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U Shield 3 Axis CNC Router Training in Tegal City Metal Group to Improve Machinery Capability

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ABSTRACT

Background: One of the main problems for small and medium industries (IKM) is limited capital. The average workforce is only junior high school graduates so that they lack competence and ability to improve product quality that can only compete at the local level.
Contribution: The improvement of the small and medium industries (IKM) of Tegal City, especially those engaged in the metal sector, is the responsibility of the relevant agencies and universities.
Method: The formulation of the problem taken from this activity is how the training model for the operation of the U Shield 3 axis CNC Router machine is and how the enthusiasm of the participants for this service activity is. The method used is Soft Program and Hard Program.
Results: The results of this training activity showed that participants understood the material presented, especially NC-based machines and its development. They also understood the role of the relevant agencies in the progress of the metal industry in Tegal City. In addition, the participants could practice the machine well, and the enthusiasm for this training was very good. It was proven by their desire so that activities like this could be carried out again, specifically discussing image design training.
Conclusion: This activity can establish cooperation between universities, small and medium industries, and the Department of Industry and Trade of the City of Tegal.

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INTRODUCTION

Tegal is Kota Bahari (a maritime city) with an area of 87.60 km^2. It has many shipbuilding industries. The boundaries of the city of Tegal are Brebes Regency in the west, Tegal Regency in the south, and Pemalang Regency in the east [1]. Besides, Kota Bahari, Tegal is also known as the Japanese of Indonesia. The nickname is due to the large number of foundry and metalworking industries and many residents that open workshops to process and produce agricultural tools, auto and motorcycle parts up to jewelry [2]. Small and Medium Industry (IKM) is the most important sector for the contribution of the country's gross income, where it is hoped that every year there will be an increase in the number of IKM centers in the regions. There are 4 pillars of a strategic approach in order to increase competitiveness, where it is hoped that small and medium industries will have creativity, innovate technology, and good insight and knowledge. The 4 pillars are [3]:

1. Product development.
2. IKM Center.
3. Restructuring.
4. The growth of new entrepreneurs (IKM).

Based on research, one of the main problems faced by micro, small, and medium enterprises is limited capital that the average workforce is only junior high school graduates so that they have low competence and ability to improve product quality [4]. Then, [5] in the study to identify the problems of micro, small, and medium enterprises, there are low quality of human resources, traditionally-managed business, and products that can only be competent in the local field.

Increasing creativity, innovating technology and having good insight and knowledge in small and medium industries (IKM) in the metal sector of Tegal City are the obligations and responsibilities of the relevant agencies and universities. The work program of the Tegal City Industry Service to advance the knowledge and skills of the IKM human resources continues to be encouraged, in synergy with the Pancasakti University of Tegal. There are so many technologies that are produced by academics but only as a beacon, and have no impact yet to IKM. Aspects of knowledge, attitudes and skills must be possessed by IKM human resources because the demands of the market and consumers are so high in productivity, ability of human resources, and quality products [6]. This strategy to increase the capacity of human resources can be done by creating a partnership program between metal producers on a national scale and metal IKM entrepreneurs in Tegal City [7], or it could be through collaborative trainings between universities-IKM and the local government. The Tegal City government's attention to the enhancement of the competitiveness of the metal industry is massive, because the Regional Government has procured CAD and NC-based machine tools, where it is hoped that the use of the latest NC-based machine methods can replace the old method that uses manual skills and simple equipment [8]. However, many of the human resources of the small and medium metal industries in Tegal City are not quite ready to operate these NC-based machines because of its high technology and they have not mastered it. One of the NC-based machine technologies, namely the U shield 3 axis router machine, was developed by lecturers and students from the mechanical engineering study program, Faculty of Engineering and Computer Science, Pancasakti University Tegal. The machine was assembled and made by the academic community themselves. The specifications of the U Shield 3 axis router machine are that it uses the TB6600 motor driver with Match3 driving software, and has been applied for pocketing [9].

