Teachers' Perspectives on the Significance of Patentability for Innovative and Commercially Technological Works: A Study at SMKN 4 Semarang

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ABSTRACT
SMKN 4 Semarang has implemented the teaching factory model, which has created many innovative and commercial technological works with the potential to be patented. This research examines the views of SMKN 4 teachers on the importance of patenting innovative and commercially viable works and how they incorporate the concept of patentability into the school's educational management. Descriptive analysis is used in the study to provide a summary of the teachers' perspectives and to understand the underlying ideas behind incorporating patenting into the school's educational management. The results of the prior knowledge assessment indicate that the respondents have a limited understanding of the importance of patents and the process of obtaining them, as evidenced by their low scores (1.0 and 1.8). On the other hand, they have a better grasp of the idea of patents and the advantages of having a patented product, with higher scores (3.6 and 3.7). Additionally, several components of educational management, such as learning outcomes, the role of teachers, leadership policies, human resources, infrastructure, and collaboration, were essential to be incorporated into the school's educational management.

Keywords: *Teaching Factory Model, Vocational Training, Technological Works, Patentability.*

1. INTRODUCTION

Innovation, commercial, and technological works play a crucial role in modern education as they drive economic growth and development [1]. In an increasingly competitive and technologically advanced world, students must be equipped with the skills and knowledge to bring new products and ideas to market. By incorporating education on innovation and commercial technology products into the curriculum, students can gain a deeper understanding of the processes involved in creating and commercializing new products. Additionally, by learning about the commercialization of technology products, students can better understand the economic and financial aspects of bringing a product to market, which can be valuable in a wide range of careers. Innovation and commercial technology products in education cannot be overstated, as it equips students with the skills and knowledge, they need to thrive in a rapidly changing world [2-4].

Patentability is a critical aspect of commercializing technology products, as it provides legal protection for the inventor's ideas and innovations [5, 6]. A patent gives the inventor exclusive rights to the product for a certain period, preventing others from using or selling the invention without permission. This protection is significant for technology products because it allows inventor to recoup their investment and profits from their ideas and innovations. In addition, a patent can also serve as a valuable marketing tool, as it can be used to demonstrate the uniqueness and value of the technology product to potential customers and investors. Patentability also encourages innovation, incentivizing inventors to develop new ideas and products. Without the ability to protect their ideas and innovations, inventors may be less likely to invest their time and resources into creating new products. In conclusion, patentability plays a crucial role in commercializing technology products. The inventor needs to recoup their investment, protect their ideas, and encourage continued innovation [6-9].

The teaching Factory (TeFa) model is well suited to incorporating patentability education into vocational training, as it provides students with real-world, hands-on experiences in producing technology products [10, 11]. In a teaching factory setting, students learn about the entire process of bringing a technology product to

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market, including the importance of patentability in protecting their ideas and innovations. Additionally, the close collaboration between the vocational school, the university, and the industry in a teaching factory setting allow for the integration of patent education into the curriculum in a way that is relevant, practical, and up-to-date [12-14].

SMKN 4 Semarang is a Vocational High School (SMK) with a 'Center of Excellence' predicate [15] which has the right to receive tertiary assistance from the university. This condition is in line with the regulation from The Ministry of Education, Culture, Research and Technology (Kemdikbudristek) through Regulation No. 165/M/2021 on the Vocational High School Center of Excellence Program [16-18]. The goal is to produce graduates who can work or become entrepreneurs through vocational education. In the program, selected vocational high schools will receive assistance from higher education institutions to meet national education standards, implement links, and match the job market. Besides, conduct in-house training for school principals and teachers, manage and develop the vocational high schools [19, 20], and assist with the use of technology.

The assistance program for vocational high schools by higher education institutions is created to work together and achieve the set goals. The assistance is general and not specific to a particular program, such as the Teaching Factory (TeFa), which is also a national program in the revitalization of vocational high schools [21] as stated in Presidential Instruction No. 9 of 2016 on Revitalization of Vocational High Schools (SMK) [22].

Concerns regarding the existence or lack of patents on innovative and commercial technological works created at SMKN 4 as the implementation of teaching factory practice should be taken seriously. By incorporating patentability education into the curriculum, vocational schools can help students understand the importance of protecting their ideas and innovations, supporting career development, promoting teachers, and increasing the popularity and the school's value.

