



Prototype Design Mini Crane Simulator as Viewer Tool Safety Accidents in Dojo PT. XYZ

Agung Tri Tjiptadi^a, Fransisca Debora^b, Sayyid Fahru Rozi^c, Rizki Arya^d
^{a,b,c,d}Department of Industrial Engineering, META Industry of Polytechnic, Indonesia
^bCorresponding Autor: sisca@politeknikmeta.ac.id

Article Info

Article history

Received : November 07, 2021

Revised : November 26, 2021

Accepted : December 21, 2021

Published : December 30, 2021

Keywords:

Risk Management System;
 Standard Operating Procedure;
 ISO 9001:2015;
 ISO 31000:2018;
 Business Process Improvement.



ABSTRACT

Occupational safety and health (OHS) is a critical aspect of the world of work that companies must fulfill. One of the ways that companies meet these needs is by providing training to employees in the form of work accident simulations that aim to allow employees to analyze accidents that arise due to work activities. PT. XYZ is a company with work activities, one of which is moving goods using a crane, so the company is obliged to provide information on work accidents that can occur in this activity. This study aims to design a tool as a simulation for activities using this crane with the method used is Research and Development. They designed a mini crane simulator prototype for work accidents at PT. XYZ was developed based on Arduino with an Infrared sensor which will cancel the light if the light is obstructed by an object and make crane activity stop so that work accidents can be overcome. This Mini Crane Simulator is placed in the Safety Dojo, a training venue. Further research on this tool is still needed and tailored to the company's needs.

DOI: <https://doi.org/10.35891/jkie.v8i3.2657>

1. Introduction

Human resources play an important role in the success of an organization or company because humans are living assets that need to be considered by organizations, one of which is a company (Wahyuni et al., 2018). Human resources as employees cannot be separated from problems related to occupational safety and health, especially while in the work environment; therefore, it is necessary to protect workers with safe working conditions, avoid physical and mental disorders through training, training, and control guidance towards the implementation of tasks and providing assistance with applicable rules from both government agencies and the companies where they work (Elphiana et al., 2017).

Occupational safety by definition is safety related to human work activities both in industry, manufacturing, and construction, which involves machinery, equipment, material handling, steam aircraft, pressure vessels, work tools for raw materials and their processing processes, workplace foundations, and their environment as well as how to doing work, as well as industry and services, which involve building cleaning equipment, transportation facilities and others (Mangkunegara, 2002).

PT. XYZ is a company engaged in manufacturing, where the process of its work activities uses heavy equipment, one of which is in moving goods. Division of Occupational Safety and Health

(OHS) at PT. XYZ seeks to increase the work productivity, knowledge, skills, and abilities of its workers by conducting training related to work activities on an ongoing basis. OHS program conducted at PT. XYZ includes: 1) Training on emergency response evacuation, 2) training on the use of APAR (Light Fire Extinguishers), c) Safety induction on Occupational Safety and Health (OHS), d) Program on SOP (Standard Operating Procedures), and e) An introduction to the hazards and risks that exist in the workplace from various work tools in the company.

Based on the activities carried out by the OHS at PT. XYZ, all media and work tools used are placed in the Safety Dojo, an area for worker training. These media and work tools are used for employee training related to their work activities and understanding OHS while working with these media and work tools. At the safety dojo, employees are trained by simulating available work tools. However, there are obstacles in the work tool, namely the crane, which is difficult to demonstrate due to the unavailability of the props. So in this study, the researchers wanted to design a prototype mini crane simulator that can be used as a work accident prop that will be placed in the safety dojo of PT. XYZ. The prototype mini simulator crane simulator was designed as a work accident prop at PT. XYZ was developed based on Arduino with the use of infrared sensors that will emit light if the light is blocked by objects and make crane activities stop so that work accidents can be overcome. Arduino is a microcontroller that will process the input given through an open-source programming language to produce output.

