

USER REQUIREMENTS SPECIFICATION AUTOMATION SYSTEM DESIGN FOR STOPPER VALVE CHAMFERING PROCESS ON BENCH LATHE SD-32 A MACHINE AT PT DHARMA PRECISION PARTS

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Abstract

PT Dharma Precision Parts is manufacturing company that produces metal components from machining process, one of the product is stopper valve. Due to increasing in competition and demand, the company must be able to decrease the process time to fulfill the demand. The process time of existing system is around 9.92 seconds/part. The way that company use to decrease process time is by modifying Bench Lathe SD-32A machine which used for stopper valve chamfering process by applying automation technology. Applying automation technology in the company will get some advantages such as reducing process time, increasing production capacity and product quality. Implementation of automation system needs a good planning and consideration to function expected well and to prevent system redesign.

This research focused on User Requirement Specification (URS) design which contains a collection of information needed to design the automation systems in the industrial manufacture. URS design consists of process description, the description of the flow of electricity connected with each equipment, and control philosophy that allows the end user to understand the determined basic control system. Based on the research conducted conclude that the design of URS for stopper valve chamfering process on Bench Lathe SD-32A machine successfully implemented and the new process time is around 5 seconds/parts. The results consist of the explanation of process description, electrical diagrams, and control philosophy.

Keywords: user requirement specification, process description, electrical diagram, control philosophy

1. Introduction

Manufacturing industries have the goal to fulfill the demand by producing products productively in order to gain profit. Nowadays these objectives can be achieved by using technology such as automation technology. Most of activities done have changed from human worker into automation technology. Some company automate process in order to reduce production time, increase manufacturing flexibility, reduce costs, and eliminate human error (Business, 2015).

PT Dharma Precision Parts is one of the major local manufacturing companies in Indonesia that produces metal components from machining process and also supplies them to several manufacturing companies operating in Indonesia. PT Dharma Precision Parts is also a supplier for OEM (Original Equipment Manufacturer) company. PT Dharma Precision Parts has a lot of machines and a wide range of products. One of existing production processes is chamfering stopper valve components which is processed by Computer Numeric Control (CNC) machines and Bench Lathe machines. The chamfering process is begun by placing the stopper valve that has been created by a CNC machine into the spindle collet which will be locked, and the spindle collet motor will rotate. The chisel will move into the part to running the chamfering process.

Due to increasing in competition, the company must be able to increase the production capacity with the best quality of production capacity so that the company can fulfill the demand. The company has a problem on the production process of stopper valve which is the processing time. The company takes too long to complete construction of part and inconsistent processing time because the production process is done manually by the operator. The work performed by operator is influenced by human factors so that the time required to produce stopper valve is different of each operator which would affect the number of production capacity. Process time of existing system can be seen in figure I.1. Currently the company is able to produce stopper valve which the average speed is 6 pcs/min. Unless this condition is immediately improved by reducing the processing time, the company will incur loss because the ability to increasing production capacity unfulfilled.

Table 1 Existing production condition

Parameter	Number
Processing time	9.92 second/pcs
1 Hour production	362 pcs
Manpower required	1 operator/shift
Average production	2525 pcs/shift

Regarding the problems, the company needs to modify the machine used for production to quicken the production time so that the production capacity increases. By modifying the machine, the company does not need to spend a huge investment to build a new machine and consequently the machine utility increases. Design of automation technology will be applied to modify Bench Lathe SD-32A machine which used for production in the company. Automation is a technology applying mechanical, electrical, and computer systems to operate and control the operation process. Automation system design on Bench Lathe SD-32A machine needs a good planning and consideration to function expected well. According to the USA Principles, there are three steps to implement automation system. The first is knowing the existing process, the second is making the existing process simpler, and the last is implementing automation system process. As a manufacturing industry that uses automation system manufacturer must know the requirements of the automation system, so that the automation system design can be applied in accordance with the requirements or the production process. One of the methods to know the requirements of automation system is User Requirements Specification (URS) design. URS design consists of process description, the description of the flow of electricity connected with each Equipment, and control philosophy that allows the end user to understand the determined basic control system. It is concluded that User Requirements Specification (URS) design needs to be implemented in processing machine modification of Bench Lathe SD-32A machine in PT Dharma Precision Parts.

