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FOCUS AND SCOPE

RIESTECH

Recent in Engineering Science and Technology **(RiESTech):** I*SSN: 2985-704X (print), ISSN: 2985-8321 (online)* a peer-reviewed quarterly engineering journal, publishes theoretical and experimental high-quality papers to promote engineering and technology's theory and practice. In addition to peer-reviewed original research papers, the Editorial Board welcomes original research reports, state-of-the-art reviews, and communications in the broadly defined field of recent engineering science and technology. **RiESTech** covers topics contributing to a better understanding of engineering, material science, computer science, environmental science, and their applications. **RiESTech** is concerned with scientific research on mechanical and civil engineering, Electrical/Electronics and Computer Engineering, and Metallurgical and Materials Engineering with specific analytical techniques and/or computational methods.

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Metallurgical and Materials Engineering (Advanced Materials Science; Ceramic and Inorganic Materials; Electronic-Magnetic Materials; Energy and Environment; Materials Characterization; Metallurgy Extractive; Polymers and Nanocomposites)

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PREFACE

Journal RiESTech (p-ISSN: 2985-704X (print), e-ISSN: 2985-8321 (online); is a peer review journal published by PT Mencerdaskan Bangsa Indonesia. The RiESTech journal is published four times a year in January, April, July, and October. This journal provides direct open access to its content on the principle that making research freely available to the public supports a greater global exchange of knowledge within the engineering field. This journal aims to provide a place for academics, researchers, and practitioners to publish original research articles or review articles. The scope of articles published in this journal relates to various topics in the field of outcomes of research activities.

The RiESTech journal publishes papers strictly following the RiESTech guidelines and templates for manuscript preparation. All submitted manuscripts will go through a double-blind peer review process. The paper is read by members of the editor (according to the area of specialization) and will be screened by the Managing Editor to meet the criteria required for RiESTech publication. Manuscripts will be sent to two reviewers based on their historical experience in reviewing manuscripts or based on their areas of specialization. RiESTech has review forms to keep the same item reviewed by two reviewers. Then the editorial board makes a decision on the comments or suggestions of the reviewers.

Reviewers provide an assessment of originality, clarity of presentation, contribution to the field/science. This journal publishes research articles, review articles/literature reviews, case reports and concept/policy articles, in all fields of Computer Science, Informatics Engineering, Multimedia, Arts. The article to be published is an original work and has never been published. Incoming articles will be reviewed by the reviewer team.

The Editorial Board will try to continue to improve the quality of the journal so that it can become an important reference in the development of engineering sciences. The greatest appreciation and gratitude to Mitra Bestari along with members of the Editorial Board and all parties involved in the publication of this journal. Complete writing instructions are displayed on the portal of this journal.

Regards,

Chief Editor

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Article

The Development of an Ergonomic-Based Roadmap for Improving Passenger Mobility Onboard Intercity Trains in Indonesia

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Abstract: Today in Indonesia, intercity railway service has become an essential part of human mobility and can carry more than 298 million passengers in 2022. It is a reliable service since it can carry many passengers and is a form of time-efficient mode of transport. More and more people are using this service including disabled passengers. They are using the railway to travel between the cities. The railway industry has changed a lot in recent years. If we look at the 90s and before, traveling by train was almost entirely used by non-disabled people and very few of the passengers are people with disabilities. It has now changed while some disabled passengers used the rail, and it created some issues for the industry. This service for disabled passengers is a part of Equality, Diversity, and Inclusion (EDI) and the Author found a mismatch between what the disabled passenger wanted and what the industry responded to. This research will try to understand what is happening in the Indonesian railway industry, compare it with the same issue in another country like the United Kingdom (UK), and what or how to get the ideal design and service for intercity onboard service for disabled passengers. This research uses the triangulation ergonomic principle which consists of measurement, observation, and consultation to combine a literature study and interviews with representatives of 4 stakeholders in the Indonesian railway: 1) A regular user of disabled passenger; 2) Executive Director of one of the Indonesian disability passengers Organization; 3) Traffic coordinator of the Directorate General of Railway (DGR) in the Indonesian Ministry of Transport; 4) A Vice President of the Passenger Division from PT. Kereta Api Indonesia (Persero)/KAI, an intercity railway operator. This interview is then combined with the data from the literature study then analyzed with several methods like Quality Function Deployment (QFD) to get the ideal coach design, Communication-Persuasion Matrix theory to address the communication gap between the parties and make an ideal roadmap solution with phasing approach.