Based on the aforementioned considerations, this study is aimed to examine SMKN 4 teachers' perspectives on the importance of patentability for innovative and commercial technological works and to understand the challenges and benefits of incorporating patentability on the educational management of the school.

The research questions in this study are:

RQ (1). What are SMKN 4 teachers' perspectives on the significance of patentability for innovative and commercial technological works?

RQ (2). How do SMKN 4 teachers incorporate the concept of patentability into the educational management of the school?

2. LITERATURE REVIEW

2.1. Teaching Factory in Vocational training

The concept of a Teaching Factory is the alignment of manufacturing education and training tailored to the requirements of modern industry. The increasingly complicated demands of the modern industry have driven professionals and academics to create a new vocational education curriculum. Teaching Factory is a form of two-way knowledge communication between academia and industry in real life. Teaching Factory serves as a real-world learning setting for academics and students to develop their abilities and comprehend the real challenges of industrial practice [23-25].

Teaching Factory is an industry-based learning system developed and integrated with production units. This learning system utilizes the production unit to run a business or production process for vocational students. Teaching Factory covers management, production, marketing, and evaluation processes [26].

2.2. Teaching Factory to the Innovative and Commercially Technological Works

The teaching factory model encourages innovation by giving students an extraordinary educational opportunity to blend in-class instruction with practical experience in an industrial environment (Figure 1). Students can work on projects, try out new methods and tools, and hone their analytical abilities. The concept also gives students access to cutting-edge tools, machinery, and equipment, enabling them to develop their technical abilities. Students are encouraged to develop their ideas into actual products, and project-based learning and cooperation with business professionals help build an entrepreneurial attitude. The teaching factory model fosters an innovative environment where students are constantly learning and developing and can use their skills and knowledge to solve problems in the real world [27, 28].

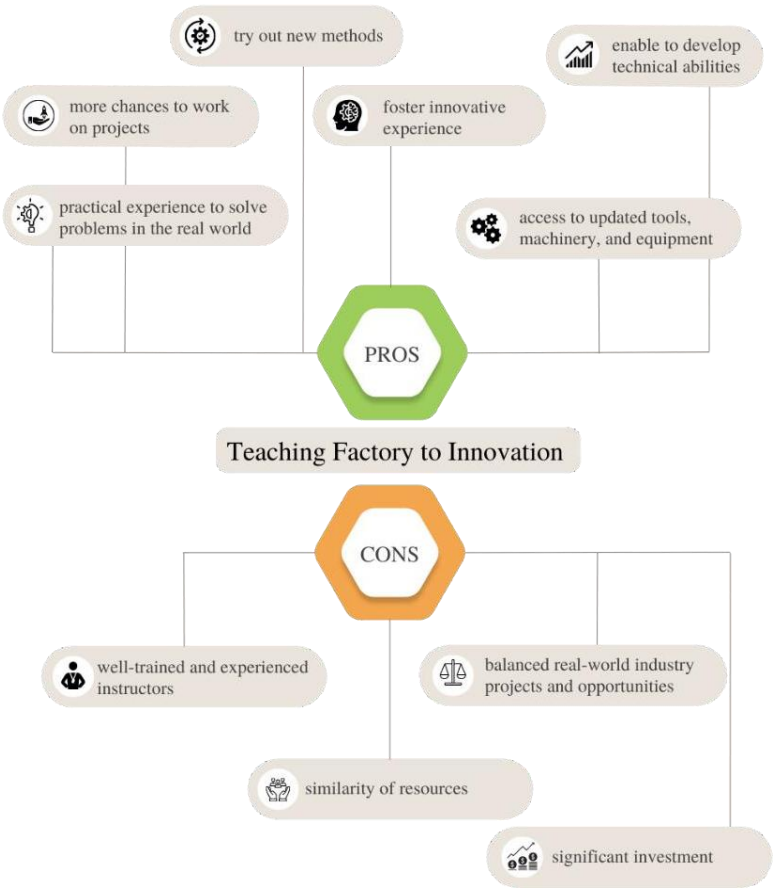

Figure 1. Pros and Cons of Teaching Factory Model to Innovative Outcomes

One of the challenges in using the teaching factory model to achieve innovative outcomes is the need for well-trained and experienced instructors. The model requires teachers to understand industry practices strongly and have a passion for teaching. In addition, access to advanced technologies and equipment is also a challenge, as not all teaching factories have access to the same resources. Another challenge is ensuring that students have access to real-world industry projects and opportunities to work with industry professionals. This condition requires building solid partnerships with local businesses and organizations. Finally, the teaching factory model requires significant infrastructure, equipment, and resource investment, which can be a barrier for some institutions. These challenges must be overcome to effectively integrate the teaching factory model into vocational training and achieve innovative outcomes (Figure 1).