Based on this background, the problem in this research is how to design the user requirements specification (URS) automation system for stopper valve chamfering process on Bench Lathe SD-32A machine in order to decrease production process time and increase quality. The objective of this research is design the User Requirements Specification (URS) automation system for stopper valve chamfering process on Bench Lathe SD-32A machine in order to to decrease production process time and increase quality.

2. User Requirements Specification (URS) Design

This research begins from the identification phases on the research objects. Identification done by observation to the shop floor, after observation, it can be defined problems that occur in the existing system. When analyzing the existing system, do also study literature to get the appropriate research methods to solve the existing problems so that from that phase obtained the problem and method that is design the user requirements specification (URS) automation system for chamfering process on Bench Lathe SD-32A machine. The inputs will be used in this research can be seen in conceptual model. The proposed system is then tested by simulating in the simulation phase so that the proposed system can be analyzed at the analysis phase, after that will be concluded at the conclusions and suggestions phase.

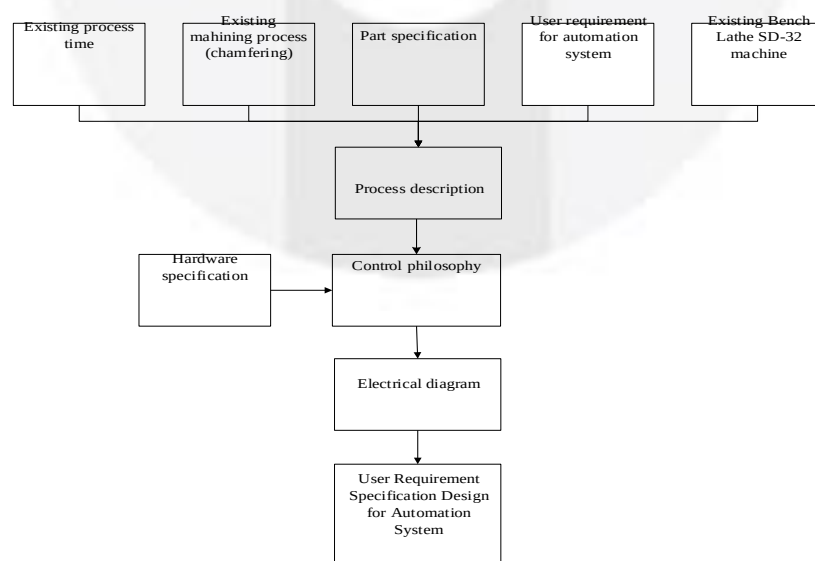


Figure 1 Conceptual model

User Requirement Specification (URS) used to provide a clear basis for tendering and for making a meaningful quotation. URS provide description about the component or system needed in order to produce a product. The URS must be in a form that can be understood by a system supplier or integrator (Love, 2007). URS that can be used for articulated functionality that required by control system such as a process description, electrical diagram, and control philosophy. Process description provides a basis for the supplier to understand and interpret the user's process objectives. The point of providing a process description is that it enables the supplier to make informed judgements about the requirements for control (Love, 2007). Electrical diagram is a graphical representation of an electrical circuit (Wikipedia.org, 2015). Electrical diagram classified into two categories, there are wiring diagram and schematic diagram. Love (2007) control philosophy is a collection of statements about policy design and principles underlying the important decisions on the control system. Control philosophy allows suppliers to understand the control system that will be used.