Keywords: Disabled passengers; EDI; Indonesian railway industry; t=Triangulation ergonomic principle; PT. Kereta Api Indonesia; QFD

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1. Introduction

Equality, Diversity, and Inclusion, or EDI, is important in human social life. It has affected many dimensions, including human mobility through transportation. The railway is one of the favorite means in the transportation industry. The railway is the best option for moving many people with its characteristics, so having a reliable service is essential. Equal and inclusive service to all passengers, whether disabled passengers or passengers without disabilities, will give a good journey experience, especially in intercity trains. However, in some countries, especially when talking to most of the developing

countries, the quality level of service is not yet settled compared to developed countries like the United Kingdom (UK). In this research, the Author will focus on his own experience in the Indonesian railway industry, where there are generally insufficient levels of proper service for disabled passengers [1].

This condition does not mention the ergonomic principles used on board train journeys. For example, the seat design could be more comfortable for several hours in cheaper economy-class intercity train services. The seat is 90 degrees upright with a non-reclined seat. Another important ergonomic feature that needs to be improved is the lack of space for wheelchair movement. It includes the problem of the gap between coach and platform levels that make it difficult for wheelchairs to access. Those two cases reflect the ergonomics and engineering improvement requirements in Indonesia.

Having better quality and utilization of ergonomic principles in railways, especially in the onboard service of the intercity train for disabled passengers, is important. Equality service for all passengers with or without disabilities is a must. Besides making the transport network accessible to those with impairments, designing transport to be accessible to all offers several advantages [2,3]. The lack of adequate disabled passenger service led to decreasing interest in disabled transportation. Therefore, an improvement must be made to elevate the number of disabled passengers [4,5].

This research is addressed to improve the quality of the service on board the train for disabled passengers (emphasizing mobility impairment as a wheelchair user) in Indonesia. The purpose is to propose a design, scheme, or road map to improve the service level in terms of ergonomic principles that suit engineering concepts. This will also become a starting point for further research related to ergonomics engineering in passenger service. The objective includes understanding the ergonomic principles, mobile impairment type of disability, and the Indonesian railway industry landscape.

2. Materials and Experiment Methods

In this study, collecting data is a part of primary qualitative research. There is a mechanism for collecting data through a series of interviews involving certain respondents/participants who have been selected according to the areas of their expertise. They also can be representatives of some party or organization. The collected data is categorized as primary, which takes it directly from the source. This method is used to obtain a perspective that cannot be measured in specific measurements from the subject/participant. The advantage of this qualitative method is that we can obtain detailed and more in-depth data compared to quantitative methods, while the disadvantage is that it cannot be used for a wider audience and cannot generalize existing data because it is specific [6]. This technique is a popular research method besides the quantitative research method which focuses more on the amount of data collected as a database.

On the other hand, interviews along with the literature study are also part of the triangulation principle to get the validity of information input. Rothbauer [7] describes it to validate and analyze the phenomenon in more than one way. It was first examined by Campbell and Fiske [8] in 1959 in their research about convergent and discriminant validation using multi-methods. Combining interviews and literature studies is a triangulation process to make the data more reliable.

2.1. Qualitative Research Methodology

Qualitative research methods through interviews are part of qualitative research. In addition to the interview method, there are several types of primary data search, namely surveys, questionnaires, observations, and Focus Group Discussions (FGD). In this study, the authors chose the interview because it can represent several stakeholder categories as research subjects on ergonomic improvement for mobility impairment in intercity passengers for railway onboard the train in Indonesia. Four categories of stakeholders represent all parts of the Indonesian railway industry as follows:

1. A mobility impairment regular railway passenger as a representative of the end-user on board the train.
2. An Executive Director of a foundation that gathered the disability people in Indonesia as a representative of institutions that empower/advocate disability issues, especially in terms of railway.
3. Section Coordinator in Passenger Traffic on DGR in the Ministry of Transport as a representative of the regulator/Government body.
4. A Vice President of the Passenger Transport Division on KAI as a representative of railway operators in Indonesia.

