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THE IMPORTANCE OF INFRASTRUCTURE, FACILITIES AND MANAGEMENT OF THE METAL CASTING WORKSHOP IN THE DEPARTMENT OF MECHANICAL ENGINEERING FT UNNES

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Abstract

The lack of current infrastructure and facilities conditions results in students practicing outside the department and having to spend funds because of the lack of facilities in the metal casting workshop. The purpose of this study is to explain the layout and management of a good workshop as well as data collection of equipment and materials needed. Using descriptive methods. Data collection using questionnaires to students of the Mechanical Engineering Education Study Program class of 2019, interviews with technicians and lecturers of the Department of Mechanical Engineering, observation, and documentation. Analytical techniques used descriptive analysis techniques. The results of the study show that: (1) a good layout is a layout that meets the standards for the size of the practice room infrastructure and in accordance with the purpose and benefits of making the layout, (2) equipment and materials are tailored to the needs of students, (3) good workshop management is an implementation that applies workshop management knowledge well.

Keywords: layout, infrastructure, facilities, management, workshop management, metal casting.

INTRODUCTION

Education is something that must be carried out by all Indonesian citizens (WNI), because through education, academic, non-academic and other knowledge can be transmitted. Given the important role of education for Indonesian citizens, the government provides a compulsory education policy for all Indonesian citizens. This policy is strengthened by the issuance of regulations contained in the Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System, namely "Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation and state." Based on this explanation, in a place (campus) to pursue education as a formal institution for the teaching and learning process, it is necessary to support the success of one's learning in pursuing his education, namely with a good curriculum.

The education system requires a teaching and learning process that pays attention to the needs of students and the activeness of students. Educators must understand the character of students well. Good learning planning can support the success of students in the implementation of the teaching and learning process. The function of the curriculum is as a tool or means used to achieve educational goals of various types of programs organized by the agency. The curriculum applies to all types of activity programs or responsible actors, as well as the media or facilities that support them (Sailor, M. J. G., Alexander, W. M., and Galen, M. A., 2020). To achieve educational goals, it is necessary to have complete infrastructure and facilities to support the curriculum. Specific infrastructure in vocational education as referred to in article 4 paragraph (4) letter b is a practice room, and the facilities as referred to in paragraph (1) consist of: learning materials, learning tools, and equipment. Facilities in vocational education must meet the provisions of one of the types and number of main equipment and supporting equipment in accordance with the concentration of expertise, this is stated in Permendikbud RI Number 22 of 2023. Students can learn well if an educational institution meets all the learning needs of students. Based on this explanation, an educational institution must have adequate infrastructure and facilities, such as in the Mechanical Engineering Department of FT UNNES which has a metal casting workshop to support learning.

The condition of infrastructure and facilities as well as a good management system will have a positive impact on the learning process of metal casting practice. A good workshop must be equipped with various facilities to facilitate workshop users in carrying out their activities. These facilities are in the form of utility facilities (universal) and special facilities (special). Universal facilities are facilities that can be used by all workshop users, for example lighting, ventilation, water, electricity and so on. Special facilities in the form of equipment, for example student desks, lecturer desks, blackboards, equipment cabinets, material holders, PPE equipment holders and others. One of the utilization of facilities and infrastructure on campus is a place to carry out

learning activities in the form of practices, experiments and research studies.

Metal casting is one of the important industrial processes in the manufacture of various products. In carrying out the production process or a job, the SOP (Standard Operating Procedure) must be applied. In order to be able to do work according to the SOP, it is necessary to have training on the work to be done. The training is generally carried out in educational institutions, in the form of worker training bodies or industrial training centers. If the SOP is implemented properly, it will produce products that are not defective, the implemented SOP will provide benefits. One example of the benefits is that it can reduce the level of errors and omissions in carrying out tasks, this is stated in the Regulation of the Minister of Manpower of the Republic of Indonesia No. 5 of 2017 Article 4 concerning the Benefits of SOPs. To support the production process in accordance with the SOP, it is necessary to have quality infrastructure and facilities. The SOP implemented in educational institutions aims to educate and familiarize students to do a good job. In carrying out good work, it needs to be supported by quality infrastructure and facilities. Quality infrastructure and facilities can affect the quality of the products produced. In addition to quality infrastructure and facilities, metal casting workshop management also plays an important role in ensuring quality, effectiveness and efficiency in the product manufacturing process. Quality infrastructure, facilities and management of metal casting workshops can reduce the additional costs of students when practicing. Research on the infrastructure, facilities, and management of the metal casting workshop is an important matter to improve product quality, product manufacturing process efficiency, and support the quality of learning metal casting practice in the Department of Mechanical Engineering, Faculty of Engineering, State University of Semarang. The purpose of this research is to explain the layout and management of a good workshop as well as data collection of equipment and materials needed based on suggestions and input from respondents.