2.1 Process Description

Process description of proposed system on bench lathe SD-32A is described by a flow chart which can be seen in Figure 2 and 3. The following is proposed system scenarios for stopper valve chamfering process PT Dharma Precision Parts:

a. System preparation

This process is a process to prepare the system to be in a safe condition so that the system can run as expected.

b. Inspection Process

Stopper valve inspection process from the nonconformity is the first process to be performed before the chamfering process. Stopper valve inspection process carried out in the inspection line by using the photoelectric sensor.

c. Chamfering Process

Stopper valve which has passed the inspection and were on the slider then be delivered by a linear motion to get in front of the collet. After the stopper valve was located in front of the collet then cylinder on the slider will extending push the stopper valve to attached on the collet. The next will be done to clamping stopper valve so that it will attached strongly. If stopper valve has been clamped on the collet and the system is in a safe condition, the AC motor will be active then linear motion back to the initial conditions and the drill will be go forward to make the process of chamfer.

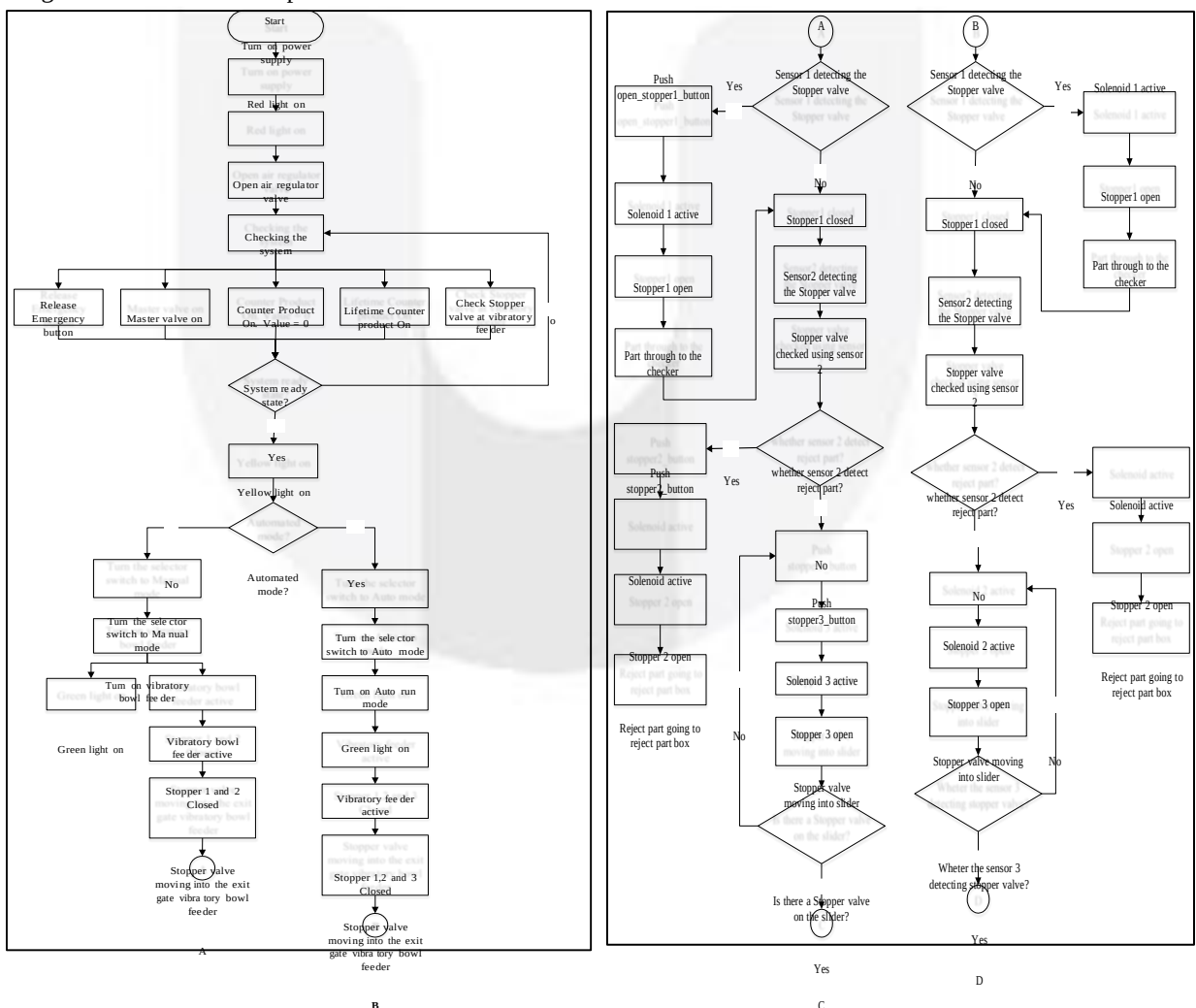


