as a reference for future work and evaluation / clarification of material in case of irregularities. A competence with code 008.01 in the table, in line with research in the journal [17]. Furthermore, competences with codes 008.02 and 008.03 in the table, in line with research in the journal [4].

4. Conclusion

This study provides empirical evidence that there are 28 competency elements in the Indonesian National Work Competency Standards that must be achieved by level 2 workers, in this case vocational high school (VHS) graduates. Overall, these competencies are in accordance with surveyor level 2 competencies. Based on 8 competency units contained in the Indonesian National Work Competency Standards, 7 units have been standardized in VHS and 1 unit that has not been used as a standard in VHS is Communication in the Measurement Process competences.

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