Commercially Valued Technology Products Mapping Developed by Vocational Education Institutions with the Prospect of Getting Patents

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Abstract. This study aims to determine valued commercial technology developed by vocational education institutions to earn patents. This study is a descriptive study with a population of vocational education institutions, including Vocational High Schools (SMK) and vocational higher education institutions with public and private status in Semarang and surrounding. Purposive sampling was used to determine the research sample chosen by SMK and Polytechnic/Academy (state and private), which had technology study programs. Data were gathered by adopting various complementary methods, including questionnaires or questionnaires, direct interviews with sources, observation, and documentation. Quantitative descriptive statistical analysis techniques and qualitative analysis were used to analyze the collected data. The study's findings can be summarized as follows: 1) The majority of middle-level vocational education institutions, in this case, Vocational Schools, have technology goods with commercial value (78.1%), although the majority (94.3%) do not have technology products with commercial value. Although 57.1% of technological products developed, patents have the potential to be patentable. 2) The lack of promotion and marketing was cited by the majority of respondents (95%) as the main barrier to commercializing technological products developed by vocational education institutions; 3) The majority of respondents (71.4%), particularly those from SMK, did not understand how to register a patent or obtain a patent.

Keywords: mapping · technology · vocational · commercial · patent

1 Introduction

Indonesia is now ranked 85th out of 131 nations in the 2020 Global Innovation Index (GII) report (with a score of 26.5). This ranking is still lower than other ASEAN countries

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such as Brunei Darussalam (71), the Philippines (42), Thailand (43), Malaysia (35), and Singapore (8). Compared to the conditions in 2019, the position remains at 85, but the score has dropped from 29.7 to 26.5. The acquisition of a patent is one of the indicators of GII [1].

Until 2018, Indonesia had only 9,754 patent applications, much fewer than developed countries like China (1542,002), the United States (597,141), Japan (313,567), and South Korea (209.992), and other developed countries [2]. This phenomenon suggests an essential link between the purchase of patents and a country's success.

Patents are exclusive rights granted by the government to innovators for their technological inventions [3]. Innovations are inventions that have been implemented and offer economic and social benefits [4]. Thus, a technology developed as a result of innovation should have economic value; in addition to having benefits over similar technologies, it may be used in real life by large and small businesses (SMEs) and the general public. As a result, it should be no surprise that innovation is a critical determinant of a country's economic development [5].

In reality, many technological products have commercial worth but lack patent protection. On the other side, some patents originate from educational institution research but have little or no commercial value. Rationally, a patent should have commercial worth because, according to Law No. 13 of 2016, a patent must be usable in the industry and be novel [3].

There are various reasons why a patent has little or no commercial value, one of which is the inventor's limited capacity to transform the invention into a technological product that can be used in industry.

Vocational education institutes have an advantage over other educational institutions when designing or manufacturing these technology items (general or academic educational institutions). Secondary education levels, mainly Vocational High Schools (SMK), and higher education levels, including polytechnics, academies, and diploma programs at a university, are included. According to their characteristics, vocational education institutions are equipped with infrastructure, equipment, and human resources (HR) who are more skilled in designing and manufacturing technological items, including patentable technology.

With the advantages of vocational education institutions, if a technology is designed from the beginning to produce products with patent value and does not simply accept orders from other parties or duplicate existing products. The production then tends to develop technological products with commercial value with a more significant patent registered.

To date, no accurate statistics on technological goods generated by vocational training institutions that have commercial value (have been sold or utilized by the public) or registered or secured patent rights have been available. In contrast, the number of vocational education institutions is reasonably significant, with 2,468 institutions at the higher education level and 14,234 institutions at the secondary education level [6].

Ozkul [7] has established a patent-based learning technique to boost student learning motivation, which can increase the formation of new ideas that can be copyrighted in universities.

The Directorate General of Higher Education has made efforts to develop patents from universities (academic and vocational universities) through an applied research system. One of the necessary outputs that must be delivered is a patent [8]. As a result, colleges have a high potential for a patent generation. Sunyoto [9] reported that up to 20.78%, or 55 of the 315 research titles conducted by Semarang State Faculty members supported by the Directorate of Research and Community Service (DRPM), have the potential to earn patents. The same procedure has been done at Yogyakarta State University, where 18.89% of research outputs have the potential to be patented but have yet to be registered for various reasons. Understanding the patent registration process, how to create patent paperwork, and cost considerations are just a few of these reasons [10]. In a similar way to academic institutions, vocational universities rely on applying the Tri Dharma of Higher Education [11], which includes conducting research that leads to patents, to improve their professionalism.