Figure 2 Proposed of new system for stopper valve chamfering process

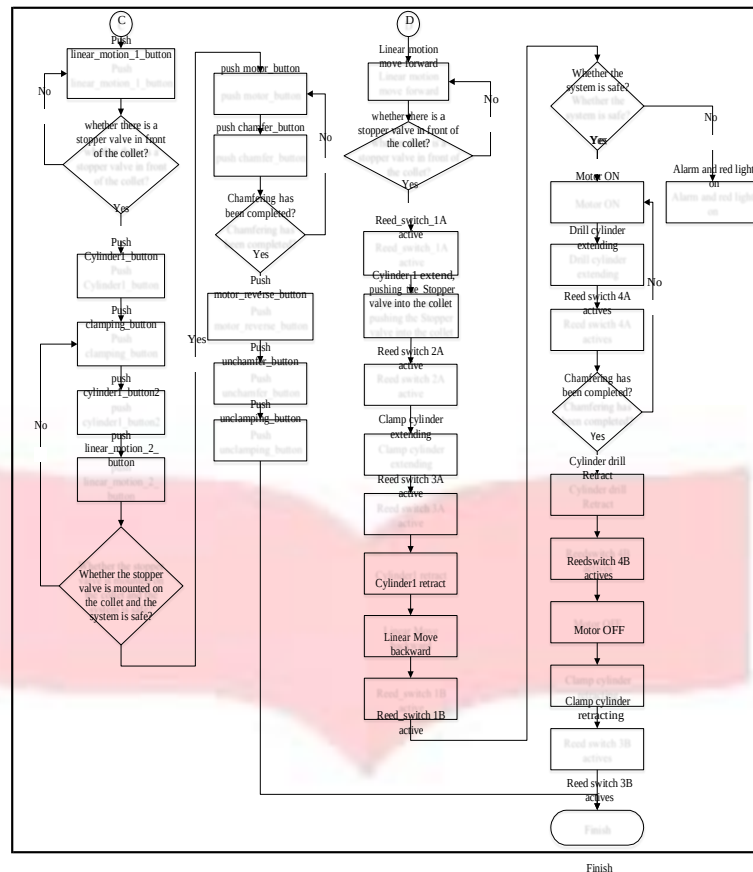


Figure 3 Proposed of new system for stopper valve chamfering process (Cont.)

2.2 Control philosophy

Control philosophy describe the selection of hardware. Hardware specification used in proposed system:

Table 2 List of hardware and specification used in proposed system

No	Hardware	Specification
1	Through beam sensor	Sensing distance : 200mm Current consumption : max 40mA Supply voltage: 12-24 VDC
2	Inductive proximity sensor	Sensing distance : 8mm Setting distance : 0 to 5mm Current consumption : max. 10 mA Supply voltage: 12-24 VDC
3	Reed switch	Detection range : 7mm Current consumption : 10 mA Supply voltage: 24VDC
4	Counter	Counter type : Digital counter Supply voltage : 24VDC Power consumption : Approximately 4 Watt
5	Ac Electrical Motor	Type : Three phase induction motor Speed : 2200 rpm Torsion : 6.6 lb/ft Power : 1.5 Kw
6	Cylinder	Type : Double acting and single acting cylinder
7	Solenoid valve	Type: 5/2 way valve and 3/2 way valve
8	Programmable Logic Controller (PLC)	Type of PLC : PLC Omron CJ2M CPU12 Quantity : 1 unit I/O module : 34 digital inputs which divided into 3 and 23 digital outputs which divided into 3 modules output. Operating voltage : 220 VAC Current consumption : 1.5 A