The realization of learning depends on the extent to which education organizers through educational policy analysis outline and identify the facilities and infrastructure that need to be prepared (Firman and Arnyana, 2023). Ni, Wang and Chen (2019) conducted research to produce a new idea to carry out a large amount of production effectively and efficiently by determining systematic layout planning.

The layout of industrial facilities is physically defined as a process for organizing the factors that make up the production system so that it suitably and efficiently meets the strategic objectives of the organization (Perez-Gosende, Mula and Madronero, 2021). According to Zhang, et al. (2021), a workshop must be neatly organized and directed, especially the layout of worker traffic routes. Evacuation routes are vital in the event of an emergency. The design and layout of the evacuation route and the location of the route need to be properly calculated, so that the evacuation efficiency is significantly improved.

Bwala (2020) stated that insufficiently available and moderately functioning modern tools, equipment, and work machines for metal engineering student practice are contributing factors to the low performance and practical skills demonstrated. It aims to produce qualified and competent Metal Technology graduates with the support of educational institution facilities and infrastructure that meet the curriculum requirements. Nepal (2016) by facilitating the support of infrastructure and facilities can create an effective learning environment. School practices, management, utilization, and planning can contribute greatly to student learning outcomes.

Xu, Xu and Zhou (2020) explained that the importance of workshop management can minimize production costs, minimize the rate of work accidents, and simplify work. The analysis conducted on foundry sites revealed that the factors affecting foundry workshop safety management mainly include educational training, safety input, control of hazardous factors, identification of hidden hazards and security systems.

RESEARCH METHOD

This research uses descriptive research methods with descriptive data analysis. The population in this study were 2019 Mechanical Engineering Education Study Program students, lecturers and technicians of the Mechanical Engineering Department. The data collection techniques used were questionnaires, interviews, observations, and documentation.

The calculation results of the percentage value can be matched with the following assessment criteria table:

Table 1. Assessment Criteria

Total Score (%)	Criteria
20,00 – 36,00	Not good
36,01 – 52,00	Less good
52,01 – 68,00	Good enough
68,01 – 84,00	Good
84,01 – 100	Very good

RESULT AND DISCUSSION

In this study, the questionnaire was distributed to students of the Mechanical Engineering Education Study Program in 2019, obtaining 20 respondents who filled out the questionnaire.

1. *Layout*

Based on the descriptive statistics in the table above, the analysis results show that the number of respondents (count) is 20 students with a total score (sum) of 329, the average score (mean) of 16.45, the middle score (median) of the descriptive statistical data of the layout variable is 16, the score that appears most often (mode) is 14, the range score is 10 with the minimum score is 12 and the maximum score is 22.

Table 2. Statistics of layout variables

Statistics	Value
Mean	16.45
Median	16
Mode	14
Range	10
Minimum	12
Maximum	22
Sum	329
Count	20

If summed up as a whole from 20 respondents who filled out the questionnaire, the calculation is as follows:

$$P = \frac{\sum x}{\sum xi} \times 100\%$$

$$P = \frac{329}{640} \times 100\% = 51\%$$

From the above calculations, a percentage value of 51% can be categorized with the assessment criteria, that the current condition of the metal casting workshop layout is not good or not feasible. The results of the questionnaire show that the layout conditions are less feasible.

The questionnaire results show that the current condition of the metal casting workshop layout is not feasible or has not met the size standards and conformity with the objectives and benefits of the layout. The results of data collection using questionnaires are reinforced by opinions from interviews. According to a source whose name does not want to be mentioned, the current metal casting workshop area is not suitable because it is still divided with other practical places.

Table 3. Broad Indicators of Layout

Criteria	Frequency	Percentage
Not enough	6	86%
Enough	1	14%
Total	7	100%

The table above shows that the highest number of interview respondents 86% answered that the current metal casting workshop layout area is "Not Enough" to meet the standard size of the practice room, and the smallest number 14% answered that the current metal casting workshop layout area is "Enough" to meet the standard size of the practice room. From the observations that have been made regarding the current metal casting workshop area, which is 36 m^2 with a length of 6 m and a width of 6 m. Meanwhile, according to the standard size of the practical room infrastructure, 8 m^2 per learner with a minimum width of 8 m.

