Mine Surveying Competency Needs: Perceptions of Mine Surveyors in Indonesia

Syafril Ramadhon, Dinn Wahyudin, Mohammad Ali

Abstract: ***This study aims to identify various competencies based on mine surveyor perceptions in Indonesia based on their level of education and work experience and to analyze the influence of educational background and work experience on the workers' perceptions about the competencies in the field. The study was conducted using a survey on 156 mine surveyors based on their education level and work experience. The survey was conducted using a questionnaire that has been tested for validity and reliability. Data analysis was performed using descriptive statistics and ANOVA. This study shows that there are significant differences in perceptions of competency, especially for mine surveyors graduating from senior secondary school with those graduating from diploma and undergraduate degrees, while the perceptions of mine surveyors from diploma and undergraduate graduates are not significantly different. From this research also shows that work experience has no significant effect on the mine surveyors' perceptions of competencies.***

Keywords: ***Mine Surveying, Competency Standard, Competency Perceptions***

I. INTRODUCTION

Mine surveying is one of the areas of work that determines the success of mineral and coal mining activities because it provides basic information for efficient management of mining activities and is related to safety aspects [1][2]. Because it is related to work safety aspects, competency authorizations issued by the agency which regulates the definition of competencies based on education and work experience for mine surveyors are needed [1]. This, of course, is a challenge for the Government Authority to issue competency standards to be able to define various competencies that are in line with the needs of industry in the field of mine surveying.

Various jobs in the mine surveying field cannot be separated from the mine surveyor who is in charge of carrying out the activities of measuring, processing and mapping the mine in a mining area [3]. In general, the tasks of mine surveyor consist of positioning mapping control points, mine topographic surveys, display the information by producing the map, staking-out survey, and measurements for mine monitoring deformation [1]. The development of technology has made major changes in the field of mine surveying work, especially on the task of mine surveyors and the survey tools used [2]. The use of Electronic Total Station (ETS); and "3S" technology which stands for Remote Sensing technology, Global Navigation Satellite Systems (GNSS), and Geographic Information Systems (GIS) have been widely used in various jobs in the field of mine surveying [4]. In addition to the 3S technology that is commonly used in the field of mine surveying, there are technologies that are used specifically, such as photogrammetry activities using Unmanned Aerial Vehicle (UAV) for mining topographic mapping activities [5]; also mine progress mapping using the Light Detection and Ranging (LIDAR) method [5]. In answering these challenges, mine surveyors must adapt through various competencies that are in line with the development of these technologies to survive [6].

Human resource management is closely related to the term competency because it gives a framework that can provide guidance to improve employee performance in a variety of specific jobs [7][8]. Competence is a detailed and specific behavior description related to various knowledge, skills, and various other characteristics needed by employees to be effective in carrying out a job [9][10][11][12]. Determination of national competency standards that are implemented nationally serves to provide guidelines for the implementation of all human resource management activities that are consistent in terms of qualification levels, training activities, employee competency assessment activities, performance management, and employee recruitment systems [13][14]. In addition to providing positive impacts on the implementation of human resource management, there are several issues related to the establishment of national competency standards, such as competency standards are generally defined by the authorities developed not based on research [15][16]; and competency standards are less relevant to the needs of the industry [17][18].

The implementation of the competency standard for mine surveying work with the open pit method in Indonesia was implemented nationally in 2009. The competency standard serves as a reference in the preparation of job training programs and preparation of competency test materials. However, these competency standards are indicated to be irrelevant to industry needs because there is no competency level based on education level or work experience. As a result, there is only one competency standard reference for any level of education and the length of work experience of the trainees and the mine surveying field certification. This can be seen based on data from training participants and mine surveying field certification from 2012 to June 2018 issued by the Ministry of Energy and Mineral Resources of the Republic of Indonesia. Out of a total of 405 participants, 263 participants (65%) were senior secondary school (SSS) graduates, 24 participants (6%) were diploma graduates, and 118 participants (29%) were undergraduate. As a result, the training material and competency test material were

Revised Manuscript Received on May15, 2019.
Syafril Ramadhon, Universitas Pendidikan Indonesia
Dinn Wahyudin, Universitas Pendidikan Indonesia
Mohammad Ali, Universitas Pendidikan Indonesia

indicated not in accordance with the competency needs for all workers with various levels of education and work experience in the field.