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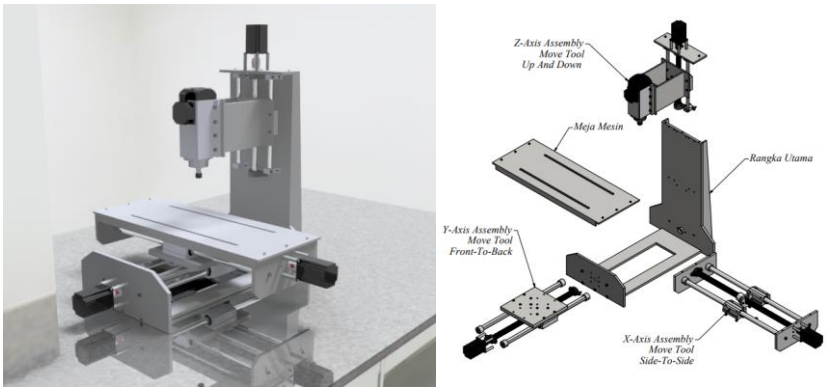

Figure 1. U Shield 3 axis CNC Router Machine [10].

Based on the problems described above, the formulation of the problems in this community service program consisting of:

a. How is the training model for the metal entrepreneur group on the operation of the 3 axis U Shiled CNC Router machine in Tegal City?
b. How is the participants' enthusiasm for the operation of the 3 axis CNC Router U Shiled 3 axis machine training activity?

The purpose of holding this community service activity is hoped that the small and medium industries of Tegal City engaged in the metal sector will increase their understanding of the operation of CNC and some supporting software and establish good cooperation between universities and small and medium industries.

METHOD

The method adopted by the community service activities is by training the operation of wood lathes on the target group Usaha Jati Murni Sekuro Village [11]. The stages of implementing this program are as follows:

a. Problem Identification.
   In implementing the community service program, planning is needed by identifying the problems of the Tegal City metal entrepreneur group. Problem identification is based on interviews with the head of the metal group in Tegal City and also interviews with the Department of Industry. The results of the problem identification are:
   1. Existing machines based on electric motors are not yet based on computerization (NC).
   2. Human resources owned by metal entrepreneurs in Tegal City only graduated from junior high school and vocational high school.
   3. Knowledge of machine operators/employees regarding NC-based machines is still low.
b. Solution
   Based on the identification of the problem, there are two solutions offered, namely Hard Program and Soft Program:
   1. Hard Program is an operational training of the U Shield 3 axis CNC Router machine.
   2. Soft Program is an explanation of teaching materials including socialization of activities and providing material about NC-based machines and their development.

