Design of Teaching Factory Practice Tools Concept, Perspective: Operation System on Solar Power Plant

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Abstract

Large-scale of solar power plants will continue to grow, especially in the tropical area. The increasing number of solar power plants required workers who have competence in operating these solar power plants. In order to prepare workers who have the ability to operate the solar power plants, prospective workers can be trained during the study period or in special training.

The purpose of this research was to conceptualized the design of teaching factory practice tools concept by focused on the operating system of a solar power plant. The method used in this research, started with a literature study in order to obtained the information about the system requirements to be design. Then continued with the observation and interviews consecutively. In this study, the observation was made on the "XYZ" solar power plant with a capacity of 21MWp and interviewed to obtained information about the equipment and competencies was needed. Then the concept of a practical tools that meet the required competencies was designed using the Backward Chaining method. The results obtained was a concept design of the practical tools that can describe the operating conditions of a large-scale solar power plant based on Teaching Factory learning method.

Keywords *— Solar Panel, Solar Energy, Learning Method*

1. INTRODUCTION

Electrical energy plays an important role in a country development process [1]. There are many kinds of alternative energy that can be converted into electrical energy [2][3]. One of the alternatives to use the solar energy is to build a Solar Power Plant. In the utilization of Solar Power Plant, there are various systems that can be used. Whether it is built on a small scale or on a large scale, each of them can play a role in the utilization of this energy. The construction of a large centralized Solar Power Plant will make the operation and the maintenance and repair easier [1][4][5].

To support the development of Solar Power Plants, skilled workers are needed to have the competence for development. These skilled workers can be prepared since students who studying at school or university. Appropriate learning methods are needed to achieve educational goals [6] One of the learning methods that can be used is the Teaching Factory learning method. The Teaching Factory learning method is one of the developments of learning strategies to improve the competency skills of students, especially in the vocational education environment [7][8]. The Teaching Factory Learning Method is always associated with practical learning in accordance with real conditions or environments [9][10]. With this

method, students will be better prepared to work in industry because they have had the same experience as when they were still in school.

To answer the needs of workers who have competence regarding the operation of Solar Power Plants through teaching factory learning, learning support equipment is needed. Learning support equipment can be such as practical equipment [11][12]. This study aims to conceptualize the design of teaching factory practice tools by focusing on the operating system of a solar power plant. With this practical tool design concept, it is hoped that it can be considered in developing practical tools that can support the learning process with the Teaching Factory method.

2. RESEARCH METHOD

The design of the Teaching Factory Practice Tool Concept aims to obtain a practical tool that can describe the actual conditions in the existing industry. In this particular case, the design of the practical tool is a practical tool that can describe the conditions in the operation of a Solar Power Plant.