Based on the issues related to the national competency standards and the gap of mine surveying work competency standards in Indonesia, the problems investigated in this study are formulated into three research questions which is stated as follows: (1) the competencies that are perceived important by mine surveyors in Indonesia based on education levels and work experience; (2) the influence of level education on mine surveyor competency perception; and (3) the influence of work experience on mine surveyor competency perception. Based on the research questions, the purpose of this study is to identify various competencies that are perceived important by mine surveyors in Indonesia in supporting their work based on education levels and work experience. In addition, this study aims to picture the effect of education and work experience on the perception of mine surveyor competencies. The results of the study are expected to provide verification of the mine surveying work competency standards in Indonesia so that it can be a reference in the preparation of various human resource management programs in the field of mine surveying that link and match the needs of the industrial world.

II. METHOD

This research was carried out using a survey method to collect data quantitatively using a questionnaire. The sample in this study consisted of mine surveyors in Indonesia who carried out open-pit mining activities. These subjects were grouped according to their level of education (SSS, diploma, and undergraduate) and work experience (≤ 7 years and > 7 years). The number of samples is 156 respondents, which consisted of 83 SSS graduates (23 respondents with ≤7years experience, and 60 respondents with > 7years experience), 17 diploma graduate (7 respondents with ≤7years experience and 10 respondents with > 7years experience), and 56 undergraduate graduates (38 respondents with ≤7years experience and 18 respondents with >7years experience).

The research instrument used was a structured questionnaire. The questionnaire was developed in two stages. In the first stage, literature reviews from various journals and manual books related to mine surveying were carried out to identify various competencies in the field of mine surveying. Each competency consists of several sub-competencies. These competencies are: establishment of mine surveying control network using Global Navigation Satellite Systems (GNSS), horizontal control network survey, vertical control network survey, mine topographic survey, stake-out survey, mine monitoring deformation survey, photogrammetry surveys using Unmanned Aerial Vehicle (UAV), mine surveying remote sensing application, mine surveying light detection and ranging (LIDAR) application, mine surveying spatial analysis using geographical information systems (GIS), mine surveying report, mine surveying health safety and environment (HSE), and mine surveying office administration. In the second stage, the questionnaires were made based on competency and sub-competencies which were identified using a 5-point Likert-type scale, with the following values of perception of competence: 5 = Very Important; 4 = Important; 3 = Neither; 2 = Unimportant; and 1 = Very Unimportant.

Validity content of the instrument was done through expert judgment. The results showed that the content in the instrument was relevant to what was measured. The validity of the questionnaire was examined by using the correlation analysis between the score of each item and the total score. The result indicated that all items have a favorable validity index. Reliability testing was carried out using the Cronbach Alpha technique using SPSS version 24. The Cronbach Alpha value is 0.984. It can be concluded that the questionnaire is reliable to use in the research.

To analyze the respondents' perceptions of competencies in the mine surveying field, calculations were carried out based on descriptive statistics. To be consistent with the research objectives, competencies that have a mean <3.6 are categorized as unimportant, while those with a mean value of ≥3.6 are categorized as important. To see the effect of level of education and work experience of respondents on the perception of competency mean scores, the analysis was carried out using ANOVA.

III. RESULT

The perceptions of mine surveyor competencies can reflect various competencies that are important in supporting the execution of tasks. The perceived value of mine surveyor competency was obtained from descriptive statistics with a focus on the mean value grouped according to the level of education and work experience. The competencies that have a mean score <3.6 are categorized as unimportant, while those with a mean score of ≥3.6 are categorized as important.

The competencies perceived as important by mine surveyors of SSS graduates with ≤7 years of work experience were mine topographic survey and stake out the survey. In the meantime, the competencies perceived as important by mine surveyors who graduated from SSS with >7 years of work experience were mine topographic survey, stake-out survey, and mine surveying HSE. These results show that mine surveyors graduated from SSS are only given routine technical tasks and are relatively not too complex. As for mine surveyors with > 7 years of work experience, they mentioned the importance of understanding HSE competencies. This indicates that these employees have been given full HSE related responsibilities, while employees with ≤7 years of work experience are only assigned with the responsibility to implement various aspects of HSE in their work. Table 1 provides a list of competencies perceived as important by SSS graduates with ≤7 years and >7 years of work experience.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Table 1: Competencies that are perceived important by SSS graduates

Competency	≤7 Years		>7 Years	
	Mean	SD	Mean	SD
Mine Topographic Survey	4.141	0.699	4.146	0.631
Stake-Out Survey	4.217	0.989	4.213	0.695
Mine Surveying HSE	-	-	3.903	1.059