In addition to the area that is not sufficient to meet the standard size of the practical room infrastructure, the current layout of the metal casting workshop is also not in accordance with the objectives and benefits of making a layout, this opinion is reinforced by respondents who state that the current layout needs to be arranged/rearranged because it is not in accordance with what should be better.

Table 4. Indicator of Layout Condition

Criteria	Frequency	Percentage
Not enough	5	71%
Enough	2	29%
Total	7	100%

Table 4. shows that the largest number of interview respondents 71% answered that the current condition of the metal casting workshop layout is "Not in accordance" with the purpose and benefits of creating a layout and the smallest number 29% answered that the current condition of the metal casting workshop layout is "In accordance" with the purpose and benefits of creating a layout. From the observations made by researchers regarding the condition of the metal casting workshop layout, it is not in accordance with the objectives and benefits of the layout because the conditions of cleanliness, tidiness, roof, ventilation, drains, electricity, and arrangement of equipment/materials are still not good.

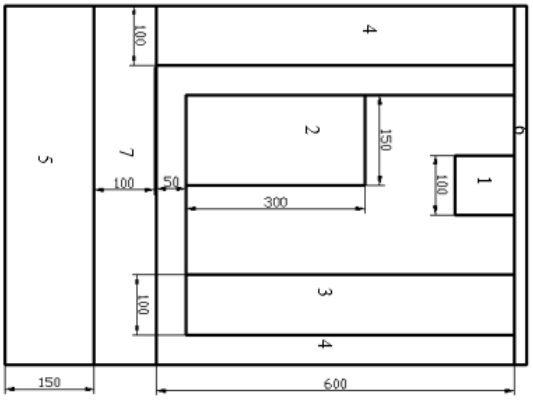

Figure 1. Initial layout

Description:

1 = melting furnace
2 = molding sand
3 = ladder
4 = open waterways
5 = driveway
6 = wall
7 = Briefing area

From the current layout drawing, it is necessary to re-layout. This re-layout adjusts the current layout conditions, namely by adding places that do not yet exist so that the layout conditions become even better. Places that need to be added to the layout drawing are places for cast materials, cast

objects and pouring results. In making a new layout, namely by using the Activity Relationship Chart technique with this simple technique to determine the facility layout plan based on the level of activity relationship. Figure 2. is a relationship map that has been compiled as well as possible as a consideration for making a new layout.

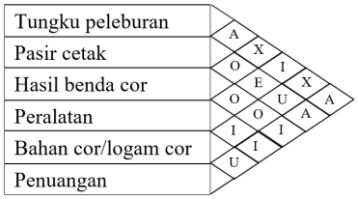

Figure 2. Activity relationship map

Description:
A = Absolutely important
E = Especially important
I = Important
O = Ordinary important
U = Unimportant
X = Undesirable

Making a new layout drawing adapts to the theory that has been presented in chapter two as well as suggestions and input from respondents who have filled out the questionnaire and during interviews. These suggestions include: (1) equipment and other unused objects are stored elsewhere (not in the metal casting workshop), (2) previously open drains, for the new layout the drains are closed, (3) wavy or terraced floors are arranged to be flat, (4) add a place for materials, cast objects, briefing, garbage, and pouring.

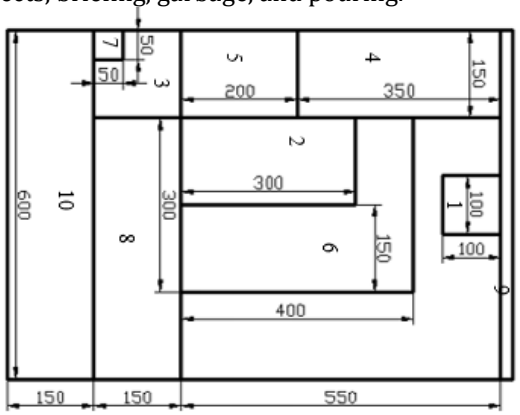

Figure 3. New layout

Description:
1 = melting furnace
2 = molding sand
3 = cast object results
4 = equipment
5 = cast material
6 = pouring
7 = trash can
8 = briefing area
9 = wall
10= driveway

2. Equipment

Table 5. Statistics of Equipment Variables

Statitics	Value
Mean	19.65
Median	20
Mode	20
Range	11
Minimum	14
Maximum	25
Sum	393
Count	20

Based on the descriptive statistics in table 5, the analysis results show that the number of respondents (count) is 20 students with a total score (sum) of 393, the average score (mean) is 19.65, the middle score (median) of the descriptive statistical data of the equipment variable is 20, the score that appears most often (mode) is 20, the score range is 11 with the minimum score is 14 and the maximum score is 25.