2.3. Patent and Commercially Technological Works

Vocational High Schools (78.1%) in Indonesia have commercial, technological works. Although 57.1% of the schools' technological works are patentable, 94.3% still need patented. Most respondents (95%) said that the main obstacle in commercializing technology products was the need for more promotion and marketing. Most of the respondents (71.4%) also did not understand the procedure for registering or obtaining a patent [29].

President Regulation No. 13, 2016 on Patents states that a patent is an exclusive right given by the state to an inventor for his invention in the field of technology for a specific amount of time, allowing the inventor to carry out the invention themselves or giving permission to other parties to do so [30]. The difference between invention and innovation is that the former refers to an inventor's concept of transforming problem-solving activity in the technology field in the form of a product

or process or improvement and development of a product or process [30, 31].

Implementing patent rights and copyrights in Indonesia is a complex issue with varying opinions. Some studies confirm that the laws and regulations are well-established and enforced [32-34] while leaving room for improvement in the country's protection and enforcement of intellectual property rights [35, 36].

2.4. Teacher's Perspectives

Teachers' perspectives refer to their attitudes, beliefs, values, and experiences that shape their teaching practices and inform how they view their role in education. It encompasses the teacher's views on learning, the curriculum, and their students, their values [37], and life experiences. Teachers' perspectives are influenced by various factors, including their educational background, professional development [38, 39], and cultural and social experiences [40], which can change over time.

There have been significant educational policy and practice recommendations as a consequence of research based on the teacher's perspective [41-43]. These recommendations aim to improve the effectiveness of teaching and learning and address issues such as teacher well-being, workload, and professional development. They are based on thoroughly understanding teachers' experiences, motivations, and challenges.

The findings from research on teachers' perspectives have helped policymakers, and educators better understand the complexities of the teaching profession and the impact of various educational policies and practices on teachers and students. The goal is to create a more supportive and empowering environment for teachers to use their expertise and creativity to inspire and engage their students [44-46].

3. METHODS

3.1. Research Design

A quantitative approach is implemented to explore teachers' perspectives in SMKN 4 Semarang and to gain a deeper understanding of their thoughts and feelings about the significance of technological works' patentability.

3.2. Population

Teachers and school administrators at SMKN 4 Semarang make up the study's population. The leaders and representatives of the normative, flexible, and effective subject instructors at SMKN 4 Semarang make up the research sample. The school's vice principal for student affairs, deputy head for personnel and infrastructure, and the principal made up the leadership team. The school was consulted to select this sample, which included up to 40 research participants.

3.3. Data Collection

This study employed a multi-method approach to gathering data, ensuring a comprehensive and valid understanding by complementing each method. These methods include: (1) questionnaires, which were used to collect primary data through self-administered surveys [47]; (2) direct interviews and Focus Group Discussions (FGD) to supplement the data collected through questionnaires [48]; (3) observations were carried out on the field to validate the information gathered from the questionnaires and interviews; and (4) documentation, which involved collecting data from statistical reports, activity records, literature, and other relevant documents related to the research problem.

There were 21 questions in the questionnaire to assess respondents' opinions on the significance of patentability for innovative and commercial technological works and the incorporation of the concept of patentability into the school's educational management. School education management was viewed through collaboration, learning outcomes, educational management, human resources, leadership policies, and infrastructure.

3.4. Data Analysis

To effectively analyze trends in the components of the study on teachers' perspectives regarding the importance of patent protection for innovative and commercial technological works, the data was collected through questionnaire distribution which is presented in tabulated form, accompanied by graphical and tabular representations.

Descriptive analysis is applied in this study to summarize and describe the main features of teachers' perspectives, to understand its underlying concepts to incorporate patentability on the educational management of the school.

4. RESULTS AND DISCUSSION

4.1. Innovative and Commercially Technological Works in SMKN 4 Semarang

SMKN 4 Semarang, through its implementation of the teaching factory model, has produced numerous innovative and commercial technological works that showcase the school's commitment to fostering

technological advancement and preparing its students for success in the real world.