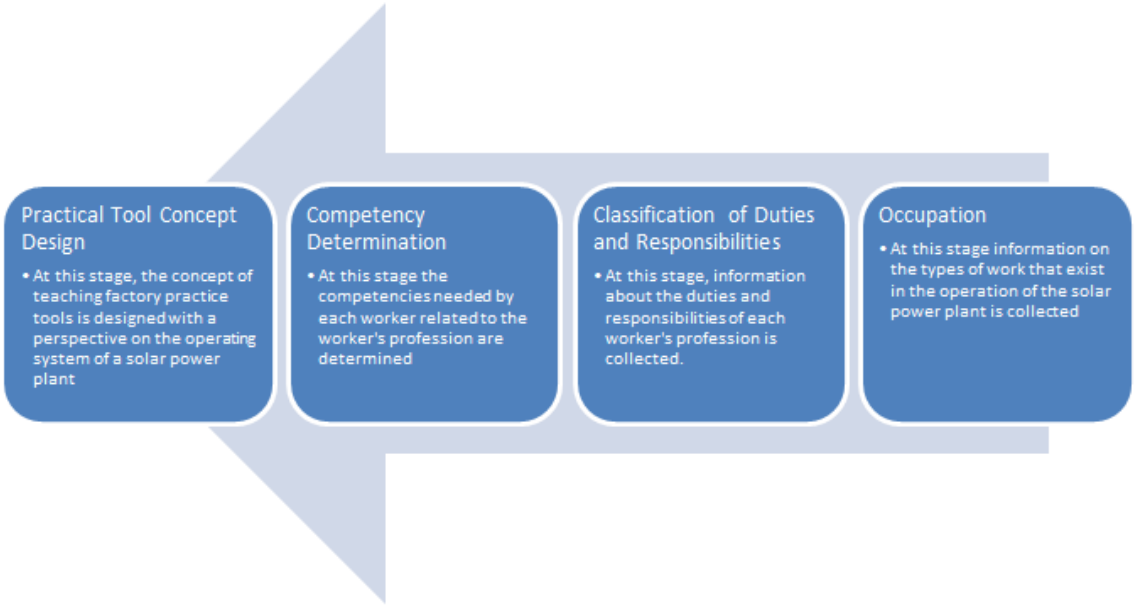

Figure 1. Stages of Practical Tool Concept Design on Backward Chaining Method

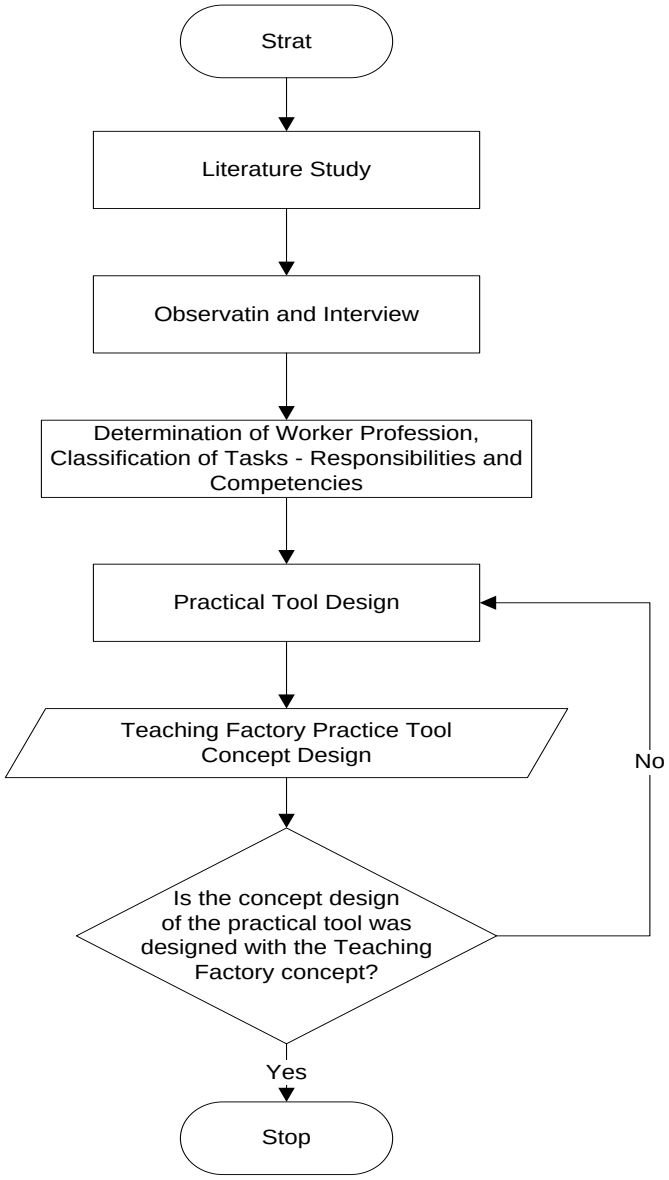

Figure 2. Research Flowchart

The research stage begins with a literature study to obtain information about the system requirements to be made. Then continued with the method of observation and interviews. At this stage, observations have been made on a Solar Power Plant with a Capacity of 21MWp. then interviews have been conducted at the management and practitioner levels to obtain information about the equipment that needs to be designed and the competencies required of workers. To get a practical tool that can fulfill the teaching factory learning concept, the Backward Chaining method [13][14][15][16] has been carried out. It has started by determining the profession of workers related to the operation of Solar Power Plants then classifying the duties and responsibilities so as to obtain the necessary competency information to be poured into the designed practical tools (Figure 1). The last stage is the stage of designing the concept of practical tools. The concept of practical tools created is a practical tool that can provide knowledge of the work that exists in solar power plants when operated. The stages of the research can be seen in the research flowchart (Figure 2).