The competencies that are perceived as important by diploma graduate mine surveyors both with work experience of ≤7 years and > 7 years are relatively the same. They are an establishment of mine surveying control network using GNSS, horizontal control network survey, vertical control network survey, mine topographic survey, stake- out a survey, mine surveying report, mine surveying HSE, and mine surveying office administration. There are two differences in the perception of competency between mine surveyor graduating from a diploma with work experience of ≤7 years and> 7 years in terms of the mine monitoring deformation survey competency and competency of photogrammetry survey using UAV. In terms of the mine monitoring deformation survey competency, the mine surveyor with work experience of ≤7 years perceives the competency is not important, while the mine surveyor with work experience of >7 years perceives important. In terms of the competency of photogrammetry survey using UAV where the mine surveyor with work experience of ≤7 years perceives important, while mine surveyor with work experience> 7 years perceives that competency is not important. Table 2 provides a list of competencies perceived as important by diploma graduates with ≤7 years and >7 years of work experience.

Table 2: Competencies that are perceived important by Diploma graduates

Competency	≤7 Years		>7 Years	
	Mean	SD	Mean	SD
Establishment of Mine Surveying Control Network Using GNSS	4.171	1.186	4.140	0.849
Horizontal Control Network Survey	4.464	0.770	4.650	0.459
Vertical Control Network Survey	3.643	1.600	4.450	0.497
Mine Topographic Survey	4.571	0.535	4.829	0.342
Stake-Out Survey	4.250	1.090	4.675	0.442
Mine Monitoring Deformation Survey			3.800	1.111
Photogrammetry Survey Using UAV	3.873	1.454		
Mine Surveying Report	4.125	1.244	4.438	0.584
Mine Surveying HSE	4.743	0.395	4.760	0.420
Mine Surveying Office Administration	4.117	0.833	4.300	0.379

The competencies that are perceived as important by undergraduate mine surveyor, both with work experience of ≤7 years and> 7 years are also relatively the same. They are an establishment of mine surveying control network using GNSS, horizontal control network survey, vertical control network survey, mine topographic survey, stake-out survey, mine monitoring deformation survey, mine surveying report, mine surveying HSE, and mine surveying office administration. There is also a difference in perceptions between mine surveyors graduating from undergraduate with work experience of ≤7 years and> 7 years related to the competency of mine photogrammetry survey using UAV. The mine surveyor with work experience of ≤7 years perceives this competency as unimportant, while mine surveyor with work experience >7 years perceives it as an important competency. Table 3 provides a list of competencies perceived as important by undergraduate graduates with ≤7 years and >7 years of work experience.

Table 3: Competencies that are perceived important by Undergraduate graduates

Competency	≤7 Years		>7 Years	
	Mean	SD	Mean	SD
Establishment of Mine Surveying Control Network Using GNSS	4.389	0.603	4.489	0.435
Horizontal Control Network Survey	4.382	0.657	4.222	0.593
Vertical Control Network Survey	3.743	1.265	3.681	1.300
Mine Topographic Survey	4.595	0.518	4.611	0.345
Stake-Out Survey	4.539	0.556	4.306	0.949
Mine Monitoring Deformation Survey	4.000	0.900	3.931	1.206
Photogrammetry Survey Using UAV			4.154	1.093
Mine Surveying Report	3.961	0.894	3.931	0.515
Mine Surveying HSE	4.558	0.659	4.656	0.479
Mine Surveying Office Administration	3.850	1.224	4.278	0.566

In general, based on the mean and standard deviation, it appears that the competencies perceived as important by mine surveyors who graduated from SSS differed from mine surveyors with a diploma and undergraduate degrees. The competencies that are perceived as important by mine surveyor graduated from SSS are less than those graduating from diploma and undergraduate degrees. This shows that mine surveyors graduated from diploma and undergraduate degrees are given more duties and responsibilities than mine surveyors graduated from SSS, especially in the application of more complex technologies, and administrative activities.

On the other hand, competencies that are perceived as important by undergraduate mine surveyors are relatively the same as those in diploma graduates' perception. This shows that the graduates of diploma and undergraduate education in the field of mine surveying in Indonesia are considered to have the ability to carry out relatively the same tasks.