No	Hardware	Specification
9	Air compressors	Type : Reciprocating air compressors Power : 1.5 HP = 1119 Watt Operating voltage : 380 VAC Current consumption : 3.7 A
10	Alarm (Buzzer)	Type : Buzzer Operating voltage : 24 VDC Current consumption : 0.02 A
11	Tower Lamp	Type : Industrial tower lamp 3 module stack colors Operating voltage : 240 VAC Current consumption : 0.19 A
12	Miniature Circuit Breaker (MCB)	Electric currents rating : 6A Voltage rating : 230 V
13	Relay	Type : Omron MY2 Operating voltage : 24 V Rated current : 36.9 mA
14	Contactor	Type : Magnetic contactor AC 3 Pole Rated operational power : 380 – 400 VAC Current rating : 9 A
15	Vibratory Bowl Feeder	Input voltage : 220 VAC, 60 Hz Load current : 80 mA

2.3 Electrical Diagram

Automation system design for chamfering process on bench lathe SD-32A is described by pneumatic schematic diagram and electro pneumatic schematic diagram to illustrate flow of electricity that are connected between equipment using Fluidsim software.

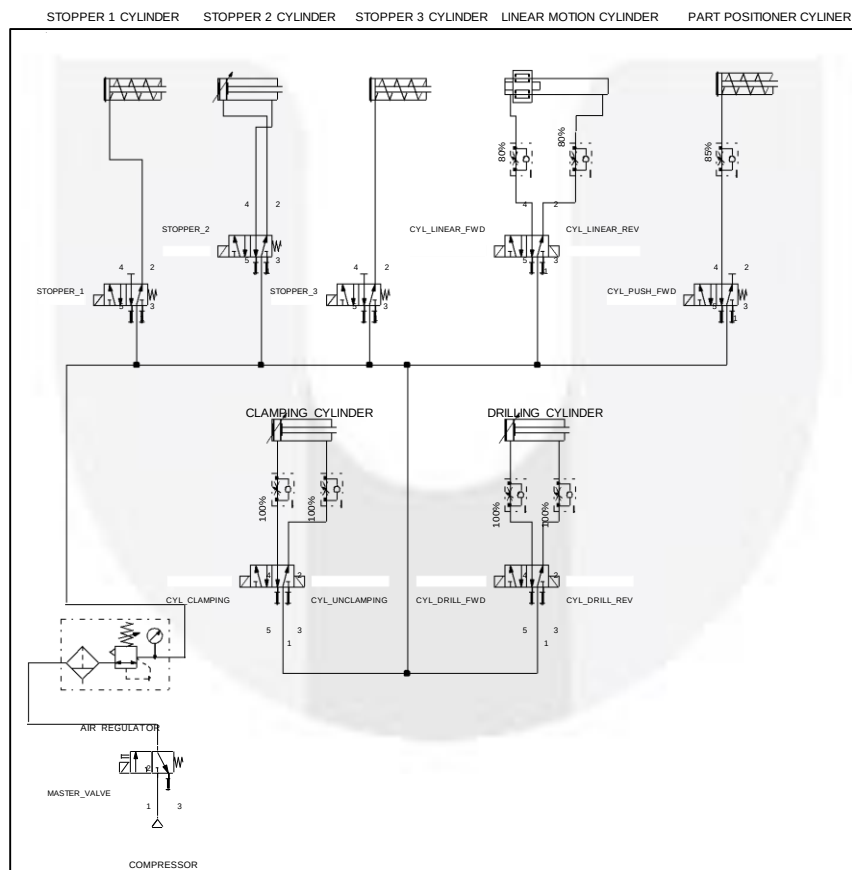


Figure 4 Pneumatic schematic diagram

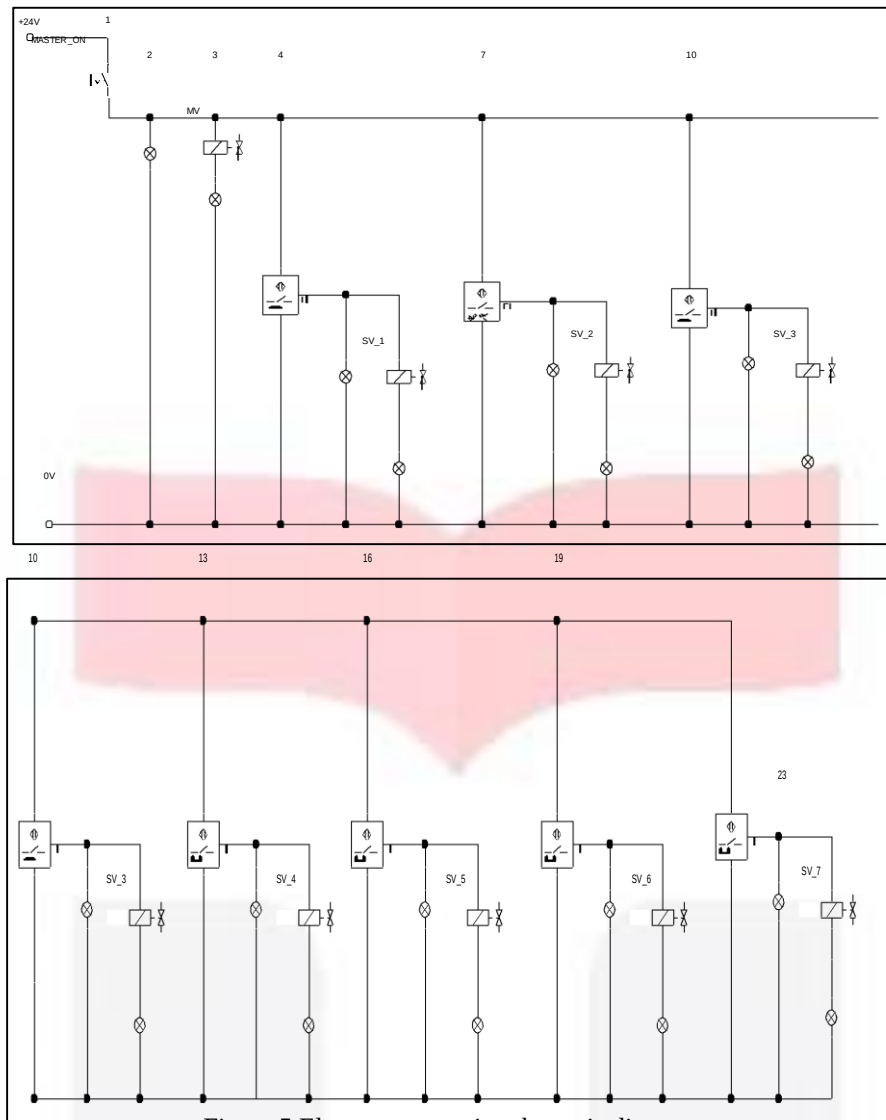


Figure 5 Electro pneumatic schematic diagram

3. Discussion

Existing system for stopper valve chamfering process at PT Dharma Precision Parts still using conventional system that causes long process time so production capacity cannot reach the demand and cannot achieving consistency in products quality. The way to increase the production capacity is done by implementing automated systems pneumatic technology, while maintaining quality of the product on automation system design for stopper valve chamfering process is done by inspection the product before chamfering process.

Process description have been created is the proposed new system for stopper valve chamfering process at PT Dharma Precision Parts. Explanation of the process that occurs in the stopper valve chamfering process is needed for stakeholder to know process flow at that system starting from the inspection process until chamfering process to produce the stopper valve in accordance with the specifications.

The determination of the hardware specification is necessary so that the equipment and instruments contained in the automation system for stopper valve chamfering process can run the system in accordance with its function. In addition, if the equipment does not match, it can allow the short circuit occurred on the system, the dimensions are not in accordance with the requirements of pressure, inaccuracies distance detection, and others. Determination of the hardware specifications necessary to ensure the equipment that were installed in the automation system stopper valve chamfering process can running the system in accordance with its function. In addition, if the equipment does not match, it will cause a short-circuit in the system, inaccuracies distance on the sensor detection, and others.

