Information System Design for Water Pump Production Monitoring

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Abstract: This study aims expedite the process of water pump production report by implementing an information system monitoring the production process in recording production output so that it can meet the accuracy, integration, and real time factors. The data was taken from an electronics company in Indonesia by means of observation and interviews. Apart from interviews, the authors also collect literature from books, journals, and research related to information system. The output of the discussion show that information system can help to reduce reporting time from 102 minutes to 49.85 minutes or efficiency 47.83% and can achieve three stages of technology development in the digital transformation of the production reporting process, namely digitization, data integration, and process automation.

1 INTRODUCTION

Provision of water of adequate quality for the community has an important role in environmental or community health which has a role in reducing the number of sufferers of water-related diseases and plays a role in increasing the standard or quality of life of the community. As a developing country, Indonesia is one of the countries that contributes 70-85% of opportunities for water, land, energy and iron productivity (Ahlberg, 2012). However, Indonesia has only produced 222.59 billion m³ per year of water that has been utilized. While the rest, namely as much as 468.72 billion m³ has not been fully utilized (Oberman et al., 2012). An electronics company in Indonesia is a business actor that assists the government in helping people have access to clean water sources by producing water pump products. The electronics company has problems in the documentation and recording of its production output. Documentation and recording of production output have not been integrated between departments. Currently, the delivery of information related to problems in the line is conveyed orally that make decision making from management is slow. In this case the company needs to integrate production output documents to facilitate the controlling function. Information systems can help company operations such as integrating documents, avoiding input errors, speeding up document search, and reducing document duplication (Mcleod and Schell, 2007). The expectation is the research will recommend information systems design as a form of digital transformation to integrate all documentation and recording of among departments production output.

2 LITERATURE REVIEW

2.1 Water Pump Production

The production system is an arrangement of activities or elements that are all interconnected to achieve the final goal (Gupta et al., 2009). In the water pump production process, there are five processes, namely the casting process, the forming process, the machining process, the joining process, and the assembly (Swift and Booker, 2003). To influence the innovation process strategy in the production process, production technology is needed to produce high quality, flexible and efficient products (Lianto et al., 2 02).

2.2 Information System

Information System is a system that has several components that collaborate to collect, process, and save data and information to help coordination, control, decision making, problem analysis and visualization in organization. Information system is divided into four activities, namely Input for data collection, process for managing data input results, output of the information transfer process, and feedback to return

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data to users to help evaluate and correct the input data (Laudon and P, 2014). There are three phases on the implementation of information system; pre implementation, implementation, and post implementation (Dachyar and Dewi, 5 05).

2.3 Digital Manufacturing Supply Chain

Digital Manufacturing Supply Chain can be defined as real-time acquisition of data about the management and decision-making of all supply chain business activities, using digital information technology, and trying to reduce supply chain risks and improve supply chain performance through intelligent management (Liu, 2 01). Most of the benefits in manufacturing from digital transformation can be summarized in five groups; to increased productivity where development and design processes, quality with high-resolution measurements, the costs involved in data capture and analysis of the manufacturing process, product customization, and safety in the workplace where dangerous tasks can be performed by robots (Albukhitan, 2020). Digital transformation implies technological advances that support existing processes (Liu, 2 01). Technology architecture contributes to the essential requirements of IoT applications: Security, Adaptability, Intelligence, Real Time, and Regulation Compliant (Saragih et al., 2018).

2.4 Business Process Reengineering

Business Process Reengineering (BPR) is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary performance measures, such as cost, quality, service and speed (Herzog et al., 9 10). BPR in Manufacturing Supply Chain is a process of modeling and documenting information architecture can be a sufficient starting point to ensure the success of BPR (Nabelsi and Gagnon, 5 05). The BPR approach and the use of RFID create efficiencies in terms of time & cost (Bevilacqua et al., 2011). In practice, there are many ways to do BPR. However, there are 10 best practices; task elimination, task composition, integral technology empower, order assignment, resequencing, specialist-generalist, integration, parallelism, and numerical involvement (Mansar and Reijers, 2007). Make a model using enterprise architecture (EA) notation is a strategic framework mapping of the new business process (Dachyar et al., 0 10).

3 METHODOLOGY

The water pump production process improvement model uses a Business Process Reengineering approach to determine scenarios in the design of information systems as a solution. The data used in this research are interview with stakeholders, observation, and production output documents. Activities will be created into an As-Is model with enterprise architecture (EA) notation using iGrafx software. This model will produce output in the form of the total time of the entire production reporting process. Based on these results, an analysis of the problem regarding the waste of activities will be carried out. After knowing the problem, a new business process model will be designed, namely the To-Be model. BPR best practices are carried out to obtain alternative solutions in the form of several scenarios. The next phase is the design of the information system, which is consist of 4 phases, namely database design, system design, system usage flow, and interface design.