It is unknown how many patents are produced by secondary vocational education schools, such as the Vocational High School in this case (SMK). According to the legislation on teacher advancement and available positions, teachers are expected to receive credit points from the primary element, namely carrying out scientific publications and innovative works, beginning in classes IIIc to IVe, according to the legislation on teacher advancement and available positions [12]. However, many teachers are still having trouble obtaining this credit score.

However, a study conducted at vocational schools concluded that obtaining credit scores by inventive work was ineffective [13]. Similar research has been conducted on technology cluster vocational high school teachers, finding that most certified educators have not been consistent in investing in self-development, scientific publications, and innovative work, either individually, in groups, or institutionally [14].

When considering the characteristics, vocational education institutions at both the higher and secondary education levels (Polytechnics, Vocational High Schools), particularly in the technology field, can generate appropriate technology or other technologies that are considered innovative works. These creative works have the potential to be commercially profitable and patentable. Thus, technology mapping in vocational education institutions has dual economic and academic benefits, namely supporting the acceleration of teacher and lecturer promotions and positions. Economic gains are achieved not just by individuals or inventors but also by educational institutions and even by national advancement. This condition is in line with the requirements of patents, which include novelty, creative steps, and industrial applicability [15].

2 Research Method

This study is a descriptive study with the primary goal of characterizing and interpreting objects based on what they are. The research was conducted using both quantitative and qualitative methods, which were translated into several actionable steps, including (1) preparation of research plans, (2) preparation of research instruments, (3) data collection, (4) organization of data collection results, (5) analysis and formulation of data collection results, (6) preparation of reports, (7) seminar results, and (8) writing of final reports and recommendations.

This study demographic is vocational education institutions, which comprise vocational and higher education schools with public and private status in and around Semarang.

There are nine areas of competence in vocational school [16] based on the spectrum of occupational knowledge, with technology and engineering being the most relevant to the objective of this research, given that patents are inventions in the context of technology. Purposive sampling was used to determine the research sample, which was chosen by Vocational Schools and Polytechnics/Academies (state and private) with a study program in technology.

Sources of data in this study consist of:

1) Primary sources, or the critical data sources originating from respondents, such as educational institution leaders and employees such as instructors, lecturers, and education staff. School principals, directors, heads of study programs, heads of laboratories, teachers, lecturers, and related education employees are among the information sources. Secondary sources augment primary data, such as reports or needed documentation from schools, campuses, or other parties to address research questions. Various strategies were utilized to collect the data needed for this investigation, with the methods complementing each other to generate more comprehensive and reliable data.
2) Questionnaires or questionnaires are used to acquire primary data from primary sources.
3) Besides, direct interviews with primary sources or focus group discussions (Focus Group Discussion) were conducted. This strategy is used to complement the information gained through the questionnaire method.
4) Observation, specifically performing field observations to cross-check data or information gathered from questionnaires and interviews.
5) Documentation is accomplished by gathering data from statistical data, activity reports, literature, and other papers relevant to research topics.

The data collected from the questionnaire were examined using quantitative descriptive statistical analysis approaches following the parameters of the studies conducted to see trends in the phenomena. Meanwhile, qualitative data collected through interviews, observations, and document studies were analyzed using interactive model qualitative data analysis techniques that included the following stages: (1) data collection, (2) data reduction, (3) data presentation, and (4) concluding/verification.

3 Results and Discussion

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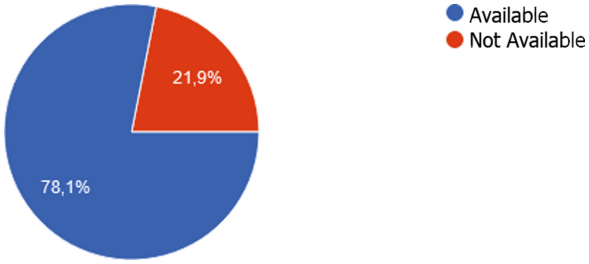

Fig. 1. The number of SMKs with and without commercially valuable items.

The findings suggest that the vocational school status in the production unit ownership in each vocational school is known that as many as 87.5% of vocational schools already have a production unit. In comparison, 12.5% claimed that they do not have a production unit. Furthermore, 51% said their institution had implemented the Teaching Factory initiative, while % said they had not. 71.6% of vocational schools have adopted learning via industrial class programs, whereas 28.4% have not implemented industrial class-based learning. The following explanation describes the analysis results of economically valuable product/technology data and product/technology data with prospective patents.