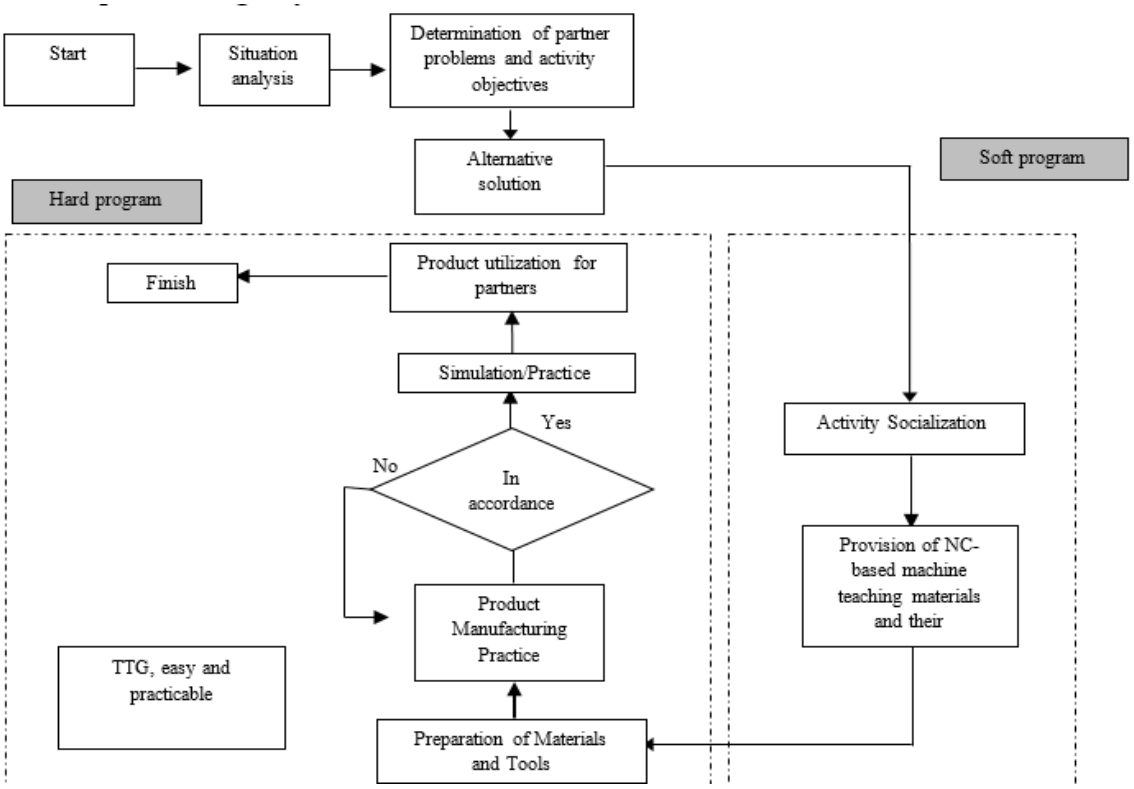

Figure 2. Program Implementation Method.

RESULTS AND DISCUSSION

Product Design and Simulation using CAD-CAM

The stages of making a product that will be made using CAD-CAM are described in the following steps :

a. First is to open the Inventor software to create an HP casing design.
b. The dimensions of the workpiece are 100 mm long, 50 mm wide and 5 mm thick.

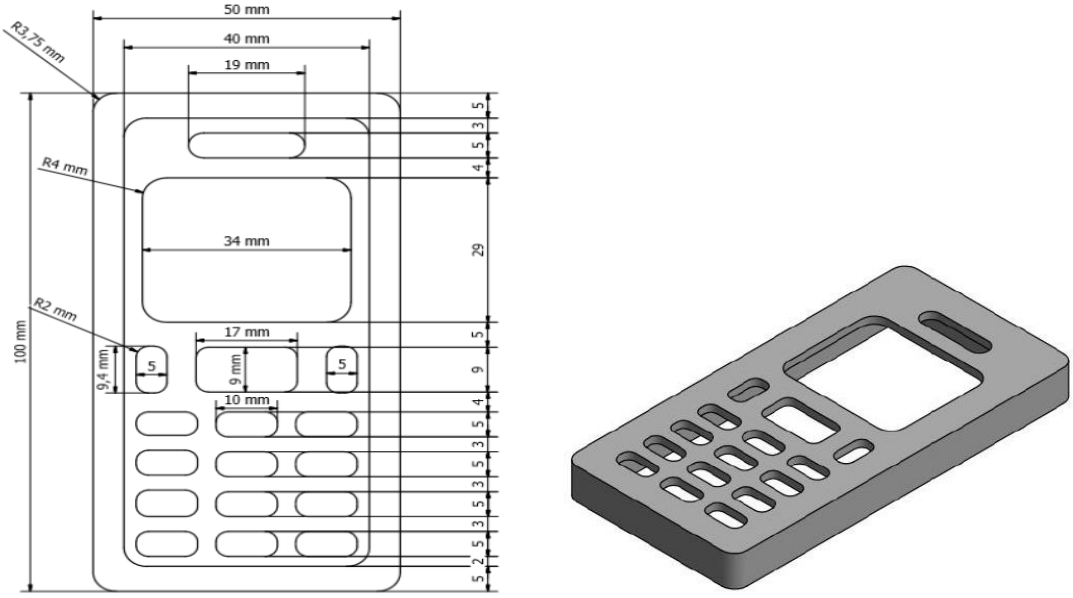

Figure 3. Product design to be made.

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c. The next step is the CAM process for setting and simulating machining. Some things that need to be set are: Workpiece setup, Tool selection, Speed and Feedrate settings, and the Simulation process.