The importance of this research is to facilitate DOJO PT. XYZ with crane simulation tools is made in the form of a prototype so that employees can be easier to understand the work activity and the risk of workplace accidents and prevent accidents from crane activity. Based on the above statement, this research's purpose is the design of the crane simulator that can be used as props in the crash simulation work in PT. XYZ.

2. Literature Review

Occupational Safety and Health (OHS)

Occupational Safety and Health (OHS) is a thought and effort to maintain wholeness and perfection both physically and spiritually. Occupational Safety and Health (OHS) is one aspect of labor protection that is regulated in Law No. 13 of 2003. A work accident is something unexpected and unexpected. Work accidents can result in property loss, life/injury/disability, and pollution. Work accidents can occur due to a relationship or work activity. The role of management or organization of a company in a safety program is an activity that is always reviewed in an efficient process, and management must also view safety not as an additional process but as part of the process itself. Management must ensure that there are no unsafe conditions and unsafe acts. Management must strive to seriously address the real problem, look for the background causes to calculate losses, and what is essential is the use of diagnostic and assessment techniques such as simulations of safety sampling activities, hazard analysis in the overall workplace organization (Sihombing, 2014). Occupational safety and health problems cannot be separated from activities in the industry as a whole, so patterns that must be developed in handling occupational safety and health and controlling potential hazards must follow a systems approach, namely by applying Occupational Safety and Health (OHS) (Natarisa et al., 2016).

Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328 (Husni et al., 2019). ATmega328 on Arduino Uno comes with a bootloader that allows uploading new code to ATmega 328 without using an external hardware program. Arduino Uno's physical form is shown in Figure 1.

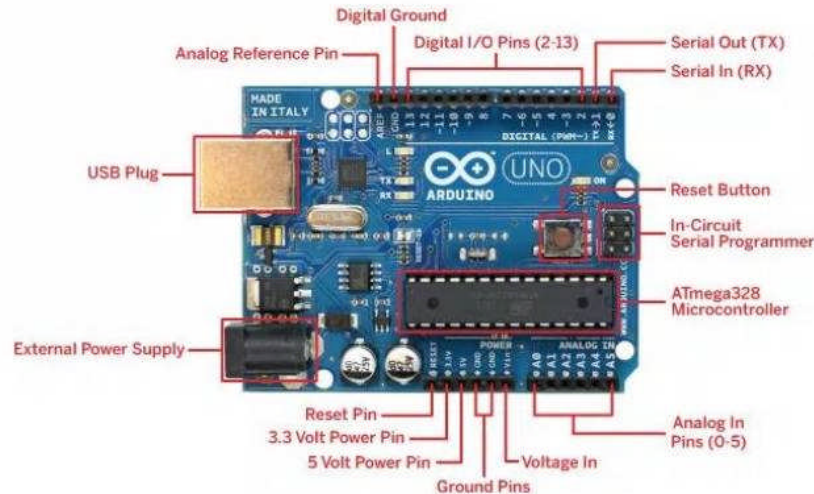


Figure 1. Board *Arduino Uno*

Motor DC Servo

DC Servo Motor (DC-SV) is a permanent magnet DC motor (DC-MP) with special qualifications following the application "serving" in control engineering. DC-SV motors are also required to operate reliably in varying torque ranges. Some types of motors DC-SV sold with drivers circuit pack already has a speed control circuit that integrates therein. Motor rotation is no longer based on the motor's supply voltage but on a particular input voltage that serves as an output speed reference. The schematic diagram is shown in Figure 2.

