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The Design Of Engineering Business Process Using Six Sigma Framework PT. Energi Makmur

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Abstract: The SARS-CoVID-19 pandemic has had a devastating impact on various sectors, prompting countries worldwide to implement measures like social restrictions. PT. Energi Makmur, a national Engineering Procurement and Construction Company, adapted to these changes during the pandemic, facing numerous challenges while striving to deliver products to clients within specified timelines. This final project aims to create a novel business process for the Front End Engineering Design phase that can effectively operate under social restrictions, removing the need for physical coordination typically conducted in an office setting. Using the Design for Six Sigma framework, incorporating Define, Measure, Analyze, Design, and Verify steps, this project seeks to maintain internal approval timelines akin to those in normal conditions. Primary data collection involves interviews, group discussions, and surveys, while secondary data is gathered through internal document review. To identify root causes, methods like the current reality tree and the 8 waste theory are employed, while the FMEA method is utilized to prioritize solutions, and the Kano model verifies the design. Nine proposed solutions emerged from the design phase, with seven slated for implementation in upcoming projects after the verification stage.

Keywords: Business Process, Design for Six Sigma, Engineering, FEED

INTRODUCTION

On December 31st, 2019, the Wuhan Municipal Health Commission reported a series of pneumonia cases in Wuhan, Hubei Province, China, marking the initial discovery of the Novel Coronavirus (*CDC Museum COVID-19 Timeline*, 2023). This eventually escalated from an isolated occurrence to a global pandemic. In response, the Government of Indonesia implemented stringent measures, such as large-scale social restrictions, authorized through Government Regulation no. 21/2020 on March 31st, 2020, aligned with health quarantine law no. 6/2018 (Post, 2020). These actions necessitated companies like PT. Energi Makmur to adopt remote work setups. Analysis of internal approval times for Front End Engineering Design (FEED) documents between 2021 and 2017 reveals a slower approval pace during the

pandemic compared to the pre-pandemic era (*Annual Report 2020 Transforming & Elevating Value for The Future*, 2020).

The research aims to pinpoint the factors causing delays in a company's engineering processes during the Covid-19 pandemic, develop solutions to sustain engineering activities amid the pandemic, and devise new business processes suited to these circumstances. Specifically focusing on FEED documents involving Piping and Instrumentation Diagrams, Specifications, Data Sheets, Calculations, Studies, Detail Drawings, and Technical Bid Evaluations, the study employs the Design for Six Sigma framework. This framework facilitates the creation of resilient business processes that can uphold engineering activities and maintain internal approval timelines in the event of future pandemics or social restrictions. The proposed business process involves four key elements: the Originator as the document creator, the Supervisor delegating the work, Quality Assurance/Quality Control (QA/QC) ensuring document quality, and the Engineering Manager coordinating engineering activities. The interrelation among these elements in the hierarchy is depicted in a swimlane diagram of the engineering process.

The Design for Six Sigma (DFSS) method is known as DMADV, consisting of five distinct phases: Define, Measure, Analyze, Design, and Verify. The Define phase involves setting project objectives and determining customer deliverables. It begins by identifying an issue needing a resolution and concludes with a clear understanding of the problem's scope. The primary concept behind this phase is that most operational problems in an organization are linked to processes or sets of activities. In the Measure phase, the focus is on gathering baseline information about the process targeted for improvement. Analyze comes next, aiming to enhance understanding of the cause-and-effect relationship in the process, determining which input factors influence the output/product/service (Setter, 2018) (Pyzdek & Keller, 2010).

Moving to the fourth phase, DMADV works on designing a new process, incorporating testing solutions and also involves mapping, workflow principles, and constructing new infrastructures. The Verify phase monitors the implementation of improvements to ensure the sustainability of business processes, aligning them with the initial needs identified in the Define stage (Setter, 2018) (Pyzdek & Keller, 2010).

Swimlane diagrams categorize processes and decision lines, indicating the groups or categories each subprocess or decision represents. These diagrams can have either vertical or horizontal line arrangements, mirroring the process flowchart. They are useful for mapping out entire processes, roles, responsibilities, and interdependencies of specific individuals or groups (GoLeanSixSigma.com, 2014).

The term "Muda" in Japanese translates to "Waste." Initially, Taiichi Ohno, the Chief Engineer at Toyota, described seven wastes as part of the Toyota Production System (TPS), later identifying an eighth. These wastes include defects, overproduction, waiting, non-utilized talent, transportation, inventory, motion, and extra processing. In an engineering context, these wastes apply by substituting the object from product to document, except for non-utilized talent and motion. Inventory waste is not considered in engineering activity as it is not produced (Pieńkowski, 2014).