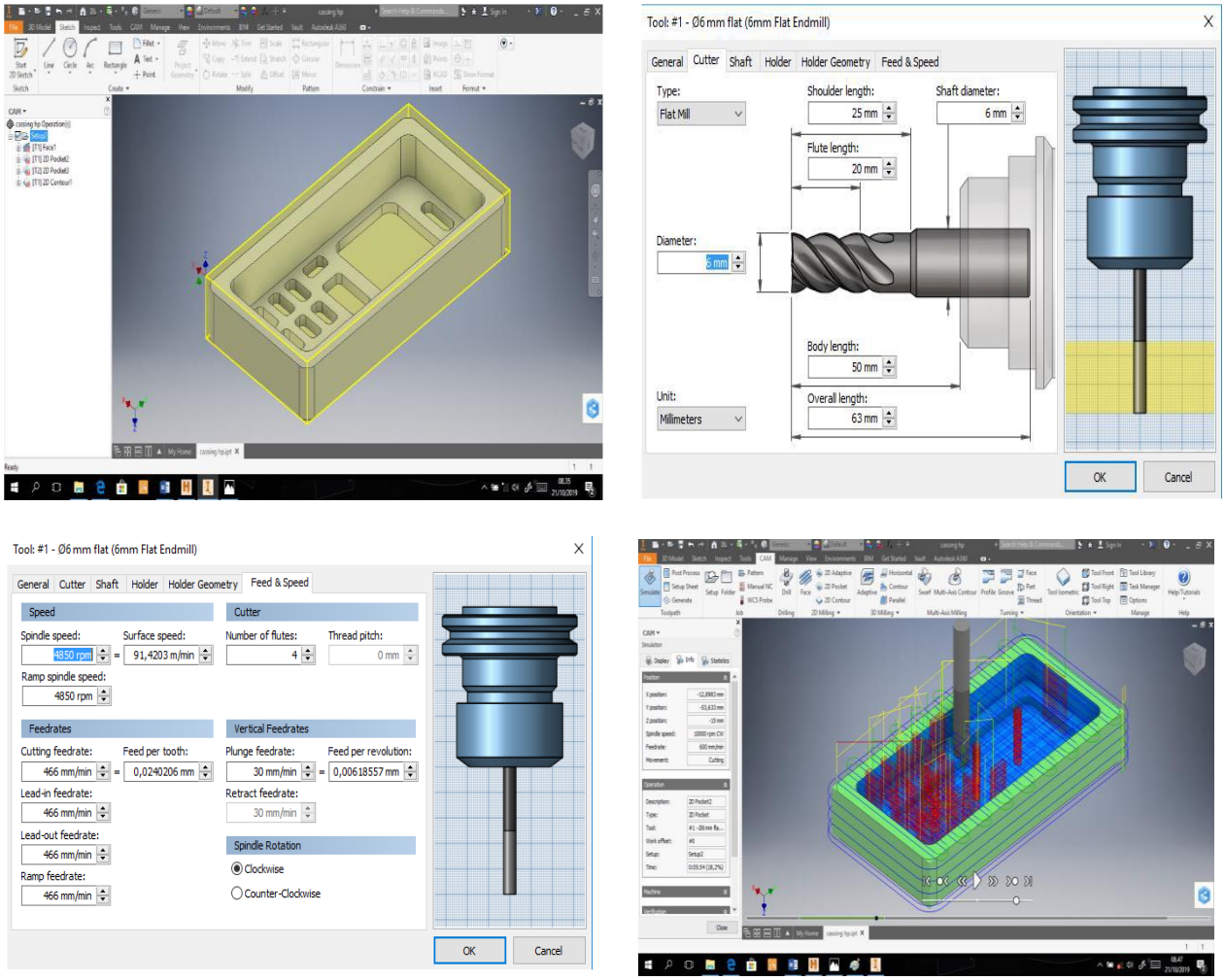

Figure 4. CAM Process.

d. The following step is to transfer the G code from the CAM to the machine using Mach3 software. The stages are as follows: Load G Code, Zero Point setting workpiece, Roughing Process, Pocket Process, Contour Cutting Process, and Finishing.

Figure 5. G Code transfer process and product machining.

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e. The total time required from design to machining is 146 minutes with the following details:

Tabel 1. Total Time Required from Design.

No	Process	Time (menit)
1	Master CAM	15
2	Machine preparation	5
3	Roughing Process	46
4	Machine setting	5
5	Pocket Process	38
6	Machine preparation	5
7	Contour Cutting Process	32
Total time required		**146**

1. The Effectiveness of Operational Training on U Shield 3 axis CNC Router Machines for Metal Entrepreneurs in Tegal City.

In accordance with the flow of activity, the implementation is divided into several stages as follow:

a. Socialization Stage

At this stage, the team coordinates and communicates with related parties regarding the training activities. Coordination and communication are carried out intensively so that activities can take place properly according to the wishes and expectations of the target group. The target group is the metal entrepreneur group of Tegal City with as many as 15 participants, so that they are present in the service activity.