3. RESEARCH RESULTS AND DISCUSSION

This research was conducted by creating a system with actual field conditions. The teaching factory tools are designed according to the operating conditions of the solar power plant. The concept of designing a practical tool that is adapted to the topography and environmental conditions at the Manado State Polytechnic – Department of Electrical Engineering which is a higher education institution that provides vocational education. As for the comparison of operating solar power plants, the solar power plant that is compared is the "XYZ" solar power plant operating in North Sulawesi with a capacity of 21MWp. It can be emphasized that the concept of the practical tool design is adapted to the conditions at the Manado State Polytechnic with real working conditions at the "XYZ" Solar Power Plant in North Sulawesi.

3.1. Occupation on Operation of a Solar Power Plant

Based on a comparison with the "XYZ" Solar Power Plant, the occupations at the site are site manager, head engineer, repair and maintenance technicians, operators, administrative staff, security and cleaning service. Every job has their own duties and responsibilities. In general, workers are grouped into several sections. The group is the management level, the operations section, the maintenance and repair section, security and general section. The management level is in charge of managing the business of solar power plants, both internally and externally coordination. Operations section is in charge to operate the Solar Power Plant. The operation begins with preparation for the start of the Solar Power Plant, control and monitoring, then the deactivation of the Solar Power Plant. The maintenance and repair section are in charge to maintain the equipment in the Solar Power Plant. In the event of a system failure, this section is also in charge to repair the trouble. The Security and General Section is tasked to ensure the environmental conditions in the Solar Power Plant are in a secure and conducive condition from social disturbances.

3.2. The Duties and Responsibilities of Operators

Comparing the existing responsibilities of the “XYZ” Solar Power Plant specifically for its operation, the specific Solar Power Plant Operation Tasks are as follows:

a. To ensure that the environment and electrical equipment are in a safe condition for operation.
b. Coordinate with superiors regarding the system startup process.
c. Turns on the system and synchronizes with the main power grid.
d. Monitor the process of energy distribution.
e. Reporting to maintenance if there is a problem
f. Stopping the system when the solar radiation conditions are below the operating standard
g. Preparing the daily reports.

3.3. The Required Competencies

Based on field conditions, the required competencies are related to the implementation of operating procedures for Solar Power Plants in accordance with SOPs and Instruction Manuals. The Elements of Competence are:

a. The implementation of operating procedures for Solar Power Plants. Workers are able to apply occupational safety and health procedures according to standards. Workers are able to apply the operating principles of the Solar Power Plant in accordance with the applicable SOP.
b. The preparation for the operation of the Solar Power Plant unit, Workers are able to identify the components/equipment related to the operation of the Solar Power Plant based on the function in accordance with the applicable standard specifications. Workers are also able to understand the measurement of technical variables along with the function of the technical variable quantities related to the operating system of the Solar Power Plant. Workers are able to assess the readiness of the operation of the Solar Power Plant when it is about to start.
c. Operation of Solar Power Plants (start up, monitoring and controlling, shut down), Workers understand the stages of starting, controlling and stopping the operation of Solar Power Plants. Workers are able to monitor, inspect, record and identify the ongoing process of energy generation. Workers are able to assess whether the Solar Power Plant is in normal condition or there are deviations in technical variables according to applicable standards.
d. Unit troubleshooting. Workers are able to identify and assess the level of disturbance that occurs during the operation of the Solar Power Plant. Workers can find out what actions need to be taken in the event of a disturbance in accordance with existing operating standards.
e. Generating operation reports. Workers are able to make reports in a predetermined format according to the standards specified in the operation of the Solar Power Plant.