A Current Reality Tree outlines symptoms stemming from an underlying core problem. It maps a sequence of causes and effects, connecting symptoms to the central issue. Most symptoms can be traced back to a core problem or conflict, often revealing the core issue by working backward from undesirable effects/symptoms (Mabin, 2015).

Failure Mode and Effect Analysis (FMEA) systematically describes and addresses potential problems or failures and their impact on systems or processes before they occur. This method involves a team evaluating potential factors affecting a product, suitable especially when working on a new product without historical data. FMEA evaluates effects,

causes, and detection, quantitatively or qualitatively rating each and multiplying these ratings (Snee & Rodebaugh Jr, 2008).

The Kano Model, introduced by Dr. Noriaki Kano in 1984, assesses the impact of features or services on customer satisfaction, distinguishing between expected and new/additional features or services in a product. This model helps identify gaps in product offerings and customer research, guiding development teams on which requirements or features to include, enhance, reduce costs, exclude, or leave unchanged. The Kano Model classifies features into six categories: One Dimensional, Must-be, Attractive, Indifferent, Reverse, and Questionable (Rashid, 2010).

METHOD

The methodology commences with (1) identifying the problem through group discussions. Following this, (2) the lead time is measured using baseline data collection. (3) Analysis of the primary cause is conducted by gathering data through interviews with respondents, aligning the answers with the 8 waste group theory to map symptoms and creating a current reality tree to identify the root cause. (4) Designing a business solution involves interviewing to pinpoint solutions to the root cause, conducting group discussions to analyze solution responses, and modeling document prioritization using the FMEA approach. Once document prioritization is established, countermeasure actions are applied based on priority, shaping both countermeasures and business solutions into three proposed new business processes. (5) Verification of the preceding steps is accomplished using the Kano model. This includes listing the points, generating functional and dysfunctional questionnaires, and conducting surveys with customers. These five steps are outlined in Figure 1.

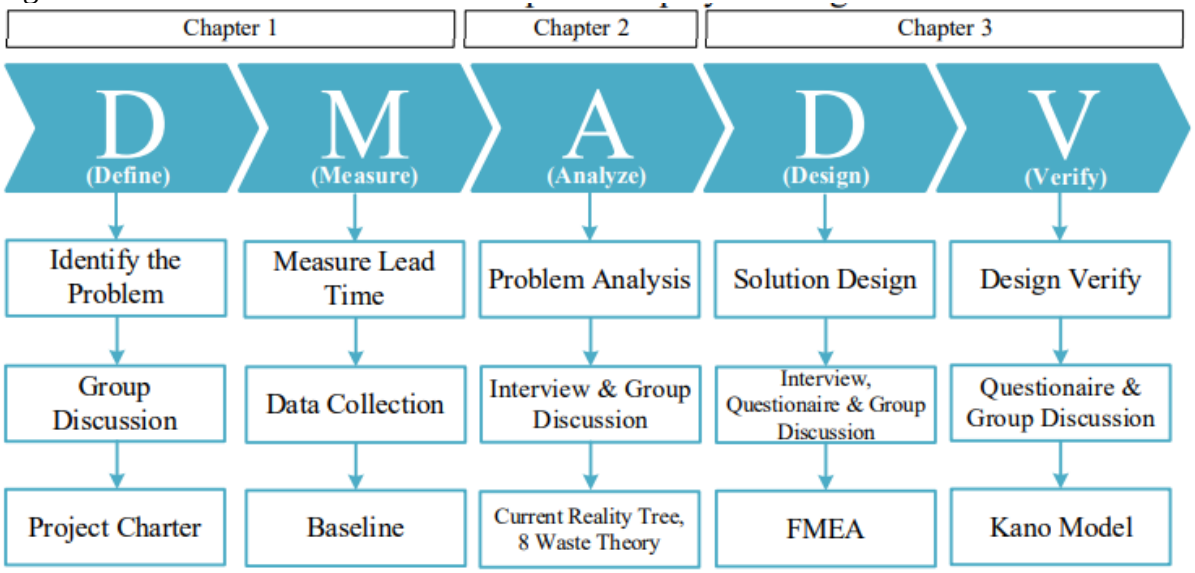

Figure 1. Research Methodology

RESULTS AND DISCUSSION

In the initial phases (Define & Measure), the focus was on identifying the problem and establishing a baseline to comprehend the impact of the pandemic on engineering business processes. These stages revealed that the 2021 FEED project experienced significantly longer lead times in the 2nd and 3rd submissions (9.46 & 7.98 gap days) compared to the 2017 FEED project, which shared similarities in scope and value.