Participants in the research, teachers and school administrators at SMKN 4 Semarang, believe that technological works owned by the school have a chance of becoming patented. In response to the question about technological works and their potential to be patented at SMKN 4 Semarang. All 40 respondents provided an average score of 4.0 (Table 1), and no single respondent gave another value than 4. Therefore, the respondents' agreement is exceptionally high (100%).

Table 1. Technological works and their potential to be patented at SMKN 4 Semarang (N = 40)

Question		Means	Values Given by Respondents			
			4	3	2	1
X2	In your opinion, are there any technological works owned by SMKN 4 that have the potential to obtain patents?	4.0	40	0	0	0

4.2. Perspectives on the Significance of Patentability

This study measures the teacher's perspective regarding the significance of patentability through several knowledge parameters, which include: (1) the understanding of patents, (2) the urgency of patents, (3) the procedures for obtaining patents, and (4) the benefits of owning a patented product. Table 2 explains the question items on the questionnaire that lead to the intended knowledge parameter.

Table 2. Knowledge parameters on teacher's perspective regarding the significance of patentability

Knowledge Parameters			
Understanding of Patents	Urgency of Patents	Procedures for obtaining patents	Benefits of Owning a Patented Product
X3. To what extent do you understand patents?	X1. Are those SMK's innovative technological works already registered to have patents?	X4. Do you understand the procedure for obtaining a patent?	X7. Do you know that if the teacher produces a patented work, thus it can be counted as an innovative work to be used for career development or promotions?
X6. Do you agree that the SMK where you work produces technological works that can be patented?			X8. Do you know that if SMK produces a patented work, the school's popularity and accreditation value can be increased?
			X9. Do you agree that if an innovative work is patented, it can boost its potential to be commercialized?
			X.14 If the school has patented works, it has a great chance of winning various competitions (eg Krenova, etc.).

An average value is calculated from the responses to the eight questions that assess prior knowledge of the importance of patentability, as shown in Figure 2. Based on the data in Figure 2, respondents need more knowledge regarding the urgency of patents and procedures for obtaining patents. However, respondents

entirely understand the understanding of patents and the benefits of owning a patented product.

Based on the data in Figure 2, respondents need to learn more about the urgency of patents and the procedures for obtaining patents. The low scores are notably 1.0 and 1.8. However, respondents entirely understand the understanding of patents and the benefits of owning a patented product. This phenomenon is demonstrated by the values of 3.6 and 3.7 and is at a higher level.

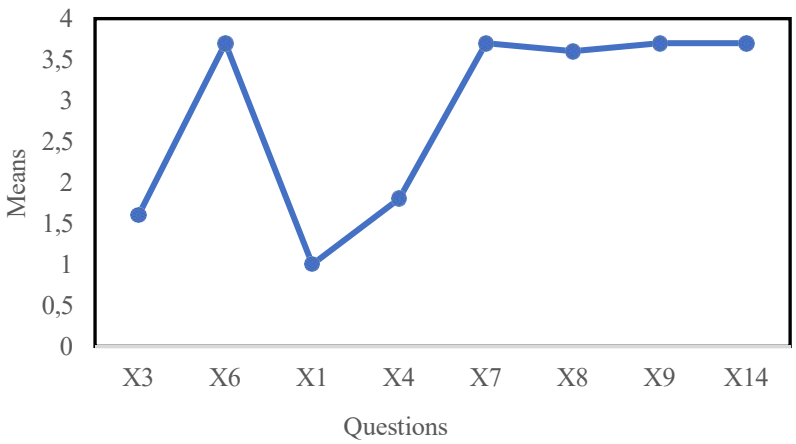

Figure 2. Teachers' perspectives regarding the significance of patentability

It is critical to pay close attention to teachers' low understanding of the significance of registering a patent for innovative commercial and technological works. Based on observation and informal interviews conducted during the study, there were at least four reasons teachers need a greater understanding of the importance of patents.

Many teachers may not have received formal training or education on patents and intellectual property. Furthermore, vocational schools often focus on providing students with practical skills, which may not include information on patent law and intellectual property rights. Additionally, teachers may have yet to gain personal experience with patent law or the process of obtaining a patent, and this makes teachers challenging to understand the urgency of the matter. Then, patent law may not be directly relevant to the subject area that a teacher is teaching, leading to a lower level of interest or understanding. Overall, it is essential for vocational school teachers to understand patent law and intellectual property rights, as it is an essential aspect of innovation and protecting creative ideas.