If summed up as a whole from 20 respondents who filled out the questionnaire, the calculation is as follows:

$$P = \frac{\sum x}{\sum xi} \times 100\%$$

$$P = \frac{393}{800} \times 100\% = 49\%$$

From the above calculations, a percentage value of 49% can be categorized with the assessment criteria, that the current condition of the metal casting workshop equipment is less complete.

Table 6 shows that the highest number of interview respondents 86% who answered that the completeness of the current metal casting practice equipment was "Incomplete" to meet the needs of metal casting practice and the smallest number 14% who answered that the completeness of the current metal casting practice equipment was "Complete" to meet the needs of metal casting practice. These results, reinforced by the opinions of interview respondents, stated that the current metal casting workshop equipment is lacking when adjusted to the number of students during practicum.

Table 6. Indikacor of Equipment Completeness

Criteria	**Frequency**	**Percentage**
Inclomplete	6	86%
Complete	1	14%
Total	7	100%

According to the results of observations regarding the completeness of the current metal casting practice equipment can be seen in the documentation appendix, with results that can be said to have not met the needs of metal casting practice with observations showing that some equipment is still missing, a small amount which means that it is not enough if 1 rombel is made into 3 groups, so its use must alternate per 1 group with other groups. So that when implementing metal casting practice, in order to maximize the available practice time. Students are encouraged to bring their own equipment by borrowing or buying equipment with a contribution of 1 rombel.

3. Material

Based on the descriptive statistics in table 7, the analysis results show that the number of respondents (count) is 20 students with a total score (sum) of 421, the average score (mean) of 21.05, the middle score (median) of the descriptive statistical data of the material variable is 21.5, the score that appears most often (mode) is 22, the score range is 11 with the minimum score of 14 and the maximum score is 25.

Table 7. Statistics of Material Variables

Statistics	Value
Mean	21.05
Median	21.5
Mode	22
Range	11
Minimum	14
Maximum	25
Sum	421
Count	20

If summed up as a whole from 20 respondents who filled out the questionnaire, the calculation is as follows:

$$P = \frac{\sum x}{\sum xi} \times 100\%$$

$$P = \frac{421}{720} \times 100\% = 58\%$$

From the above calculations, a percentage value of 58% can be categorized with the assessment criteria, that the current condition of the metal casting workshop materials is quite complete. However, according to the opinion of one interview respondent, stating that the current metal casting materials do not meet, because students are told to buy their own materials. The opinion of the interview respondent was reinforced by other respondents who stated that the materials for cast objects, cores and patterns did not exist so they did not meet the needs of metal casting practice.

Table 8. Material Requirement Indicators

Criteria	Frequency	Percentage
Not enough	5	71%
Enough	2	29%
Total	7	100%

Table 8 shows that the highest number of interview respondents 71% who answered that the current metal casting practice materials are "Not Enough" to meet the needs of metal casting practice and the smallest number 29% who answered that the current metal casting practice materials are "Enough" to meet the needs of metal casting practice.

Based on the results of these interviews, further research was conducted by observing the current materials in the metal casting workshop. The observation showed that the current materials for metal casting practice are not complete and do not meet the needs of metal casting practice. The results of observations regarding materials can be seen in the documentation appendix.

4. Manajemen Bengkel

Table 9. Statistics of Workshop Management Variables

Statistics	Value
Mean	26.85
Median	27
Mode	30
Range	12
Minimum	19
Maximum	31
Sum	537
Count	20

Based on the descriptive statistics in table 9, the analysis results show that the number of respondents (count) is 20 students with a total score (sum) of 537, the average score (mean) of 26.85, the middle score (median) of the descriptive statistical data of the workshop management variable is 27, the most frequently occurring score (mode) is 30, the score range is 12 with the minimum score of 19 and the maximum score is 31.

If summed up as a whole from 20 respondents who filled out the questionnaire, the calculation is as follows:

$$P = \frac{\sum x}{\sum xi} \times 100\%$$

$$P = \frac{537}{960} \times 100\% = 56\%$$

From the above calculations, a percentage value of 56% can be categorized with the assessment criteria, that the current condition of workshop management in the metal casting workshop is quite good. These results, in contrast to the opinion of the interview respondents, imply that it is still being pursued, which means that the workshop management is not yet good. This opinion is also corroborated by other interview respondents by stating that the head of the laboratory, technicians and laboratory assistants are still halfway carrying out their duties in accordance with their tupoksinya (main tasks and functions), because the monitoring is not clear, 1 laboratory assistant takes care of 3 to 4 workshops, and not his field of expertise.