4 RESULT

Figure 1 shows the current water pump production output reporting process. In the last process, namely receiving reports and recording reports into Excel manually, it creates a vulnerability for human error, which are:

- Writing numbers on production report paper can be wrong due to mistakes in writing back from targets that are on the computer to paper
- Error reading the number written by the leader regarding the number of units produced
- Error in entering data into excel

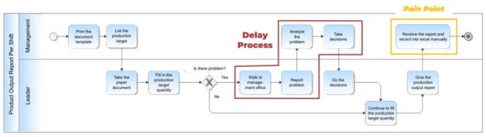

Figure 1: Production Output Reporting As-Is Model.

In addition, in the middle of the process, if there is a problem, the leader must walk to the office and report the problem, then the section head will analyze the problem so that decision making is a process that has high barriers or a delay process. From the simulation results on iGrafx (Table 1) it is found that the average waiting time for this process is 0.42 hours. When divided by the production takt time of 1 water pump model, which is 33 seconds/unit, an opportunity loss of 45 units/shift is obtained.

Table 1: As-Is Model Simulation Result, Transaction Statistic (Hours).

Count	1
Avg Cycle	1,75
Avg Work	1,33
Avg Wait	0,42
Avg Res Wait	0,00
Avg Block	0,42
Avg Inact	0,00
Avg Serv	1,75

From the results of the interviews, it was found that the user requirements. The company wants an accurate process, integrated data, and information that can be accessed in real time. From this, three alternative solutions are obtained by implementing BPR best practices, namely automating information recording by implementing RFID so as to increase the accuracy of recording the number of product outputs, Automating information recording by implementing a barcode scanner so as to increase the accuracy of recording the number of product outputs, and Designing a database or information system by creating a production monitoring dashboard that can be accessed by all actors in real time.

Based on these alternative solutions, possible improvement scenarios that can solve problems in recording water pump production output are as follows Table 2.

Table 2: Improvement Scenario.

Solution	Automate recording by implementing RFID	Automate recording by implementing barcode scanner	Database or information system can be accessed by all actors in real time
Scenario Name	Automated recording system with RFID chip tag	Automated recording system with barcode scanner	Monitoring system with Power BI
Scenario 1	✓		
Scenario 2		✓	
Scenario 3	✓		✓
Scenario 4		✓	✓

The scenarios are modeled into the To-Be model in Figure 2 for scenario 1 automated recording system with RFID chip tag. The Automated Recording System with RFID chip tags is an automation of recording information by implementing RFID to increase the accuracy of recording the number of product outputs. The tools and software needed are RFID Tags in the form of a microchip that contains a unique product code, an RFID Reader to decode data on the tag, and a Software System to process data from RFID Tags and RFID reader devices.

Figure 3 for scenario 2 automated recording system with barcode scanner. The Automated Recording System with Barcode Scanner is an automation of recording information by implementing a barcode system so as to increase the accuracy of recording the amount of product output. The tools and software needed are the Omni Directional 1D Laser Barcode Scanner.

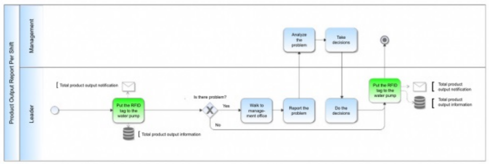

Figure 2: To-Be Model Scenario 1.

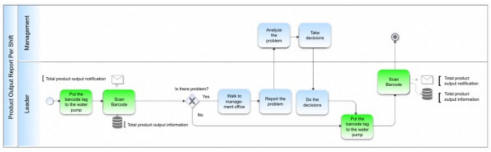

Figure 3: To-Be Model Scenario 2.

Figure 4 for scenario 3 combination of automated recording system with RFID chip tag and monitoring system with Power BI. Automated Recording System with RFID chip tags and Automated Monitoring System with Power BI is a database or information system design by creating a production monitoring dashboard that can be accessed by all actors in real time. The tools and software used are RFID, SQL, and Power BI.

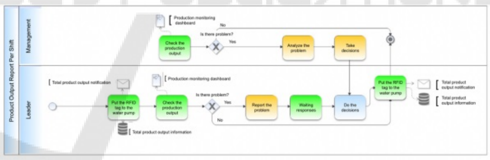

Figure 4: To-Be Model Scenario 3.