The questions are in structured interviews (as the questions were already set up before launch) with additional leaflets as a media of communication. On the leaflet, the Author describes the details of the research (including the description, aim, compensation, data security, etc.) and, in the end, asks for permission from the participants by putting in their sign-in consent form. It is part of an ethical protocol from the University and UK law. In this case, Jennifer Mason [9] also stated the importance of an ethical document as a boundary for an interview to avoid violating personal boundaries and general ethics.

2.2. Piloting Interview

Before conducting interviews with existing participants, the authors conducted a pilot interview to determine how effective the questions would be. Several postgraduate and Ph.D. students in the Author's environment agreed to become pilot interview subjects, and they provided input regarding these questions. The revised questions will then be addressed to the selected participants. To acquire the best possible data in the interview, the atmosphere of the interview must be enjoyable and non-threatening. The Author must suit the time differences between the UK and Indonesia and stand neutral to avoid bias. Conducting a pilot interview is also an essential part of qualitative research since it highlights the process of the major study itself [10]. The perspective given by the piloting interview respondents can become a breakthrough to improve the interview.

There are 4 categories of respondents used in this research, with one proportion coming from the public and the remaining three being experts in the railway sector, including: Disabled users, Disability Organizations that provide for the needs of people with disabilities, Train operator, and Railway Regulator (Ministry of Transportation).

3. Results and Discussion

The Author decided to summarize all the gaps into questions as a simple way to dig deep into the answer that in the end will be the foundation to creating a road map. The four questions are a tool to develop a road map framework for the future of railways in Indonesia. The first question will focus on how to plan an ideal coach design that can meet the needs of disabled passengers. By answering this question, it is expected that all their needs will be addressed. The second question will focus on the concept of good service for disabled passengers on trains. The answer to this question will present a service concept that upholds EDI. Services that can also eliminate discrimination and make disabled passengers feel safe and comfortable.

The third question emphasizes how to overcome differences in perspective between disabled passengers and their supporting organizations as users vs. KAI and DGR as service providers regarding the utilization of existing services. This question will seek a solution that unites the opinions of both parties and maximizes the use of existing facilities. The answer can also be a medium for collecting data on the number of disabled passengers who use the intercity railway services which is currently not yet available in Indonesia.

The final question focused on how to create the best systems and regulations for this situation. By answering the fourth question, the Indonesian railway industry will be better regulated. These four questions are a single entity that must be answered and resolved in a holistic approach so that the obstacles that have occurred for passengers with disabilities can be resolved. This will provide a sense of security and comfort for them when traveling by train between cities.

Based on the above gap recapitulation, the Author comes to several questions to be addressed in this research. It needs a comprehensive solution to overcome this problem and make the journey for disabled passengers more seamless. The author will use a problem-solving mind map and graphical analysis with analysis to answer 4 questions. All stages 1-4 are determined through weight ranking which is based on calculations using the QFD method, persuasion-based communication.