4.3. Integrating the Concept of Patentability on the Educational Management

Generally, to integrate the concept of patentability into the educational management of a school, some following steps need to be taken. The steps cover; policy development, training, innovation encouragement, collaboration with the related organization, and integration of patent education in the curriculum. Therefore, this study highlights several elements of educational management, such as learning outcomes, the teacher's role, leadership policy, human resources, infrastructure, and collaboration (Figure 3).

Observing from the teachers' perspective, SMKN 4 Semarang can incorporate education on patents and intellectual property into its curricula, making it a regular part of the student's learning experience focusing on learning outcomes and the teacher's role. By concerning the matters, the school may encourage students to engage in innovative thinking and problem-solving by fostering a culture of creativity and encouraging the protection of their ideas through patents.

SMKN 4 Semarang considers developing a policy that outlines the importance of patents and intellectual property and how it affects the school and its students by focusing on leadership policy and improving human resources. Additionally, the teachers view that it is necessary to collaborate with related organizations, like universities, to provide students with opportunities to learn about patents and intellectual property. This collaboration can also provide training and resources.

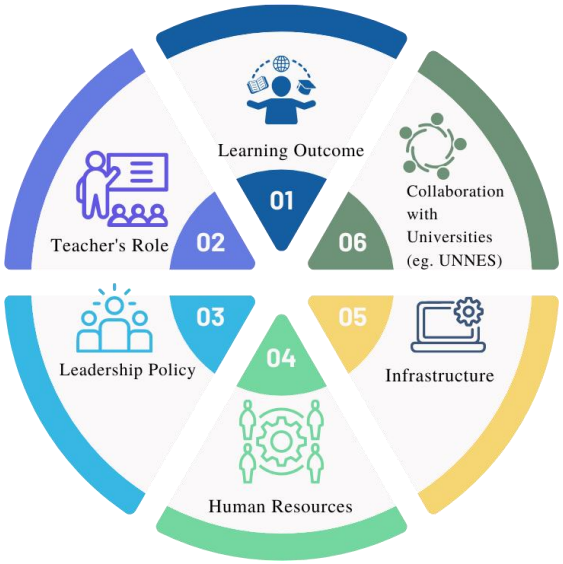

Figure 3. How teachers integrate the concept of patentability into educational management

for teachers to help them better understand the subject of patents and intellectual property, in the form of online resources and workshops.

4.3.1. Learning Outcome

Technological works can be as final student assignments, and this is a form of learning outcome. Consequently, technological works can also be produced during teaching factory practices. Given the value of 3.6 and 3.7 on average, the teachers consider that it is necessary to integrate the design of technological works as learning outcomes and conceptualize teaching factory practices to produce innovative technological works. Based on the data in table 3, the teachers consider it necessary to fix problems regarding learning outcomes to incorporate patent education into school curricula.

Table 3. Teachers' Opinion on Learning Outcome

Question		Means
X10	The patentability of technological works value can be a student's final project.	3.7
X11	Patentability technological works can result from Teaching Factory practices.	3.6

By managing learning outcomes, (1) the education on patents is effectively applied, (2) the school can demonstrate accountability and transparency to stakeholders, including students, parents, and regulatory bodies, and (3) it shows that the school is committed to providing high-quality education. As a result, the education provided can be effective, accountable, and continuously improving.

4.3.2. Teacher's Role

In designing and producing patentable innovative technological works, teachers are expected to act as mentors and partners for their students. Teachers can guide and support students as they navigate the process of designing and producing innovative technological works, helping them overcome challenges and succeed in their projects. By acting as mentors and partners, teachers can encourage students to think creatively and develop innovative ideas that can be protected through patents.