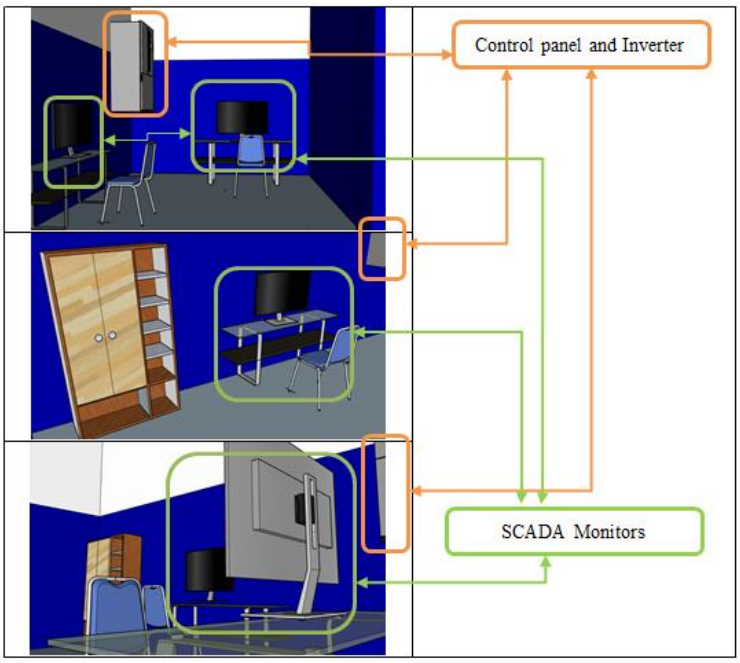

Figure 3. Control Room Indoor Area

3.4. Concept Design of Practical Tools

The design of the practice tool concept was carried out by considering the need of competency achievement by making practical equipment that seems to be the same as the conditions in the "XYZ" Solar Power Plant. The design of the practice tool concept is carried out by following the conditions in the Manado State Polytechnic - Electrical Engineering Department area. A total of 72 units of Solar Panels are determined to be similar to the one string installation of solar panel on the "XYZ" Solar Power Plant. The work area is divided into two major parts: the indoor area (Figure 3) and the outdoor area (Figure 4). There is a Computer Monitor in the indoor area, which contains a monitoring application of Solar Power Plants control system. Through this Solar Power Plant monitoring application, operators can start, monitoring and control, and stop the operation of the Solar Power Plant. In this room, there is an inverter to converts a DC electricity system to an AC power system to be synchronized with the Main Power Grid.