Table 10. Indicator running workshop management so far

Criteria	Frequency	Percentage
Not enough	6	86%
Enough	1	14%
Total	7	100%

Table 10 shows that the highest number of interview respondents 86% answered that the management of the metal casting workshop that has been running so far is "Not Good" and the smallest number 14% answered that the management of the

metal casting workshop that has been running so far is "Good".

Table 11. Indicator suitability of tasks with their main objectives and functions

Criteria	Frequency	Percentage
Belum baik	2	29%
Sudah baik	5	71%
Total	7	100%

Table 11 shows that the highest number of interview respondents 71% who answered "Already Good" indicated that the head of the laboratory, technicians and laboratory assistants have carried out their duties in accordance with their main tasks and functions well and the smallest number 14% who answered "Not Well", indicating that the head of the laboratory, technicians and laboratory assistants have not carried out their duties in accordance with their main tasks and functions well.

CONCLUSIONS AND SUGGESTIONS

Conclusions

1. The expected layout recommendations in the metal casting workshop of the Department of Mechanical Engineering, Faculty of Engineering, State University of Semarang are (1) The metal casting workshop room can meet the standard size of the metal casting practice room infrastructure, (2) It does not interfere with the smooth running and avoid potential hazards that threaten health or life safety by rearranging a good layout, (3) The existing waterways should be closed, (4) Each location is given a work station, (5) The available equipment is neatly arranged, adjusted to size and weight, unused items should be removed.
2. Recommendations in the form of equipment data needed in the metal casting workshop of the Department of Mechanical Engineering, Faculty of Engineering, State University of Semarang are equipment cabinets, induction furnaces, sand molds, permanent molds, composite molds, crucibles, metal and wood frames, hand ladles, cups, pattern and core mold making machines/tools, sand pounders (pointed, flat, air pressure), wood molds (woodworking tools), buckets, shovels, hoes, sand scoops/cement scoops/shovels, sand picks, rubber hammers, sand filters/sifters, small brushes,owi lifters, molding boards (molding mats), risers, molding sand levelers, wind sprays, spray bottles, sand buckets, pattern lifters, grinders, files, sandpaper, jigsaws, drills, thermoguns, large pliers (tools for lifting cast objects), chimneys/blowers, presses (or vibrating mode presses), and plastic hammers.
3. Recommendations in the form of data on materials needed in the metal casting workshop of the Department of Mechanical Engineering, Faculty of Engineering, State University of Semarang are parting powder (talc, graphite, and dry silica), silica/quartz sand, aluminum, wood, metal, resin, wax, styrofoam, pepset sand, furan sand, CO2 sand, and croning sand/RCS (Resin Coated Sand).
4. Recommendations for good workshop management in the metal casting workshop of the Department of Mechanical Engineering, Faculty of Engineering, State University of Semarang are (1) The management science must be applied. Each workshop has a workshop head, lab coordinator and lab manager, job desc (with the existence of an organizational structure along with each job description must be clear), inventory (data collection) of equipment recorded in and out and what the future plans are, (2) Created metal casting standards, standardized workshops, safety meets work standards, or in accordance with the metal casting industry, (3) Pay attention to efficiency and productivity in workshop operations, (4) Signs of danger, and more complete regulatory signs, (5) The workshop needs good human resources because it greatly affects the workshop formed. Human resources who understand the management of the workshop in order to create a good workshop, (6) Technicians and laboratory assistants need to have training certificates to obtain the required competencies so that they can help when carrying out tasks in the metal casting workshop.

Suggestion

Based on the above conclusions, the suggestions that can be made are as follows:

1. The researcher then created a picture of the ideal layout.
2. Department managers need to reorganize the layout in accordance with the objectives and benefits of creating a layout or relocation of the metal casting workshop in accordance with the suggestions and input from the interview respondents.
3. Department managers need to procure equipment and materials according to the suggestions and input given by respondents and interview respondents so that practical learning can meet student needs.
4. Metal casting workshop managers need to improve the performance of their human resources by applying their management knowledge based on the interview respondents' suggestions and feedback.

5. For further research to be able to examine the solution of problems related to the analysis of the standardization of metal casting workshops so that the metal casting workshop in the mechanical engineering department of FT UNNES becomes even more feasible.

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