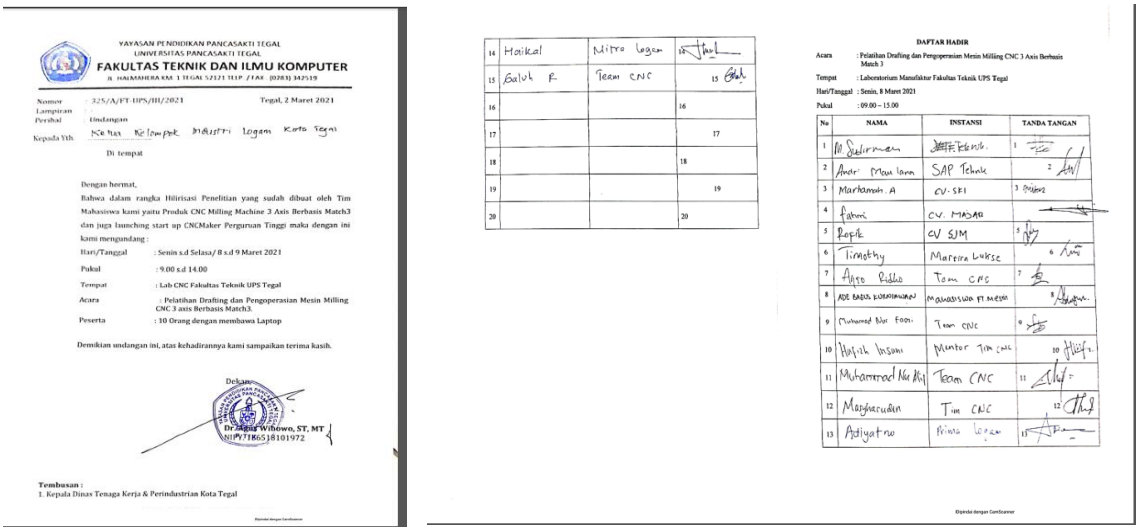

Figure 6. Invitation and attendance list of training for target groups.

b. Providing knowledge about NC-based machines and their development

The second stage is delivering the lesson, which is to explain the knowledge of the development of NC-based machines. The lesson was given orally and images through PowerPoint displays and videos. The materials presented included:

1. Development of small and medium metal industry (IKM) in Tegal City

   This material contains the development and improvement programs for Metal IKM Tegal City from the Department of Industry and Trade. The material was delivered directly by the Head of the Department of Industry and Trade of the City of Tegal to more clearly provide the existing programs at the service for the progress of the Metal IKM Tegal City.

Figure 7. Presentation from the Department of Industry and Trade of the City of Tegal.

2. NC based machines and their development

   This material contains the concept of an NC-based machine and its development. This material introduces supporting software technology for attachment tools for NC-based machine development.

Figure 8. Presentation of NC-based machines.

c. Product Manufacturing Practice

   At this stage, participants are trained on how to make HP casing products using materials that have been prepared. The target group was given design practice in 2D and 3D and machining simulation using supporting software and the practice of using U Shield 3 Axis CNC Router machine.

Evaluation of Training activities

This stage was the evaluation of the implementation of the U Shield 3 axis CNC Router machine training activity using the questionnaire method [12]. It was carried out during practice, namely by looking at the direct conditions of participants doing practice and post-practice evaluation.

During the practice, many of the participants complained about the slow loading of their laptops because they had to install some supporting software. This took time as the technical specifications of the laptops from the participants were different each other. Then, during the practice of making product designs using CAD and machining simulations using CAM, some participants often missed the drawing and simulation steps [14-17]. It was because the

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participants' abilities in understanding technical drawings and understanding of G code were not the same. For the practice of machining the U Shield 3 Axis CNC Router machine, participants did not experience many problems because they had prior understanding of machining [18-20]. The only obstacle experienced by the participants when they first operated the NC-based machine was setting the zero point of the work piece and the tools used.

Post-Activity Evaluation

Post-activity evaluations were carried out to monitor the progress of the target group towards the training, both hard skills and soft skills that have been given. The evaluation was to see the level of success and enthusiasm of participants for this service activity [13]. In the post-activity evaluation, an online questionnaire was given to the participants to see their enthusiasm, understanding, and knowledge about this service program.

Some of the questionnaires given, especially the role of the Department of Industry in Tegal City regarding progress and programs to support Metal entrepreneurs in Tegal City, showed that the role of the Office was related to the good category of metal entrepreneurs in Tegal City. Then, the material delivered by the tutor regarding NC-based machines and their development was also categorized as good by the participants.