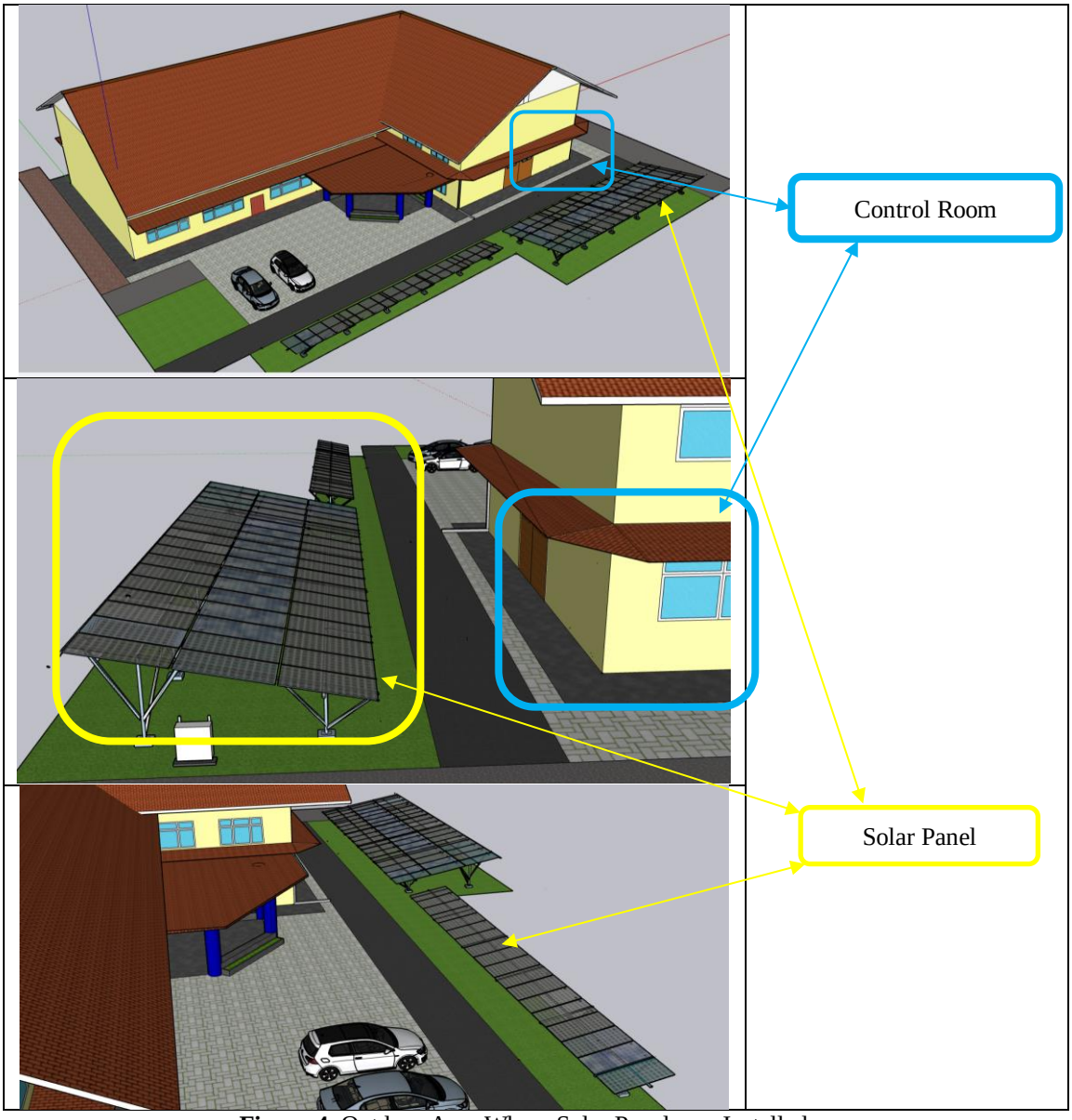

Figure 4. Outdoor Area Where Solar Panels are Installed

The concept design has been created as in the "XYZ" Solar Power Plant; only the capacity is smaller. The concept of practical tools designed to be implemented in the Manado State polytechnic area then followed the "XYZ" Solar Power Plant characteristics. The determination of the capacity, type, and the number of solar panels, as well as a string parts in "XYZ" Solar Power Plant.

An essential part of the operation is the application for the operation of the Solar Power Plant as a complement to the SCADA (Supervisory Control And Data Acquisition) System. In designing the concept of teaching factory practice tools, the application menu is determined according to the operation of the Solar Power Plant as in the "XYZ" Solar Power Plant. The Applications need to contain menu such as:

a. Home display, the display concept contains information about general conditions related to general conditions. This general view contains information on the location and condition of the electrical energy conversion process. It also contains other information, such as general information regarding the achievement of Solar Power Plant performance on each site connected to this application.

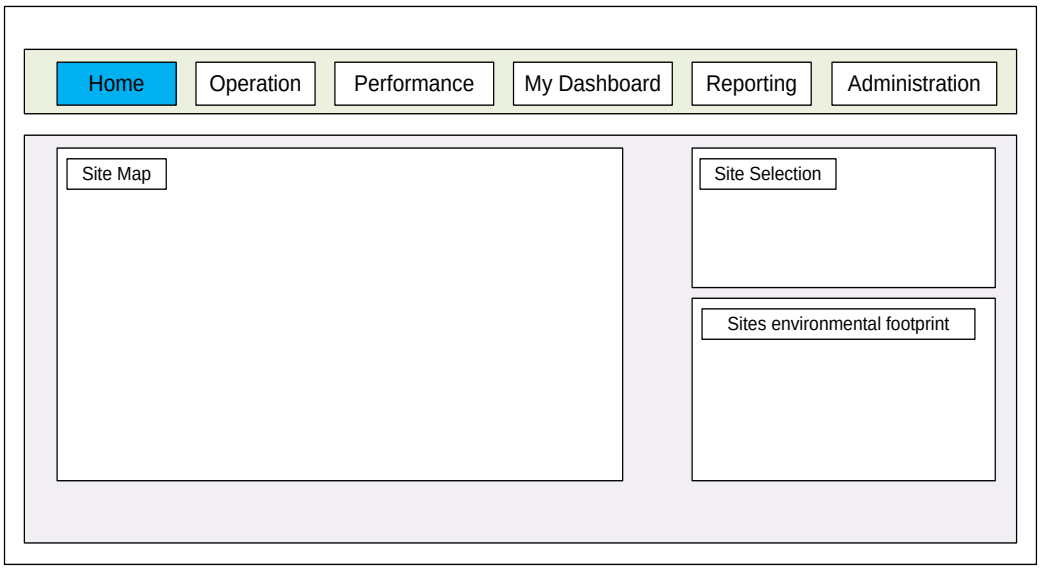

Figure 5. Home Display Concept Design on the application

b. Operating Condition Display, the display concept in this section contains the information on Energy Potency, Energy Production and Energy Distribution Conditions. This display is also equipped with a status marker whether there is an indication of a disturbance or under normal conditions. The operating conditions of the equipment group, such as the grid group operation whose signals are obtained at from each junction box and inverter, are shown in this section.