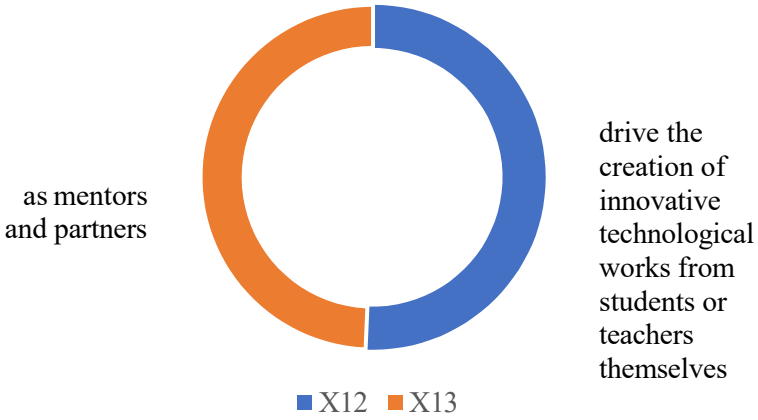

Figure 4. Teachers' opinion on their role in the concept of patentability education

The teachers are also of the view that it is important to ensure that the practice of teaching factory is not only to receive orders from the industry, but also to drive the creation of innovative technological works that can be registered as patents designed by teachers or students at SMKN 4 Semarang.

The questions regarding the two issues are; X12. The teacher should be the students' assistant in designing and manufacturing patentability works, X13. Teaching factory practices should not only accept orders from industries but also drive the creation of innovative works from teachers or students. The respondents give the average of 3.6 and 3.7 values weighing 49% and 51% for both items. This event also signifies positive opinions from teachers.

4.3.3. Leadership Policy

Teachers perceive a leader's crucial role in implementing any program plan, regardless of the circumstances. In addition, the leadership policy has to have the support of all stakeholders in the school, including the faculty, administration, and students. Meanwhile, the teachers also believe there is an adequate support structure for creating inventive works with patentability.

Good leadership policy helps to provide direction and guidance for the integration of patentability into education management, ensuring that all stakeholders understand the goals and objectives of the initiative. Besides, it can help ensure accountability and transparency in integrating patentability into education management, ensuring that all stakeholders are aware of their responsibilities and are held accountable for their actions.

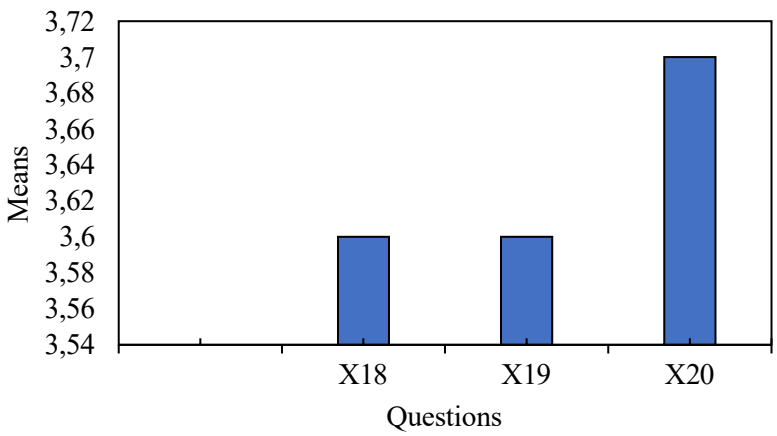

Figure 5. Teachers' opinion on leadership policy

The teachers' viewpoint on the significance of the leadership role in advancing the patentability concept (X19) is shown in Figure 5. They gave an impressive score of 3.6 on average or 90%. It is similar to their views on the system supporting the concept. However, the teachers emphasized the significance of comprehensive support at 3.7 points on average or 92.5% from all parties, including teachers, academic staff, and students, to the leader to succeed in the integration of patent education.

4.3.4. Human Resources

The teachers agreed that human resources are critical in integrating the concept of patentability into education management. Human resources are crucial in executing and implementing strategies and policies related to intellectual property. They are responsible for communicating the importance of patent protection to teachers, students, and other stakeholders and providing training and support to ensure that patentable innovations are correctly identified and managed. Additionally, they can help foster a culture of innovation and entrepreneurship within the educational institution, encouraging the development of new ideas and technologies. By effectively integrating patentability into education management, institutions can ensure that their innovations are protected, allowing them to derive maximum value from their intellectual property.