Figure 5 for scenario 4 combination of automated recording system with barcode scanner and monitoring system with Power BI. The yellow boxes are processes that are reduced time process from the As-Is model, and the green boxes are additional processes from the As-Is model.

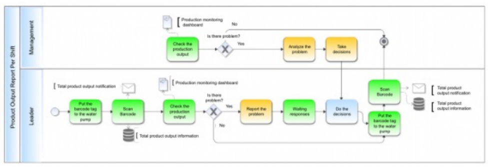

Figure 5: To-Be Model Scenario 4.

The improvement scenarios built into the information system design. Based on the results of interviews with companies and the results of the literature, several system requirements were obtained for a stock monitoring system, production target achievement charts, and daily production monitoring which functions to create databases and menus on the water pump production dashboard. The details are described in Table 3 System Requirements in General.

Table 3: Sysrem Requirements in General.

No	Functional Requirement	Non-Functional Requirement
1	User can login with email and password	The system can accomodate large amounts of data
2	Certain users can download certain documents	This information system has a security system
3	Certain users can view certain dashboards	
4	The system can manage the access of interested users	
5	Certain users can input, edit, and delete	
6	Certain users can access certain menus	
7	The system can record time and related users whenever there is a change in data in the system	

4.1 Database Design

First thing to design a database is by make entity relationship diagram (ERD). ERD describes how the conceptual design of the database model for reporting the water pump production process (Btoush and Hammad, 2015). The conceptual model of this database is broadly divided into 8 parts, namely database for motor casing production, database for core & die cast motor production, database for pump casing production, database for rotor production, database for stator production, database for finishing parts, database for semi-finished products, and a database for the final assembly. ERD of production output database is shown on Figure 6.

4.1.1 System Design

The next step after determining the system to be built and the requirements that have been determined is to design related documentation. For system design, the diagram used is a Use Case Diagram which shows cases in the use of information systems. In database design, Entity Relationship Diagram is used as a conceptual model of the database and Relational Table to design the logical model of the database and the last is development planning using Data Flow Diagrams. Use case diagrams are used to describe the activities of actors or parties who will use the system against the system (Kendall and Kendall, 2014). Use case diagram of daily production monitoring are shown in Figure 7. There are 6 entities which are employee, management, leader, RFID reader, barcode scanner, and monitoring system.

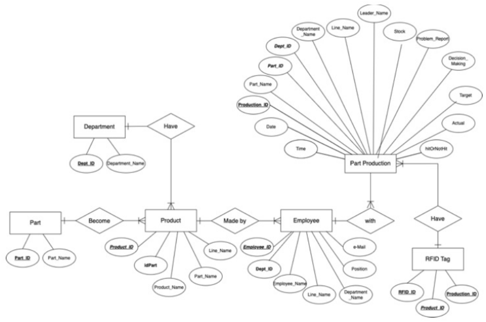

Figure 6: ERD of Production Output Database.

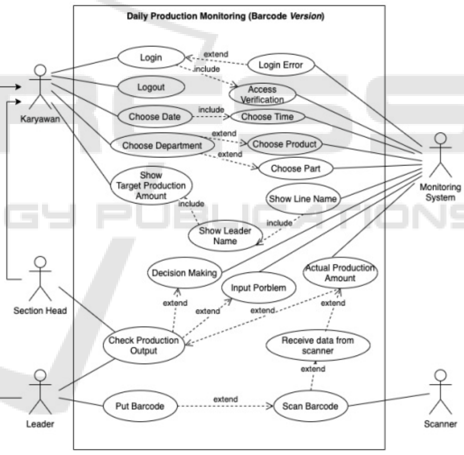

Figure 7: Use Case Diagram of Daily Production Monitoring (Barcode Version).

DFD shows the flow of data in the system which are input, process, output, and data store used (Kendall and Kendall, 2014). Figure 8 displays a context diagram on a water pump production monitoring information system using RFID and barcode scanner. The context diagram describes six external entities that will be related to the daily production monitoring information system using a RFID reader or barcode scanner, namely management, leader, scanner, stock monitoring, production target achievement charts, and daily production monitoring.

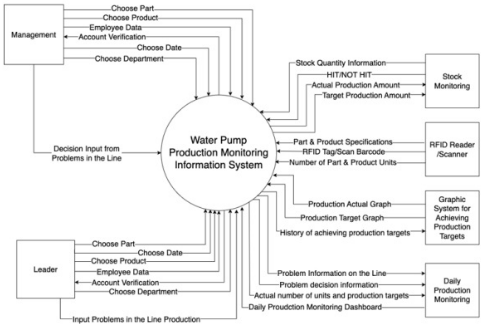

Figure 8: Data Flow Diagram of Water Pump Production Monitoring.