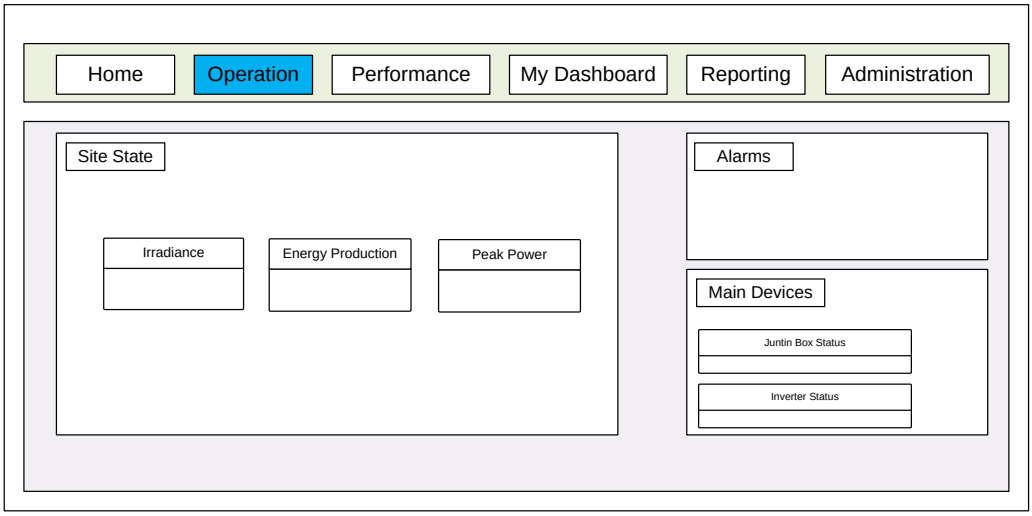

Figure 6. Concept Design of Operation Display on the application

c. Performance Display of Solar Power Plant performance, the concept displays of the performance menu are contains of information on the performance of the Solar Power Plant. The sections displayed are the supporting variables of the potential of solar energy, which solar energy will convert to electrical energy. This display shows the energy potency and the results of the energy produced.