Moving to the third step (Analyze), data collection involved interviewing staff involved in the project to pinpoint symptoms contributing to the delayed lead times during the pandemic's work setup. The interview findings were categorized into the 8 waste categories,

identifying 6 waste categories responsible for the delays: defects, waiting, non-utilized talent, transportation, motion, and extra processing. These categories were further explored to identify undesirable effects, aiming to discover the root cause through the current reality tree. The analysis indicated that 3 out of the 6 categories were the root cause: waiting related to preparation for remote work and necessary tools, transportation concerning task/document flow monitoring within the project, and motion associated with coordination and application utilization for monitoring and work. The analysis of the current reality tree is presented in the appendix.

Moving on to step four (Design), the root causes were mapped onto a swimlane diagram, as depicted in figure 2.

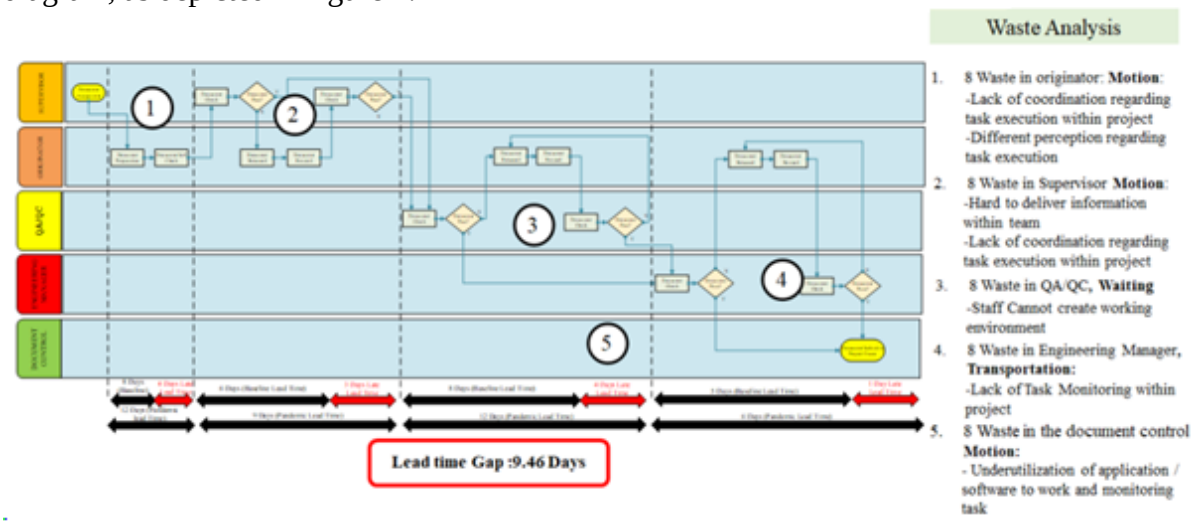

Figure 2. Waste Analysis of Swimlane Diagram

Data collection was conducted to address the three root causes identified in the preceding section. Within the waiting category, solutions were designed to tackle tools handover and training. For the transportation category, the proposed solutions included software or application upgrades for notifications and organizing socialization meetings for tasks. In addressing the motion waste category, the plan involved scheduling regular coordination meetings to disseminate information or instructions to the team.

Additionally, to mitigate the four internal approval procedures, a document prioritization system was designed using the FMEA method. A survey was carried out by the committee to score these documents, assigning a weight ratio of 30% to the Engineering Manager, 20% to QA/QC, and 15% to the Supervisor. The results obtained from the data collection and processing categorized the documents accordingly: Piping & Instrumentation Diagram as priority 1, Specification, Study, and Calculation as priority 2, Datasheet and Detail Drawing as priority 3, and Technical Bid Evaluation as priority 4.

Addressing the handling of these document priorities, a special committee was proposed to review priority 1 documents immediately after submission by the originator. Priority 2 documents would involve establishing a direct communication line between the reviewer and originator through telephone or social media to resolve comments after the document's return. Priority 3 document evaluation outcomes would be conveyed via graphical or textual representations and delivered to the originator through mail or social media. Lastly, priority 4 documents would undergo revision based on the comments received. The summary of step 3 is detailed in Table 1, and the updated swimlane diagram is depicted in Figure 3.

Table 1. Summary of Design Business Process to mitigate root cause

No	Root Cause	Description	Existing Condition	Improved Design Recommendation
1	Waiting	Staff cannot create working environment	Bad Internet Connection	Provide hardware and mobile broadband connection to work remotely.
			Need additional tools (monitor,Internet, etc)	
			External Disruption	Provide training to empower staff to be more discipline and proactive when working remotely
2	Transportation	Lack of task monitoring within the project	Notification by mail & application dashboard	Improve application to sent notification on social media
			Staff doesn't aware due date	Socializing Document Workflow & Due date
3	Motion	Underutilization of apps / software to work and monitoring task	Hard to monitor task & deliver information to PIC	Schedule Coordination Meeting Regularly
		Lack of coordination regarding task execution within project	Less coordination between staff	
4	New procedure for internal approval	Document Prioritization to accelerate internal approval	Conventional approval procedure time 37.22 days	Approval using 4 priority level (Target 20 days):
				Priority 1: Creating new committee for internal document approval
				Priority 2 create a direct link between checker and originator to discuss the comment via meeting application or social media
				Priority 3 : Checker create a message explaining the comment via email / chat on social media
				Priority 4: the document returned with comment as usual