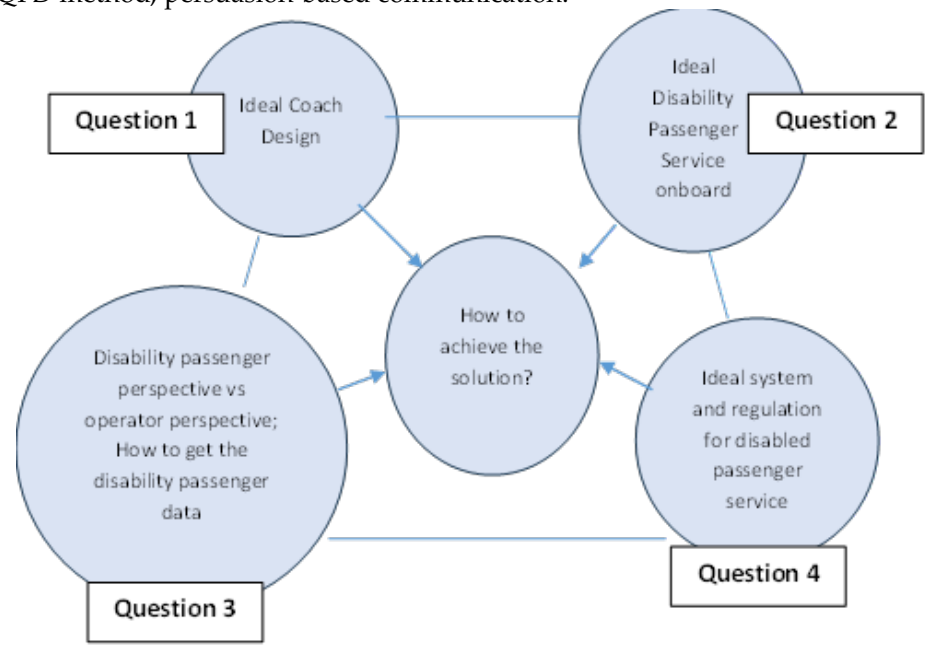

Figure 1 Questionary Research Gap Diagram

3.1. Question 1: Ergonomic Principle in Coach Design with Quality Function Deployment Method

In this section, the Author will discuss how to create a solution for the above-resumed condition of ergonomic improvement of mobility-impaired passengers of the intercity railway in Indonesia. This section will analyze how the ergonomic principles will suit the design of ideal seating, tables, toilets, access, and interior parts of the railway coach. The author is using the theory of Quality Function Development (QFD) and the House of Quality (HOQ) approach as a tool to get the idea of an ideal ergonomic and mobility impairment-inclusive product design based on customer input. it can also act as the basis of further research on what is ideal for coach design in the later recommendation section.

The QFD was initially designed by Yoji Akao in 1966 [11,12,13] and became the basis of the project design scheme used today. Many companies use this method to create new product designs as it is expanded to HOQ. In this case, based on a previous interview, the Author can create a basic QFD design to create an ideal description of the inclusive product design of the coach that suits ergonomic principles. QFD is based on the customer needs and functional requirements can be seen in table 1. Meanwhile, the QFD matrix can be seen in figure 2.

Table 1. Quality Function Deployment Table

Importance rank	Passenger Requirement	Function Requirement
1	Wheelchair Safety	Distance between seats and isle
2	Wheelchair space availability	Wheelchair storage size
3	Easy access in/out from the coach	Door and isle size
4	Door design and easy access	
5	Isle design and easy access	
6	Accessible toilet for disabled passenger	Toilet size
7	Emergency button aid and availability	Emergency button design
8	Dedicated personal table on the disability seat	Distance between seats and isle
9	Caregiver dedicated seating	