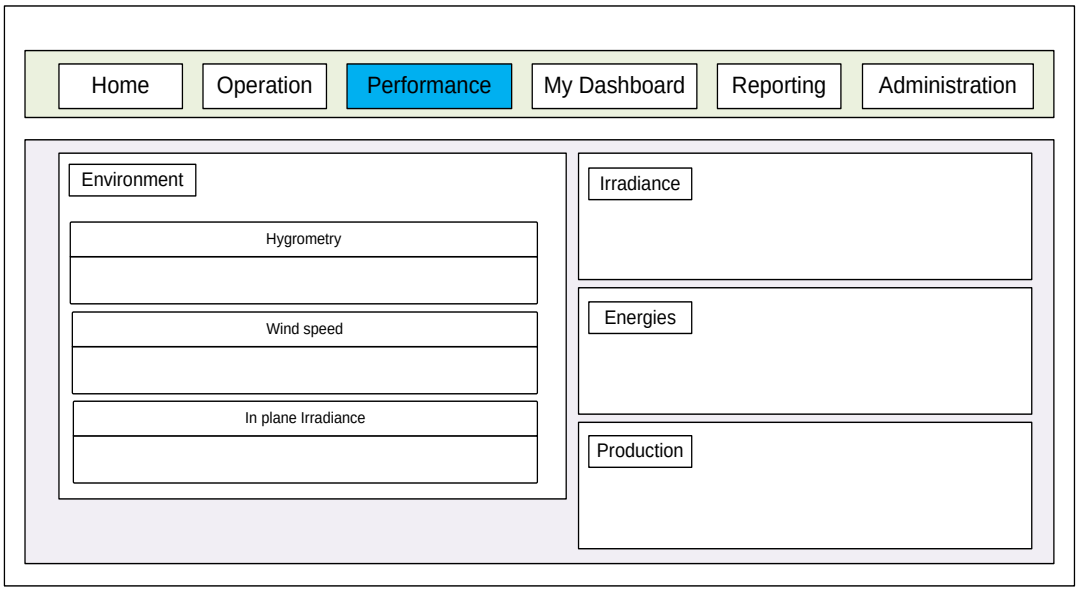

Figure 7. Performance Display Concept Design on the application

d. The My Dashboard Display, the concept of the display on My Dashboard contains of the operation data by each operator. This section is intended for essential records that need to be kept by the operator.

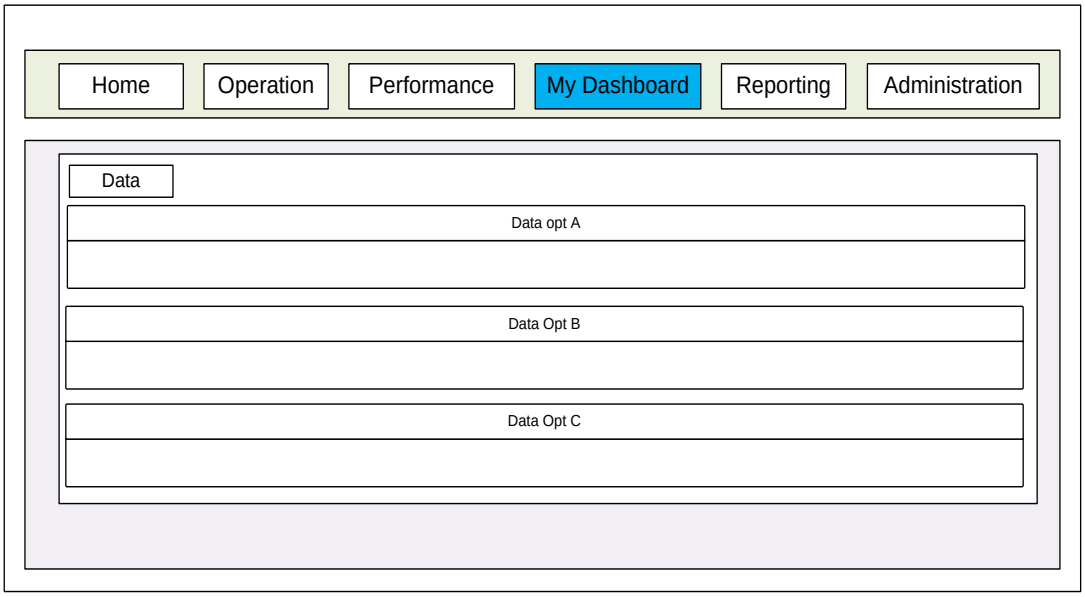

Figure 8. My Dashboard Display Concept Design on the application

e. Reporting Display, in this section, the display concept contains reports that need to be recorded every time. The report is divided into three parts. The sections are daily energy reports, monthly energy reports and the total energy reports since the solar power plant was operating.