Based on the analysis related to the effect of education levels on the respondents' perceptions of mine surveyor competencies using ANOVA showed that at r = 0.05, all competencies had a significance value (p) <0.05, except in stakeout survey competency with p = 0.104. Thus, it can be concluded that the level of education has a statistically significant effect on perceptions of the competency. Through post hock analysis, it was found that the perception of mine surveyor with SSS graduate does not statistically significant from mine surveyor with diploma graduates only in four competencies, namely: Stake out survey (p = 0.365), Remote sensing data application (p = 0.448), mine surveying spatial analysis using GIS (p = 0.099) and LIDAR application data (p = 0.147). As for, the perception of mine surveyor with SSS graduate are statistically significant from mine surveyor with undergraduate graduates in all competencies. On the other hand, the perceptions of competencies of diploma graduates do not statistically significant from the perception of undergraduate graduates on all competencies. On that basis, it can be concluded that the perceptions of competencies of mine surveyors of SSS graduates are significantly different from the perceptions of competency of those mine surveyor of diploma and undergraduate graduates, while the competency perceptions of mine surveyors of diploma graduates are not significantly different from the perceptions of competency of undergraduate graduates.

On the other hand, the results of the analysis related to the influence of work experience on the respondents' perception of mine surveyor competencies using ANOVA showed that at r = 0.05, all competencies had a significance value (p) of > 0.05. Thus, it can be concluded that work experience has no significant effect on the respondents' perceptions of mine surveyor competencies.

A human capital theory states that investment in education has an impact that is directly proportional to the opportunity to get a better job [19][20]. Meanwhile, based on the allocation theory, work is given to employees based on competence, by providing complex work to the most competent employees, while simpler work is given to employees who are not too competent [20]. This is in line with research which states that the level of education is positively related to the completion of tasks in work and tasks that are complex [21]. These theories are used as a reference for many companies by making education as the main indicator of employees' competence in working [22].

Based on the results of the study, SSS graduates tend to be given responsibilities related to field operational tasks that are routinely carried out, while jobs related to work and the use of more complex technologies are given to employees graduating from diploma or undergraduate degrees. This is in line with the allocation theory, where employees who are considered incompetent will not be given complex tasks. This is strengthened by the results of the significance test with the finding that the competencies perceived important in supporting the implementation of tasks by SSS graduates differ significantly from the perceptions of diploma and undergraduate graduates. However, the perception of important competencies of diploma graduates is not significantly different from those mentioned by the undergraduate graduates. These findings indicate that in Indonesia, especially in the field of mine surveying, educational backgrounds, especially between SSS and higher education levels determine the assignment of tasks in jobs and occupations. This is in line with the Human Capital theory that the level of education has an impact on the position and the assignment of tasks at work.

Another factor that can be used as an indicator of employee competency is work experience. This is based on research which indicates work experience as the main source in building competency [23]. With work experience, employees can have expertise that allows them to get more complex tasks or higher positions [24]. Findings related to the influence of respondents' work experience on perceptions of competence show that work experience does not have a significant influence on the respondents' perceptions of mine surveyor competencies. Perceptions of SSS graduates with ≤7 years of work experience are not much different from those of SSS graduates with> 7 years of work experience. Likewise, it also happens to employees graduating from diploma and undergraduate programs. These findings are certainly not in line with several studies which state that work experience is one of the competency indicators that allow workers with certain work experience to get more complex tasks and higher positions. On this basis, it can be concluded that the mine surveyors' competencies in Indonesia are represented by their level of education, not the length of their work experiences.

IV. CONCLUSION

Based on the results found, we can conclude that the perceptions of mine surveyor competencies of SSS graduates differ significantly from mine surveyors with the diploma and undergraduate degrees, while the perception of mine surveyor competencies of diploma and undergraduate graduates is not significantly different. The mine surveyor's level of education has a significant effect on their perceptions of competencies, especially mine surveyors graduated from SSS compared to mine surveyors graduating from diploma and undergraduate degrees. However, the perceptions of diploma and undergraduate mine surveyors are not significantly different. In the meantime, work experience has no significant effect on the perception of mine surveyor competencies for either those from SSS graduates, diploma or undergraduate program.