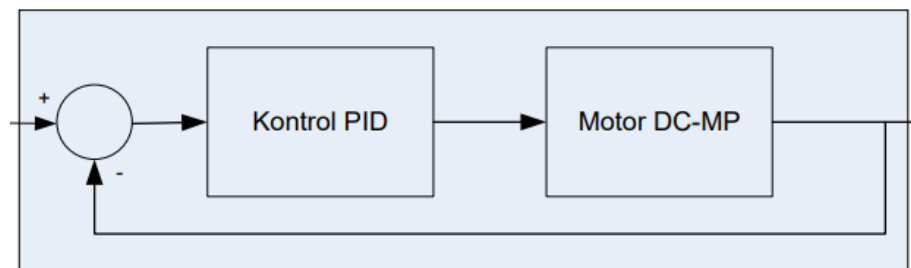


Figure 2. Equivalent Scheme DC Servo Motor with Speed Control

Lifting Equipment (Crane)

Lifting equipment (Crane) is lifting and moving material that works on the principle of rope work. Crane used to lift loads vertically and horizontally moving direction of motion simultaneously and unloaded to a predetermined place with a crane moving mechanism in two degrees of freedom (Hidayat et al., 2018). Crane has several hydraulic, tow motors, and manual winches (Kholis, 2014).

Prototype Design Mini Crane

Design is a stage of the system development cycle that can be defined as functional requirements and describes how a system can be formed (Satzinger et al., 2012). The design process can be in the form of a system. It can also be in the form of teaching aids which are media that help process activities understand the demonstration of the content of the material provided (Arsyad, 2014). For example, through visual aids, explaining a discussion of the material directly can be more effective.

The design resembles a prototype mini crane hoist crane. Hoist cranes are lifting aircraft usually found in warehouses and workshops that are placed on the ceiling and run on special rails mounted on the ceiling. The rails move back and forth in one direction, as shown in Figure 3.



Figure 3. Hoist Crane

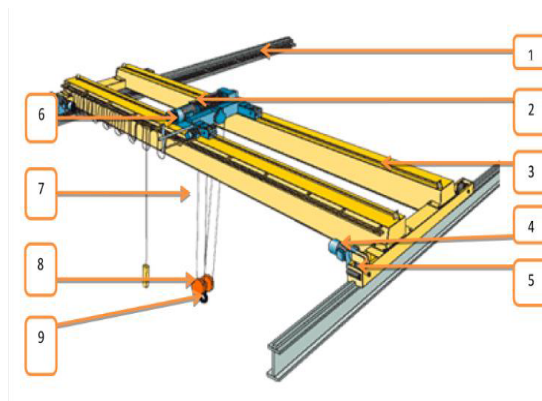


Figure 4. Components on Hoist Crane.

Hoist Crane Component Description:

- (1) The track (runaway rail) serves as a path for the crane to move forward and backward.
- (2) The drum functions as a steel rope winder.
- (3) The cross-bridge serves as a passage for the crane to move left and right.
- (4) The wheel drives motor functions to move the wheels on the track to allow the crane to move forward and backward.
- (5) Drive wheel: The driving wheel serves as the wheel of the crane crossbar.
- (6) The driving motor up/down (hoist) serves to raise and lower objects attached to the hook.
- (7) Steel ropes:
Steel ropes are widely used in conveying machines as lifting furniture.
- (8) Pulleys:
Pulleys are made with a fixed and accessible design. Pulleys are used as guides because they function as a changer in the direction of the equipment. For example, on the free pulley, some ganders move and are loaded with loads. The combination of several free pulleys and fixed pulleys is a pulley system that is used to change the force on the crane system.
- (9) Hooks:
In lifting equipment, steel rope chains are used to lift loads that are connected by hooks. Single hook and horn hook are the most widely used hooks in crane systems.

3. Methodology

The flow of the mini crane prototype design process is shown in Figure 5.