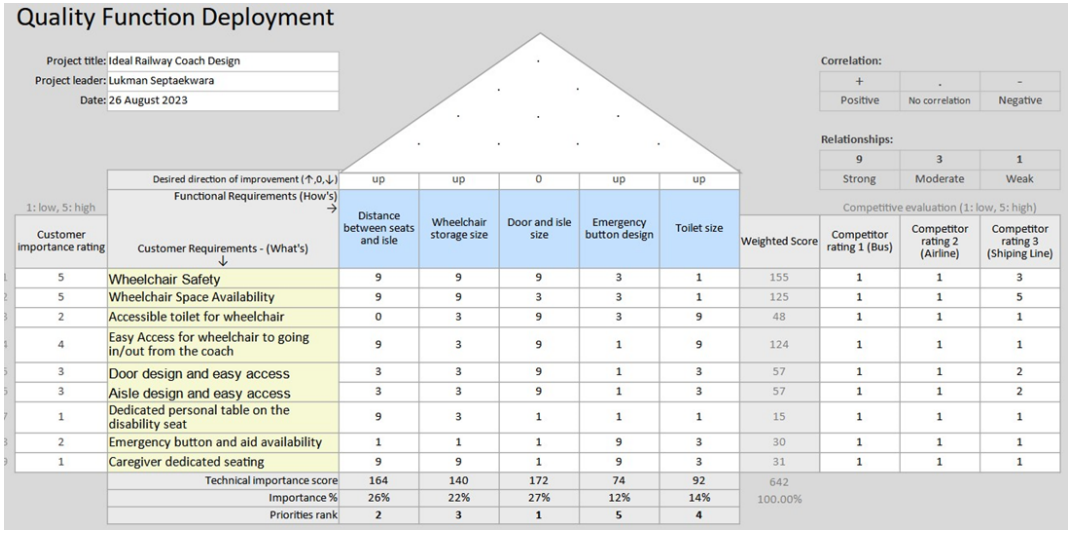

Figure 2 Quality Function Deployment Matrix

After conducting QFD, we can see that door and aisle size is priority no 1 to review to get the best design. INKA product now supports the wheelchair size; however, the access door is manual since the automatic system from the previous batch is unreliable. That is the crucial issue to be solved. The second is the arrangement of seats and aisles. Then the wheelchair space is priority no 3, redesigning the toilet on no 4, and the availability of the emergency button is the last priority. In competition with buses and airplanes, the railway coach is a clear winner since it can support the wheelchair. It can only be challenged by shipping lines. Because of the limitations of this research, further and detailed research in QFD and HOQ with financial analysis of coach redesign is also needed to emphasize this research. Also, further anthropometric analysis for the above coach redesign is important.

3.2. Question 2: Mobility Impairment Service on board the Train

Based on the literature review, legislation law, rules, and standard that are applied in most countries today, the Author can describe what is needed in the service for the disabled passenger on board the train as follow:

1. Passenger assistance is the most important service that needs to be provided by the TOCs. whether with or without the caregiver, the TOCs need to prepare the service for the disabled passenger/. It included the pre-booking service, wheelchair space booking, etc. which can be relied on artificial intelligence or Information Technology.
2. Platform level, platform ramp, and platform lift mechanism. This service assists the movement of the wheelchair from platform to coach or vice versa. It is a must for the majority of the train service so there will be no hassle on their journey.
3. Helpful and high awareness of railway staff especially onboard the train. KAI needs to add and train its staff to be more aware of disabled passenger needs.
4. Emergency facility and quick response procedure for serving the disabled passenger. There is a mobile contact number for the train attendance on board, but it will be better if they can provide the emergency facility (whether an emergency button, switch, lever, or in any kind form) to overcome the emergency.
5. Accessibility and responsive complaint channels. it needs to be added both physically via customer service or online and social media platforms.
6. Priority and special registration price and validated disability passengers in a membership program. It also can receive any kind of feedback from the passenger, and the registration process can act as a database to know how many disabled passengers use the intercity service.

With that kind of service provided onboard, we can address question no 2 about the ideal service level onboard the train. Disabled passengers will experience comfort, ease of access, and seamless in their journey.

3.3. Question 3: Communication Tool to Bridging the Perception Gap

In the UK in 2012, a survey conducted by ORR revealed that 70% of disabled passengers were not aware of the available passenger assistance scheme by the TOCs [14]. In Indonesia, even though there is no formal passenger assistance program, passengers (even non-disabled passengers) are not aware of the situation that they can call KAI to book a staff help. The only recorded statistical data is the wheelchair request in 2022 for 1,098 while there should be way more requests. Based on the same survey by Illuminas Consulting [14], 2 factors lead to low disability passenger awareness of service by TOC: they are not sure about their eligibility (they feel they can go by themselves) and they know that TOC doesn't have much staff and feel guilty if they have to ask for their help. Another fact is that they are not thinking of asking for passenger assistance when they are traveling with a caregiver.

This problem is having a significant impact on disabled passenger service, and it needs a tool to be solved. One of the gaps between customers and companies is the communication gap [15]. This gap shows the difference between what KAI decides to provide regarding a service-disabled passenger and what the disabled passenger receives and responds to. Lack of cohesion and communication between promotion, information, and service deliveries act as a cause of this communication gap. KAI, as obligated by law is providing the service but the disabled passenger is not aware of it. The Author uses the Communication-Persuasion Matrix by Yale University Professor William J. McGuire [16] to map promotional communication through social media as a powerful communication tool today. It is also supported by such offline campaign activities. That matriculated theory concludes in table 2.