According to the questionnaire analysis completed by respondents from vocational schools, 78.1% of vocational schools have commercially valuable items. Each vocational school has an average of less than five economically valuable items (5), although there are 3.2% of vocational schools have more than 15 commercially valuable products (>15) (Fig. 1).

In terms of product sales, 60% of the vocational school said they had sold the product to third parties. Furthermore, there is a substantial disparity between the engineering technology vocational schools and other types of vocational schools, such as business management, catering, fashion, and others, based on the number of products that have been successfully marketed. The average number of items sold to third parties in engineering technology vocational schools ranges from 25 to 80 units. Compared to the engineering technology vocational school, the average sales of vocational school products in business management, catering, and fashion can sell 300–20000 units of product with an average total sales value of Rp. 5,000,000 – Rp. 180,000,000, -.

The majority of vocational schools' struggle to commercialize and sell their products. As many as 95% of respondents reported that the lack of a marketing network and a lack of human resources dedicated to selling vocational school products were the most difficult challenges, they faced during the product commercialization process. On the other hand, vocational school products continue to lack consumer trust compared to identical products from manufacturers who already have a brand and a reputation for quality.

Aside from the issue of commercialization and product sales, some vocational schools do not have any commercially valuable items at all. 48% of vocational schools that do not yet have commercially valuable items/technology reported that the most significant barrier to developing commercially valuable products is a lack of vocational

school facilities and infrastructure. A separate barrier is the lack of support for R&D collaboration from other institutions, such as universities or government R&D.

Another barrier to product ownership is a shortage of teachers/HR who focus on generating goods typical of vocational schools. Vocational schools lack economically valuable products/technology due to a lack of training from the government and other organizations.

Most respondents strongly agree that their university generates commercially valuable products/technology. If their vocational school can produce commercially valuable products/technology, 83.8% of respondents strongly agree. Furthermore, respondents (76.3%) strongly agree that if the outcomes of vocational schools produce products/technology that can be sold to the business community, it can generate school income, hence improving the welfare of teachers and employees.

Suppose the vocational school can develop commercially valuable products/technology that can be sold to outsiders (consumers). In that case, the vocational school will instantly acquire the trust of the larger community. This condition will be directly proportionate to public trust in the school's educational quality. However, because it is regarded as creative work, the eventual product/technology will be able to deliver additional benefits. This phenomenon will be able to help teachers' or employees' career growth or promotion/position.

In creating or manufacturing products, 96.2% strongly agree that commercially valuable products/technology can be produced through final student projects fully supported by Production Unit or Teaching Factory activities integrated into the learning process at vocational school. Lecturers and industry partners should guide commercially viable products/technology development and creation.

All responders strongly agree that the vocational schools' production unit and Teaching Factory accept orders from third parties and generate commercially valuable creative products/technology designed by teachers/students. This condition will also improve the quality of the product/technology produced so that the vocational school's product/technology has a good chance of winning various contests e.g., Krenova.

Concerning the issue of human resource quality, 2.3% of vocational schools state that human resources are a difficulty for vocational schools in generating commercially valuable products/technology. Only 29.5% responded that the competency of Vocational High Schools' human resources (HR) today supports the generation of economically significant products/technology. On the other hand, the problem of vocational school's lack of facilities and infrastructure. Besides, the current state of vocational schools has a significant gap between business chamber and industrial partners (systems, facilities, facilities, and infrastructure), which are significant impediments to the development of teacher and student innovation to produce valuable commercial products/technology (Fig. 2).

The findings suggest that 94.3% of the vocational schools claimed that the product/technology had not been registered or had a patent. However, 57.1% felt that vocational schools' products/technology have the potential to be patented (Fig. 3).

The level of expertise and awareness of SMK HR towards patent acquisition is directly related to the ownership of SMK products/technology with prospective patents. There are 28.6% of vocational schools already familiar with and understand patents, but

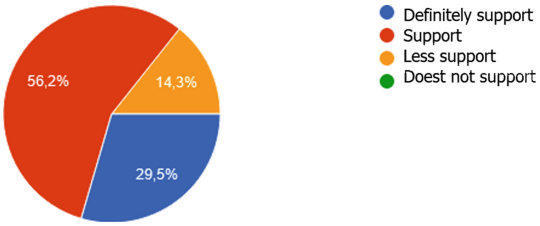

Fig. 2. Support of SMK HR in the development of commercially valuable products/technology

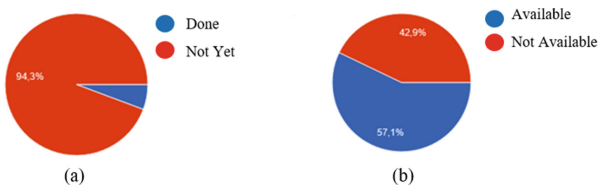

Fig. 3. (a) percentage of vocational school products that have been registered in a Patent; (b) the existence of potentially patented products in vocational school