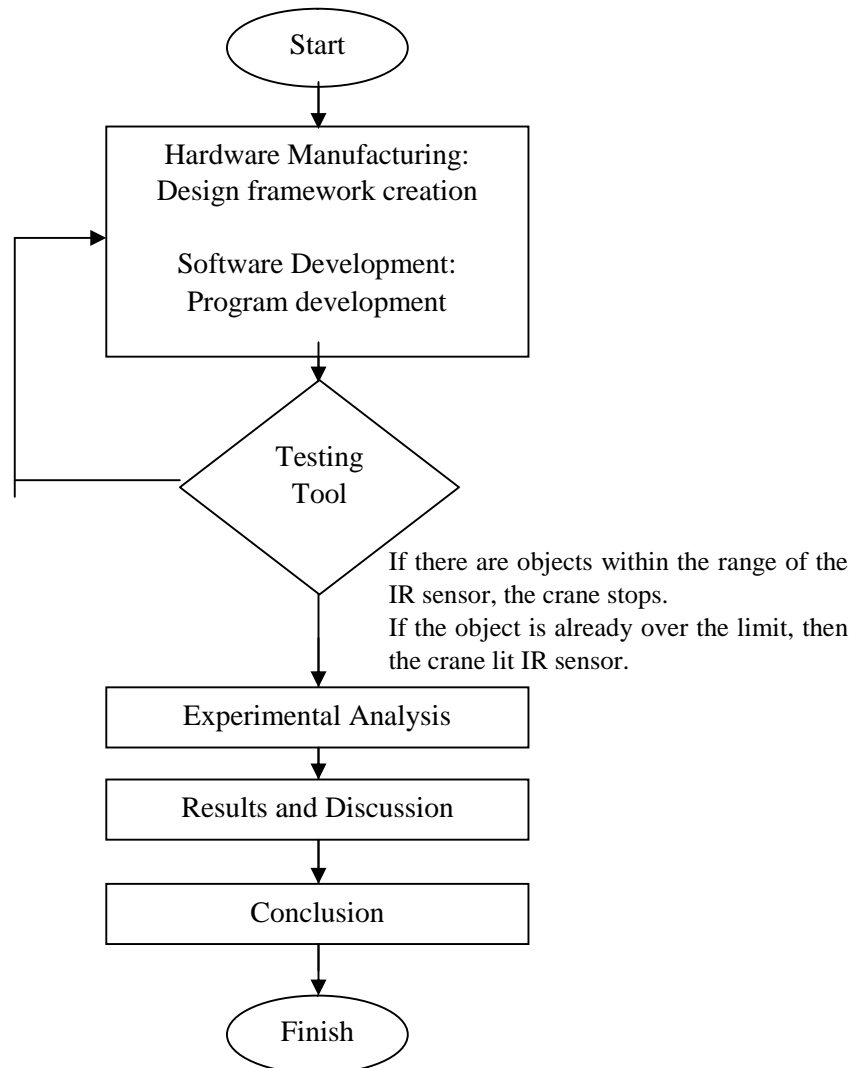


Figure 5. Mini crane prototype design process flow

Design Framework Design Crane

Making the framework begins with creating a design using the SolidWorks application. The design aims to determine the shape on a small scale from the actual crane in PT. XYZ, the design is shown in Figure 6.

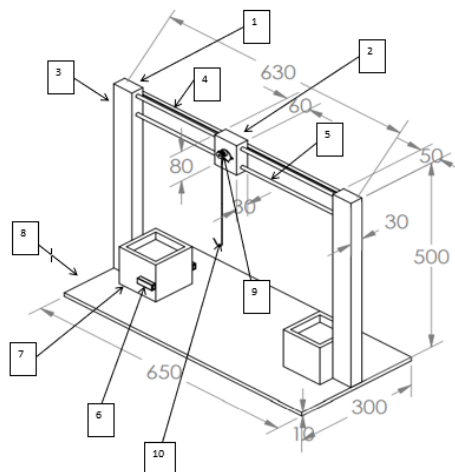


Figure 6. Crane Frame Design

Information:

- (1) A stepper motor that functions to move the Base Motor Crane on the track, making it possible to move right and left.
- (2) Base Motor Crane serves as a place for the motor to move up/down.
- (3) The pole serves as the primary support of the crane.
- (4) The belt that functions as a mechanical drive for the Base Motor Crane.
- (5) A track that served as a path for the Base Motor Crane to move right and left.
- (6) IR sensor, which functions as a security system to detect if some people or objects pass, all crane activities will be stopped.
- (7) The workstation serves as a place to put objects to be lifted by the crane.
- (8) 8 mm plywood board serves as the base of the crane.
- (9) Stepper motor functions to lift objects so that it is possible to move up and down.
- (10) The hook is used with a magnetic mechanism to make the object can be attached to the hook.