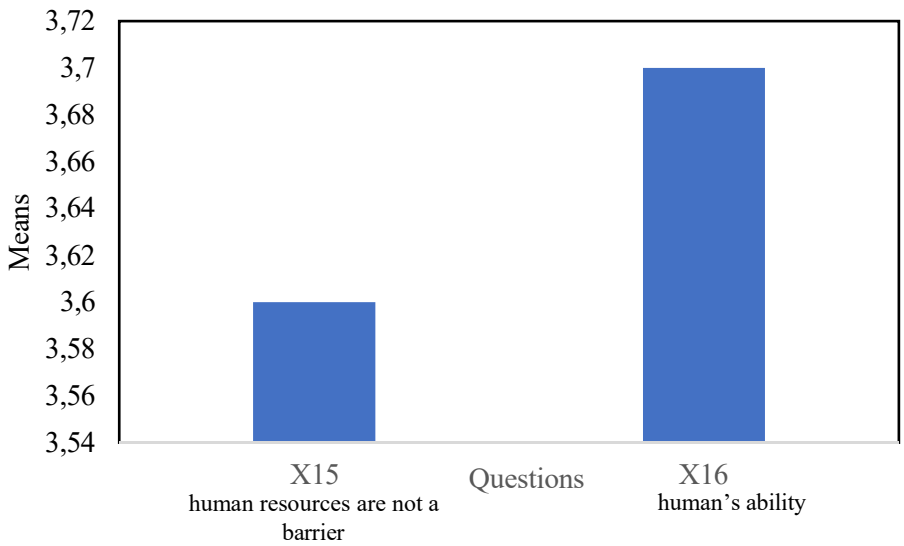

Figure 6. Teachers' opinion on human resources

Teachers may acknowledge that human resources are not a barrier to successfully implementing the concept of patentability into education management through questions X15 and X16. In this instance, the teachers' confidence level is 3.6 on average or 90%. The teachers have more confidence in the human resources' ability to provide quality education, with 3.7 points on average or 92.5%.

Several factors can hamper the success of integrating the concept of patentability into education management caused by human resources, including lack of understanding or knowledge, resistance to change, limited resources, inadequate communication, and lack of incentives. The challenges should be well notified by the school to ensure the successful integration of patentability into education management and maximize the benefits of protecting their intellectual property.

4.3.5. Infrastructure

Infrastructure is essential in integrating the concept of patentability into education management as it provides the necessary framework to implement patentability policies and procedures. Some examples of the necessary infrastructure include information technology, legal support, processes and procedures, training and support, and funding. A well-developed infrastructure provides the foundation for successfully integrating the concept of patentability into education management, allowing institutions to protect and commercialize their intellectual property effectively.

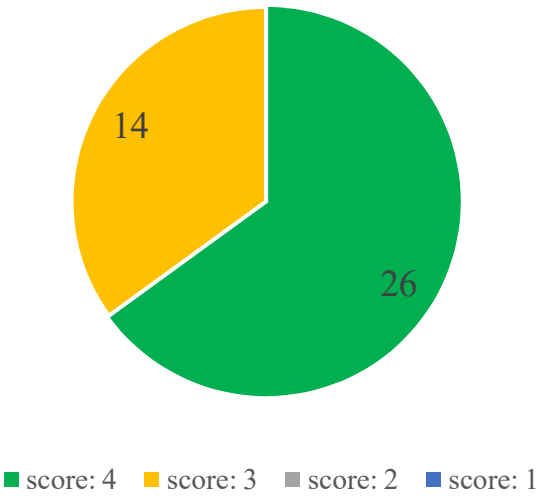

Figure 7. Teachers' opinion on infrastructure at SMKN 4 Semarang

The condition of the facilities and infrastructure owned by SMKN 4 Semarang are currently conducive to patent education (X17). Figure 7 shows that 26 teachers give a relatively high level of trust regarding the availability of infrastructure in supporting the concept of patentability in education management, or 65% of all respondents. Meanwhile, the remaining 14 teachers, or around 35%, provide a lower value (3). All of the respondents are satisfied with the availability of infrastructure at SMKN 4 Semarang. This condition demonstrates the readiness of SMKN 4 Semarang to incorporate the idea of patentability into their education management.

4.3.6. Collaboration with Universities

The concept of collaboration between SMK and universities or other organizations can leverage each other's strengths and resources to improve the process of protecting and commercializing intellectual property. Figure 8 illustrates how the patent process happens in the collaboration of UNNES and SMKN 4 Semarang. At UNNES, patent registration proposals are processed at the Intellectual Property Right Center (Sentra HAKI), which then will be verified at the Faculty level and, more specifically, by the particular Department or Study Program. Meanwhile, SMKN 4 Semarang must be prepared with an expertise program that has the potential to generate technological works. Both convenient systems at UNNES and SMKN 4 Semarang will support the teaching factory practice in producing innovative products that can become income-generating.