Selection of hardware involves several variables that need to be considered. Some of these variables is the electric power used in the process of chamfering stopper valve, the comparison between the existing condition with the hardware specifications that will be implemented, and the installation position of each hardware.

The electrical diagram design used to know the configuration of equipments that are connected with each others in the automation system for stopper valve chamfering process. By using electrical diagram stakeholders can easily determine the equipment used in the system along with the interconnection between the equipment. In the process of chamfering created of two types of electrical diagrams that is, pneumatic schematic diagram which is an

description of pneumatic systems and electro pneumatic schematic diagram which is a description of the relationship between electrical equipment and pneumatic system installed on the system.

URS automation system design successfully implemented by creating process description, control philosophy, and electrical diagram so that automation system running as expected to reducing processing time. Reducing processing time can be seen in Figure 6.

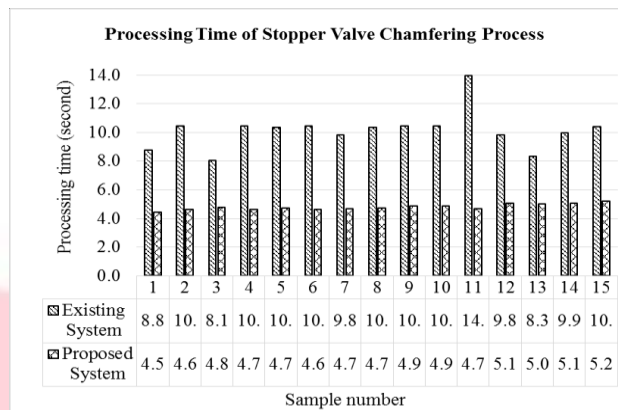


Figure 6 Processing Time of Stopper Valve Chamfering Process in Existing and Proposed System

Reduction of processing time would increase production capacity so that the profit also increased. Comparison of production condition between existing and proposed system can be seen in Table 3.

Table 3 Comparison production condition

	Proposed System (Automation)	Existing system (Manual)
Working time/shift (seconds)	25200	25200
Shift per day	3	3
Production time (second/pcs)	5	9.92
Production per shift (pcs)	5040	2525
Production per day (pcs)	15120	7575
Production per year (pcs)	3931200	1969500
Revenue per year	Rp393,120,000	Rp196,950,000
Profit per year	Rp78,624,000	Rp39,390,000

Based on the calculation the proposed system gives higher profit then existing system and the pay back period can be seen in the following :

Payback period (year) = Investment/(Profit per year)

Payback period (year) = 43.842.000/78.624.000

Payback period = 0.6 year

Payback period = 6.7 months

It can concluded the length of time to recover the cost of an investment to modify Bench Lathe SD-32A machine is 6.7 months.

4. Conclusion and Suggestion

4.1 Conclusion

Based on the research that have been done, it can be concluded that User Requirement Specification (URS) automation system design that consists of process description, control philosophy, and electrical diagram which used as a basis to designing automation system automation system design for stopper valve chamfering process on Bench Lathe SD-32 A machine at PT Dharma Precision Parts successfully implemented by decreasing the process time from around 9.92 seconds/part to around 5 second/part or it can said that modifying existing machine can decrease 45.5% of process time.

Process description consists of process scenario description on the proposed system by applied automation technology. In process description also described additional processes on the proposed system is the inspection process of stopper valve performed before chamfering process. Control philosophy describes the information of hardware specification used in proposed system and the identification of input and output as the address that will be used in PLC programming. Electrical diagrams are used to describe the flow of electricity is connected between

the equipment used in the proposed system. User Requirements Specification (URS) can be used as a basis for designing automation control system for stopper valve chamfering process on Bench Lathe SD-32A machine at PT Dharma Precision Parts.

4.2 Suggestion

The suggestions given related to this research for further purposed, that is :

1. To the next research, the design is done can noticed the cost analysis or energy consumption analysis of making selection of hardware specification.
2. To the next research, to make more detailed electrical diagram in order to describe the flow of electricity more clear.

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