REFERENCES

1. A. Jarosz, "Mine Surveying," in SME Mining Engineering Handbook, Third., P. Darling, Ed. United States of America: Society For Mining, Metallurgy, and Exploration, Inc., 2011, pp. 731–742.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

2. G. Wang, G. Guo, J. Zha, and B. Liu, "The development process and prospects of mine surveying in China," Applied Mechanics and Materials, vol. 71–78. pp. 1311–1317, 2011.
3. G. Ovesná, H. Staňková, L. Plánka, and A. Wlochová, "The history of mine surveying and mining maps," Geod. Cartogr., vol. 43, no. 3, pp. 118–123, 2017.
4. J. F. Shi, W. D. Song, J. C. Zhang, and D. M. Zhang, "The application of modern surveying technology in mining survey*," J. Coal Sci. Eng., vol. 14, no. 2, pp. 283–286, 2008.
5. Ľ. Kovanič, P. Blišťan, V. Zelizňaková, and J. Palková, "Surveying of open pit mine using low-cost aerial photogrammetry," Lecture Notes in Geoinformation and Cartography, vol. Part F3. pp. 121–129, 2017.
6. D. Allsop and M. Calveley, "Miners' identity and the changing face of the labour process within the UK coal mining industry," Qual. Res. Account. Manag., vol. 6, no. 1/2, pp. 57–69, 2009.
7. R. R. G. Priyadarshini and D. Dave, "Competency-based Training Needs Assessment Model," Manag. Labour Stud., vol. 37, no. 3, pp. 195–207, 2012.
8. A. De Vos, S. De Hauw, and I. Willemse, "An integrative model for competency development in organizations: the Flemish case," Int. J. Hum. Resour. Manag., vol. 26, no. 20, pp. 2543–2568, 2015.
9. R. S. Mansfield, "Building competency models: Approaches for HR professionals," Hum. Resour. Manage., vol. 35, no. 1, pp. 7–18, 1996.
10. M. Ali, "The Use of Professional Development School for Developing Student-teachers Professional Competencies," in Proceeding Computers and Advanced Technology in Education, 2003, pp. 5–18.
11. G. Nybø, "Personnel development for dissolving jobs: Towards a competency-based approach?," Int. J. Hum. Resour. Manag., vol. 15, no. 3, pp. 549–564, 2004.
12. M. Uhm, G. Lee, and B. Jeon, "An analysis of BIM jobs and competencies based on the use of terms in the industry," Autom. Constr., vol. 81, no. March, pp. 67–98, 2017.
13. A. Smith and E. Smith, "The role of training in the development of human resource management in australian organisations," Hum. Resour. Dev. Int., vol. 10, no. 3, pp. 263–279, 2007.
14. K. Terry, C. Stirling, R. Bull, and D. Fassett, "An overview of the ways nurses understand and utilise the existing Australian Competency Standards for Registered Nurses," Collegian, vol. 24, no. 2, pp. 109–116, 2017.
15. T. Packard, "How Competent are Competencies?," Hum. Serv. Organ. Manag. Leadersh. Gov., vol. 38, no. 4, pp. 313–319, 2014.
16. S. Hodge, "After competency-based training: deepening critique, imagining alternatives," Int. J. Train. Res., vol. 14, no. 3, pp. 171–179, 2016.
17. M. Young and K. Conboy, "Contemporary project portfolio management: Reflections on the development of an Australian competency standard for project portfolio management," Int. J. Proj. Manag., vol. 31, no. 8, pp. 1089–1100, 2013.
18. A. Peyvand Robati and D. Singh, "Competencies required by special librarians: An analysis by educational levels," J. Librariansh. Inf. Sci., vol. 45, no. 2, pp. 113–139, 2013.
19. A. Edzes, M. Hamersma, V. Venhorst, and J. van Dijk, "Labour market performance and school careers of low educated graduates," Lett. Spat. Resour. Sci., vol. 8, no. 3, pp. 267–289, 2015.
20. M. Velciu, "Job matching as a new challenge for work performance," Balk. Reg. Conf. Eng. Bus. Educ., vol. 3, no. 1, pp. 14–19, 2017.
21. T. W. H. Ng and D. C. Feldman, "How broadly does education contribute to job performance?," Pers. Psychol., vol. 62, no. 1, pp. 89–134, 2009.
22. G. S. Benson, D. Finegold, and S. Mohrman, "You paid for the skills, now keep them: Tuition-reimbursement and voluntary turnover," Acad. Manag. J., vol. 47, no. 3, pp. 315–333, 2004.
23. S. Paloniemi, "Experience, competence and workplace learning," J. Work. Learn., vol. 18, no. 7–8, pp. 439–450, 2006.
24. B. R. Kotur and S. Anbazhagan, "Education and Work-Experience -Influence on the Performance," IOSR J. Bus. Manag. Ver. III, vol. 16, no. 5, pp. 2319–7668, 2014.