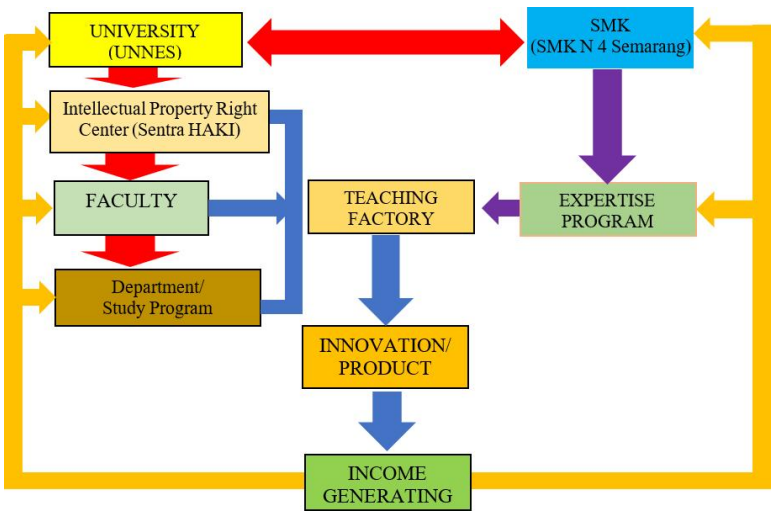

Figure 8. Collaboration model between SMKN 4 Semarang and UNNES

Table 4 shows the average score for this issue, 3.6 points, revealing that the teachers place a high value on collaboration between SMK and universities (X5). The 22 respondents provided a score of 4, and the 18 respondents gave a score of 3. None of the respondents provides a score of 2 or 1. Teachers also recognized the necessity for SMKs to collaborate with other parties, such as the university (X21), like UNNES, to address any available shortcomings or hurdles. Around 67.5% of respondents, or 27 people, gave a score of 4, while about 32.5%, or 13 people, gave a score of 3. None of the respondents rated on this issue provides a score of 2 or 1. This phenomenon demonstrates the teachers' enthusiasm for supporting the collaboration between Vocational Schools and universities.

Table 4. Teachers' opinion on collaboration with universities

Question		Means
X5	Do you agree that SMK (SMKN 4 Semarang) should collaborate with universities (UNNES) to train and assist teachers in obtaining patents?	3.6
X21	To produce patentable works or overcome existing constraints, SMK needs to work with other parties, in this case, universities (UNNES).	3.7

However, both parties (university and SMK) must be aware of factors that hamper the collaboration process. The factors may deal with (1) different priorities and goals between SMK and universities, (2) how the organizational culture works because different organizational cultures can also hinder collaboration and create difficulties in working together effectively, (3) lack of communication which can lead to misunderstandings and mistakes in the collaboration process, (4) limited significant resources such as time, money, and personnel, (5) different regulations between SMK and university may lead to the difficulty to collaborate and share resources.

5. CONCLUSIONS

This study recognizes SMKN 4 teachers' perspectives on the significance of patentability for innovative and commercial technological works and how teachers optimize their prior knowledge about patents into the integration of the patentability concept on the educational management of SMKN 4 Semarang.

Respondents need to gain more knowledge about the urgency of patents and procedures for obtaining patents, as shown by low scores (1.0 and 1.8) in the assessment of prior knowledge. However, they better understand the concept of patents and the benefits of owning a patented product, with higher scores (3.6 and 3.7). This phenomenon is due to a need for formal training or education on patent law and intellectual property rights in vocational schools and teachers' lack of personal experience with the subject. It is essential for vocational school teachers to have a basic understanding of patent law and intellectual property rights to support innovation and protect creative ideas.

Several steps need to be taken to integrate the concept of patentability into school education, including policy development, training, encouragement of innovation, collaboration with related organizations, and integration of patent education into the curriculum. In line with that, this study highlights several elements of educational management, such as learning outcome, teacher's role, leadership policy, human resources, infrastructure, and collaboration. Of the six components, teachers and school administrators believe that all of these parts are highly urgent in incorporating the idea of patentability into educational management. The high level of agreement among respondents falls between the average values of 3.6, or about 90% of respondents, and 3.7, roughly 92.5% of respondents.

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