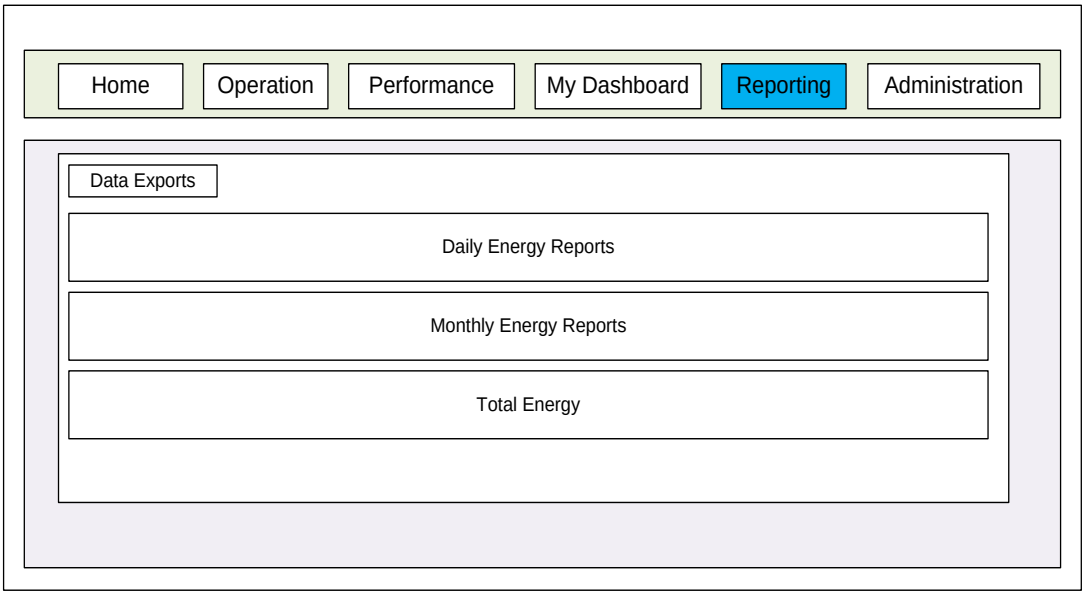

Figure 9. Reporting Display Concept Design on the application

f. Administration Display, in this section, the display concept contains the operation process's administration. The Records are the officer data of the Solar Power Plant operation. Schedules and attendance of the operators are recorded in this section. In addition, the recording of essential variables that need to be carried out periodically is recorded in this. There is also a message menu and notes about communication with each worker and/or work leader.

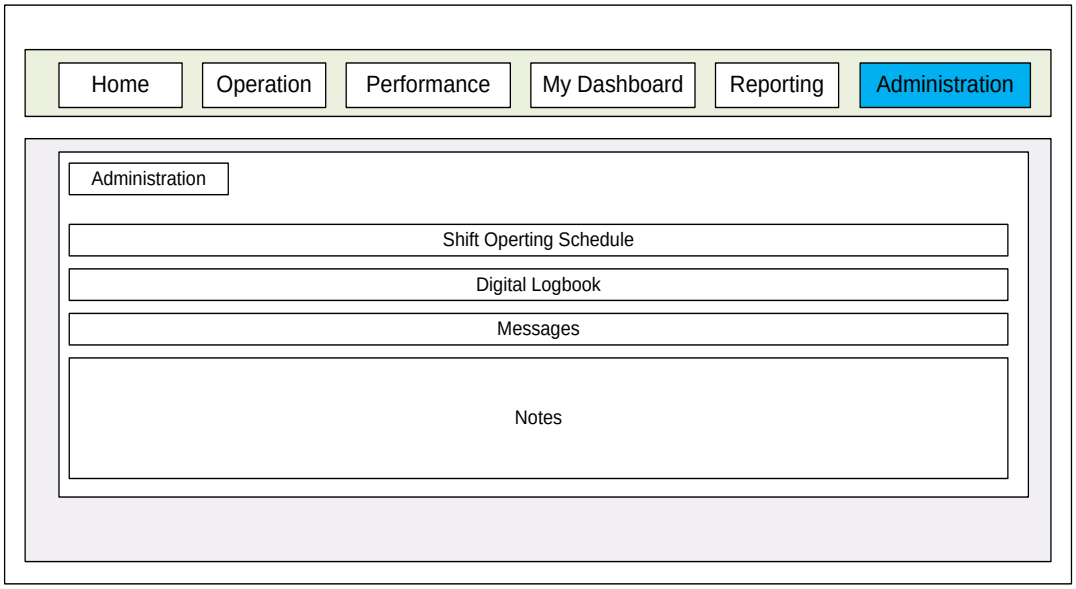

Figure 10. Administration Display Concept Design on the application

4. CONCLUSION

The concept of teaching factory practice tools with a focus on the operating system of the Solar Power Plant has been created. This design of practice tool is divided based on the occupation of each worker. The implementation of the practical is an activity as if it were on operating on a large-scale of solar power plant like in the "XYZ" solar power plant. Simulations under normal and/or disturbance conditions can be done by modifying the existing equipment.

5. SUGGESTED

For the further research can be continued by built the real practical tools under this design concept. The research can be divided into two major parts, i.e., the hardware and software design.

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