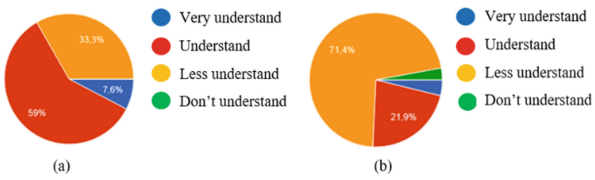

Fig. 4. (a) the number of respondents who understand about patents; (b) respondents who do not understand the flow of patent filing

71.4% are unaware of how to process a patent application, from the application process to get a patent for the product itself. The majority of respondents strongly agree that workshops or training on how to obtain patents are held at the vocational school where they work to be used for filing patents on products with prospective patents (Fig. 4).

Most respondents strongly think that producing a patentable product/technology through a student's Final Project is a good idea. Patentable products/technology can also be developed through Production Unit/Teaching Factory activities. Furthermore, developing patentable products/technology necessitates collaboration with third parties, such as specialists from universities or businesses.

Based on the study's findings, the inputs of vocational school respondents were classified into three categories: 1) elements of facility and infrastructure fulfillment, 2) features of patent socialization and facilitation, and 3) factors of cooperation and human resource development. The following are statements made by SMK respondents:

1) Aspects of Fulfillment of Facilities and Infrastructure

   a. The requirement for the fulfillment of supporting facilities and infrastructure in the development of vocational products/technology as a result of innovations by teachers and vocational students;
   b. Adjustment of facilities and infrastructure to the business chamber and industrial partners' demands;
   c. The demands for high innovation are not comparable to the facilities available in schools;
   d. Limited funding from internal vocational school to produce specific products/technology innovations.

2) Patent Socialization and Facilitation Aspect

   a. Vocational school patent socialization.
   b. The importance of protecting vocational school products/technology;
   c. The importance of patents for teacher/employee career advancement in vocational school;
   d. Periodic facilitation/assistance for patent applications from the beginning until the acquisition of a patent certificate;
   e. Promotion of vocational school products is still very lacking; f. The need for a particular market/online buying and selling platform, specifically for vocational school products;

3) Aspects of Collaboration and Human Resource Development

   a. All parties, including the Education Office, Universities, and Related Ministries, must commit to cooperating in the development of vocational technology products/innovations with commercial value and patentability;
   b. The gap in vocational skills (infrastructure and human resources);
   c. Poor cooperation between vocational schools, business chambers, and industrial partners is necessary to develop human resources regularly.
   d. a lack of technology innovation;
   e. the routine of school learning has taken up much time.

4 Conclusion and Suggestion

4.1 Conclusions

According to the study's findings, it can be concluded as follow:

1) In this case, vocational schools and middle-level vocational education institutions have primarily (78.1%) economically valuable technology products, whereas the remaining 21.9% do not.
2) Most middle-level vocational education institutes, and vocational schools (94.3%), do not have patentable technology goods. According to reports, up to 57.1% of technology goods generated to have the potential to receive patents.

3) The majority of respondents (95%) stated that the most significant barrier to commercializing technology innovations developed by vocational education institutions was a lack of promotion and marketing. Both vocational schools and polytechnics/academics are affected by this.
4) Most respondents (71.4%), particularly those from vocational school, do not comprehend registering or obtaining a patent.
5) Expanding the commercialization of the generated technological products and increased promotion and marketing, improved facilities, human resource capabilities, increased collaboration with other parties, and policy support from the leadership are required.
6) To increase the number of patents owned by vocational education institutions, teachers, lecturers, students, and students must better grasp patents and their registration procedures. This target can be accomplished by socializing or patent workshops at vocational education institutions. Furthermore, patented technology products can be developed through student/student final projects and activities carried out in production units or teaching factories.

4.2 Suggestions

Based on the study's findings, the researcher can make the following recommendations:

1) Further and in-depth study is required to overcome the challenges encountered by vocational education institutions (SMK, Polytechnic/Academy) to overcome the obstacles encountered and the intended expectations to create commercially valuable items and get patents.
2) It is crucial to continue the activities mentioned in conclusion, namely, increasing the promotion and marketing of items manufactured by vocational education institutes.
3) It is necessary to improve teachers', lecturers', students', and students' comprehension of patents and patent registration procedures. This goal can be accomplished by socializing or patent workshops at vocational education institutions.

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