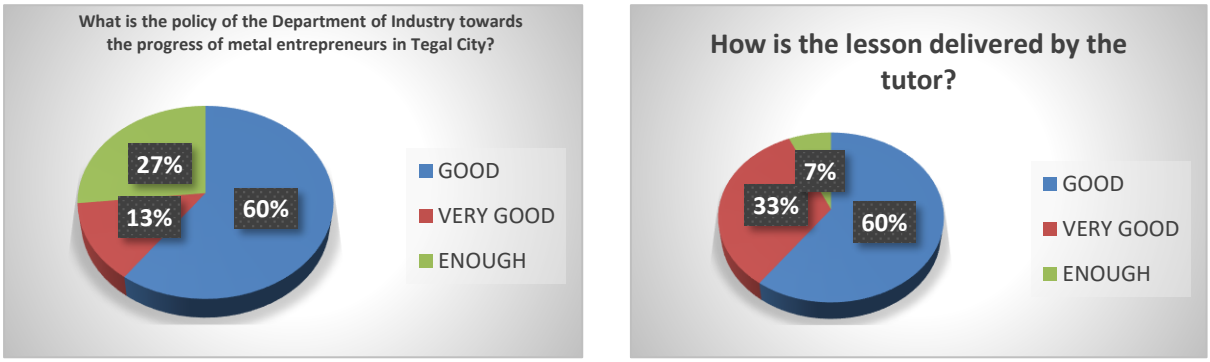

Figure 9. Participants' answers to the lesson and the role of the relevant offices.

Based on the questionnaire regarding the practice of operating the U Shield 3 axis CNC Router machine, many participants answered that the machine was very easy to operate. They answered that training activities like this were very necessary to increase knowledge of NC-based machines.

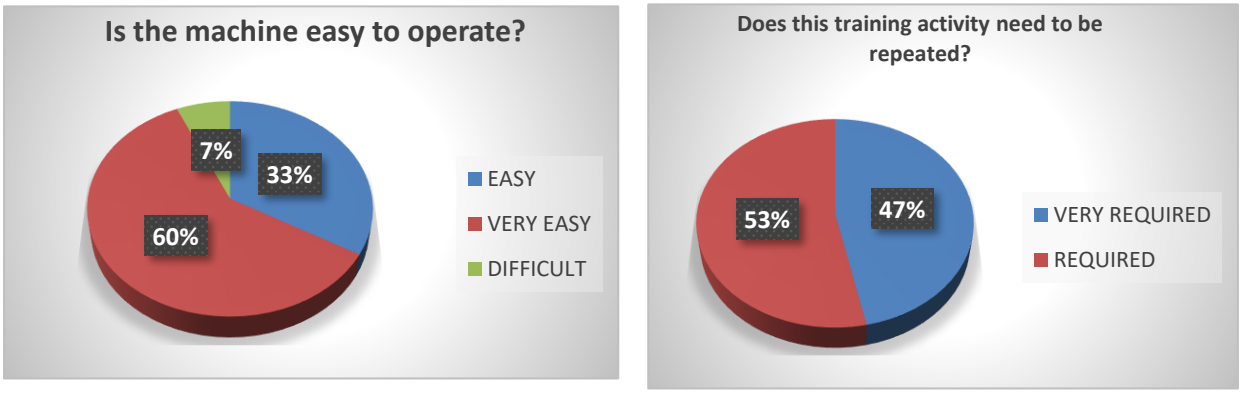

Figure 10. Participants' answers regarding machine operation and training enthusiasm.

CONCLUSION

It can be concluded that the implementation of activities divided into several programs, namely Soft Program and Hard Program. The Soft Program includes the provision of material from the Department of Industry regarding programs from the Regional Government on the progress of metal in Tegal City and material on NC-based machines and their development. While the Hard Program covers the practice of how to make 2D and 3D product designs, machining simulation, G code transfer and machining practice. Evaluation of activities during practice is about the slow loading of laptops from participants whose specifications are not the same. Then, there are still many participants who are left behind in carrying out the design steps to simulation. The post-activity evaluation is that the participants are enthusiastic about the continuation of this service activity. They expect the continuation of this training program but more concentrated on design training or drawings in 2 and 3 dimensions, because many metal entrepreneurs in Tegal City get job sheets from consumers in the form of finished objects that must be redrawn, while the redrawing process usually uses a third party.

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