System planning

The system design is carried out by integrating remote controls, Arduino nano and Arduino Uno, IR sensors, and other electronic devices such as stepper motors, relays, power supplies, 5 V step-downs, and LED lights. The schematic design of the prototype mini crane simulator is shown in Figure 7.

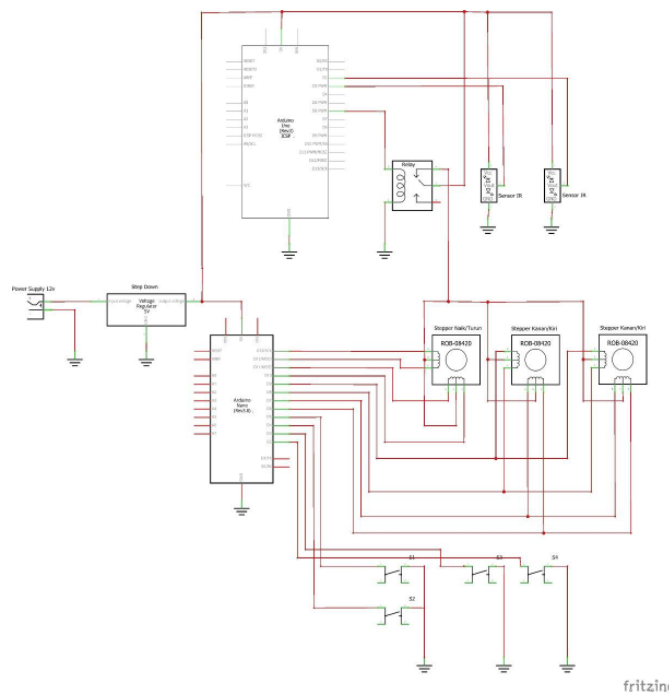


Figure 7. Schematic Prototype Mini Crane Simulator

4. Results and Discussion

Testing Tool

The process of designing and manufacturing tools completed will proceed to the tool testing stage. It aims to determine whether the hardware and software are by design. Here are the steps to operate a prototype mini crane simulator:

- (1) Connection of tools with electricity. Make sure the LED light on the remote control is on (the mini crane is ready to operate)
- (2) Operate the mini crane to the right or left and moved the hoist up and down.

- (3) When the mini crane is being operated, only one indicator light on the sensor is lit to indicate that no object has been detected passing through the sensor.
- (4) When an object is detected passing through the IR sensor, the indicator light on the sensor will be active both.
- (5) After the two indicator lights are active, the LED on the remote control will turn off, indicating that the mini crane cannot be operated for 10 seconds.
- (6) After 10 seconds, the LED light will come back on and, the mini crane can be operated again. The appearance of the mini crane that has been made is as shown in Figure 8.



Figure 8. Final of Prototype Mini Crane Simulator

After testing the prototype mini crane simulator, it can be concluded that the test results are as in Table 1.

Table.1 Condition, Results of the Mini Crane Simulator Prototype

No	Conditions	Results	Description
1	No objects pass through the sensor	LED Light = ON Motor Stepper = ON Sensor IR = OFF	LED lights on, and the motor is active
2	Can be given commands right/left, up/down.	LED Light = ON Motor Stepper = ON Sensor IR = OFF	LED lights on, and the motor moves
3	There is an object that passes through the sensor	LED Light = OFF Motor Stepper = OFF Sensor IR = ON	LEDs turn off, and the motor drive can not be operated for 10 seconds

5. Conclusion

Based on the development of the Prototype Mini Crane Simulator tool, PT. XYZ can provide understanding through visual media for work accidents caused by cranes in PT. XYZ. This simulation also provides technical information on how the crane works and its automation, which prevents work accidents at PT. XYZ of crane activity.

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