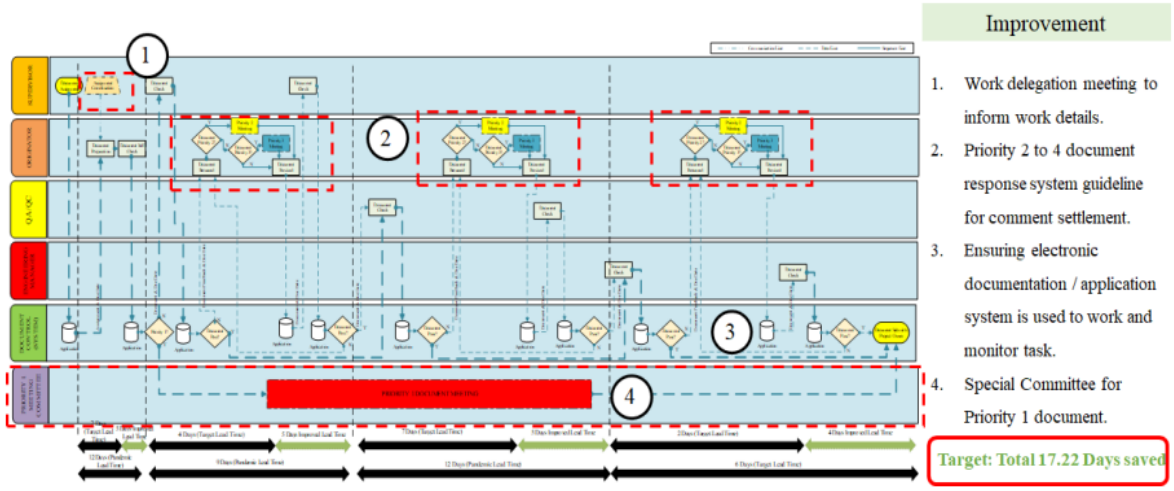

Figure 3. Proposed Swimlane Design

In the final step (Verify), the validation of proposed business solutions is conducted through the implementation of the Kano model. Surveys are administered to customers, employing solution points that have been transformed into both functional and dysfunctional questionnaires. The outcomes of this survey are classified into the five Kano categories, determining approval based on these categories. Out of the nine proposed solutions, seven points are approved for implementation in the subsequent project. The validated business process is itemized in Table 2.

Table 2. Verified Business Process Result

Item	Solution Description	Status
1	Provide hardware and mobile broadband connection to work remotely.	Accepted
2	Provide training to empower staff to be more discipline and proactive when working remotely	Accepted
3	Improve application to be able to send notification on social media	to be reviewed
4	Socializing Document Workflow & Due date	Accepted
5	Schedule Coordination Meeting Regularly	Accepted
6	Approval Priority 1: Creating new committee for internal document approval	Accepted
7	Approval Priority 2: create a direct link between checker and originator to discuss the comment via meeting application or social media	Accepted
8	Approval Priority 3: Checker create a message explaining the comment via email / chat on social media	Accepted
9	Approval Priority 4: the document returned with comment as usual	to be reviewed

CONCLUSION

Three primary causes contribute to the delay in internal approval lead time: (1) waiting, linked to the acquisition of working tools and readiness for remote work; (2) transportation, associated with the flow of tasks or documents; and (3) motion, emphasizing enhanced coordination and software or application utilization. To address these issues, verified solutions have been identified: (1) mitigating waiting by providing necessary tools and training for efficient remote work; (2) addressing transportation issues through task socialization among staff; and (3) managing motion concerns by scheduling regular coordination meetings to disseminate information/instructions to the team.

Furthermore, in addition to these solutions, a new business process has been established, encompassing four document prioritization strategies. These include forming a special committee to address Priority 1 documents, establishing direct communication between originators and reviewers for comment resolution, submitting detailed comments via email or social media for Priority 3 documents, and requiring originators to revise comments on Priority 4 documents.

Comparing the pandemic-era working process with the new business process, it's evident that the latter has shorter lead times. This is attributed to the provision of tools and training, regular coordination, and a structured review settlement procedure.

Further recommendations entail evaluating document prioritization based on project necessity, allocating a budget for the implementation of this new business process beforehand, expanding communication methods beyond recent technological advancements, considering adaptability to various communication means, conducting further studies on notification systems, and enhancing the settlement procedure for Priority 4 documents.

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