4.1.2 System Usage Flow

After designing the system which is the relationship between the actors and the system, designing the database and the relationship between each table in the database, the last thing to do is designing activities for a system. In this study, activity diagrams were used to provide an explanation for users about how to use the system and for software developers to make the system according to the user's wishes. In this study, activity diagrams were used to provide an explanation for users about how to use the system and for software developers to make the system according to the user's wishes (Kendall and Kendall, 2014).

4.1.3 Interface Design

The final design stage is interface design. Interface design is needed to make it easier for software developers to make it. Interface design also helps provide an overview of the results of the system design to prospective users. In this study, the interface design created on Microsoft Power BI with a desktop or web computer display. Figure 9 shows the daily production monitoring dashboard. In reporting problems in the line of stages, the first step is for the leader to click the link or scan the barcode. Then, the leader can fill out the form. By submitting the form, management will receive an e-mail notification of a problem report on the line. Then management can fill in the decision of the problem. The results of these reports and decisions will be immediately updated automatically because they have been integrated into the daily production monitoring information system.

4.1.4 Analysis

The improvement scenarios are analyzed by comparing the processing time of the simulation results and financial projections for selecting scenarios as described in Table 4. Scenario 3 produces the shortest processing time with a significant increase in changes, where the Automated Recording System with RFID chip tags and Automated Monitoring System with Power BI added in scenario 3 provides a greater change delta than the Automated Recording System with RFID Chip Tags in scenario 1, Automated Recording System with Barcode Scanner in scenario 2, and Automated Recording System with barcode scanner and Automated Monitoring System with Power BI in scenario 4. However, scenarios 1 and 2 only implement RFID chip tag solutions or a barcode scanner that can be developed in combination with other solutions in scenarios 3 and 4 to improve financial projections over a longer period.

Financially, scenario 3 requires the largest initial investment cost because it is a combination of an Automated Recording System with RFID chip tags and an Automated Monitoring System with Power BI. However, when compared to scenario 4 which requires lower initial investment costs plus scenario 4, it provides the largest net present value (NPV) among the four scenarios over a longer period, in this case within 12 months. The internal rate of return (IRR) given is also the largest for scenario 4, which indicates that by taking risks from large investment costs, companies can obtain higher profits as well. In addition, scenario 4 is projected to have the shortest payback period, which is 5.9 months.

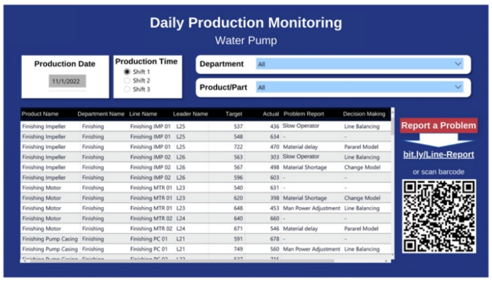

Figure 9: Data Flow Diagram of Water Pump Production Monitoring.

Table 4: Comparison of Processing Times and Financial Projection.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Process Time Before (Minutes)	74.85	75.33	54.78	55.15
Process Time After (Minutes)	30.15	29.67	50.22	49.85
Change (%)	28.71	28.26	47.83	47.48
Total Investment ($)	T13,965	3,385	23,464	12,877
Net Present Value ($ Million)	C18,644	30,434	49,065	57,611
Interest Rate Return (%)	15.75	29.62	23.69	35.36
Benefit Cost Ratio	1,463	1.997	1.925	2.265
Payback Period (Months)	7.7	6.5	6.8	5.9

5 CONCLUSIONS

To speed up time spend on water pump production output report, the company should implement information system as a form of digital manufacturing supply chain. There are four strategies to speed up water pump production output report. Scenario 1 is automated recording system with RFID chip tag. Scenario 1 can reduce cycle time of water pump production output report by 30.15 minutes or 28.71%. Scenario 2 is automated recording system with barcode scanner. Scenario 2 can reduce cycle time of water pump production output report by 29.67 minutes or 28.26%. Scenario 3 is a combination of automated recording system with RFID chip tag and monitoring system with Power BI. Scenario 3 can reduce cycle time of water pump production output report by 50.22 minutes or 47.83%. Scenario 4 is a combination of automated recording system with barcode scanner and monitoring system with Power BI. Scenario 4 can reduce cycle time of water pump production output report by 49.85 minutes or 47.48%. Scenario 3 is the best scenario in reducing cycle time water pump production output report. However, the selection of scenarios depends on the company's finances and needs.

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