Table 2. Communication-Persuasion Matrix

Input Factor	Definition	Implementation
Source	Whose person is responsible for delivering the message?	The company spoke person in the person in charge of this campaign. He/she can also delegate to the communication

		agency to conduct some campaign awareness for this project
Message	What is the form used to deliver the message?	Social media channels and offline and some offline campaign activities such as community gatherings, transportation events, etc.
Channel	How is the way the message delivered?	Posting ads in audio/video format, also mixed with an interactive method
Theme	What is the theme/topic of the message?	The main theme is to introduce the passenger assistance travel program to support disabled passengers. KAI needs to explain more of its disability service to the public
Intent	What action does the message call for?	To increase public awareness, especially the disabled passengers and their caregivers about the disability service provided by KAI
Receiver	For whom the message be delivered?	1. The disabled passenger 2. The caregiver 3. Disability passenger organization/Non-Governmental Organization related to disability issue. 4. General public
Effect	How successful is the message expected by the company?	It will be measured by the number of passenger assistance requests. If it increases, it means the communication program was successful

3.4. Question 4: Ideal System and Regulation

The last question is about the ideal system and regulation for supporting disabled passengers. From the above explanation, we can see that the essential needs of disabled passengers are already covered in the constitution, Governmental, or institutional regulation. But some more things need to be covered or updated to get a better idea of serving a disabled passenger onboard the intercity train in Indonesia. Those things are:

1. Passenger assistance needs to be updated in legislation. It consists of updating the service level of the staff, emergency button mechanism, etc.
2. The comfort, ease of access, safety, and dignity of the disabled passenger must be provided by the authority since they are guaranteed by the country's constitution. The government on the other hand must also give an appreciation to TOC who can satisfy the needs of the disabled passenger.

In Indonesia, there are 2 channels to raise the voice for regulation revision which is through DGR as a regulator or to the House of Representatives for higher-level legislation.

3.5. Planning for the Action: Integrated Roadmap for Disabled Passenger Onboard Service in Indonesian Railway

In this section, the Author will conclude the above discussion by planning some road maps using phase mode. It divided the questions and action into several phases to improve the level of service for disabled passenger. The Road Map Phasing for Indonesian Railway Disability Passenger Improvement can be seen in table 3.

Table 3 Road Map Phasing for Indonesian Railway Disability Passenger Improvement

No	Gap/Questions	Actions	Timeline/Remark
1	Ideal coach design	• Rearrange the coach layout by adjusting the access door. • Adding 1 dedicated wheelchair space • Rearrange the isle for wheelchair access, especially near the exit way and disability toilet. • Providing 1 disability toilet • Providing an emergency button for disability • Set up the Passenger Assistance Program • Training the staff for service improvement	Since it needs much effort to implement this program, it is considered the last phase of the road map. Financial analysis is crucial in this stage **(Phase 4)**
2	Ideal disability passenger on board service	• Preparing platform ramp. Also, a step-free access platform is an essential part to support this plan. • Disabled emergency procedure setup • Improving the complaint and problem-handling channels • Launching the disability registration and discount program	Because there is a physical project by setting up the platform ramp and other supporting facilities, it can be the second phase **(Phase 2)**
3	Perception gap communication strategy	• Utilizing the KAI mobile apps to support multifunction service to a disabled passenger. • Existing service promotion to the disability passenger, the caregiver, disabled organization/Non-Government Organization, or public	As this is already operated today and is not fully utilized, this will be the first phase of implementing this roadmap **(Phase 1)**
4	Ideal system and regulation	• Conducting the discussion, FGD, and other surveys and feedback from the implementation of Phase 1 and Phase 2 • Updating the legislation, regulation, and law	It needs to get the feedback from Phase 1 and Phase 2, so it will become **(Phase 3)**

Dividing the plan into several phases will make it easier to group the activities and measure the details of the plan to be carried out. Each phase has its own actions, timelines, and milestones which are described in table 15. The author plans the existing phases based on the level of difficulty and availability of resources:

1. Phase 1 creates a communication program and utilizes existing service facilities for disabled passengers. This phase is categorized as a simple and straightforward phase that can be done in a quick time of 1-2 years.
2. Phase 2 creates ideal service facilities for disabled passengers. This phase is classified as moderate difficulty because creating a culture of serving and delivering it for passengers with disabilities takes time, it will last 2-3 years.
3. Phase 3 creates systems and regulations. This phase has a moderate level of difficulty because it involves many parties/stakeholders, includes in-depth regulation studies, requires feedback and evaluation from the implementation of phases 1 and 2, and requires time to make decisions at the Government level. It is estimated that it will take 2-3 years for implementation.
4. Phase 4 creates an ideal intercity coach design. This phase is considered the most difficult difficulty because it requires research and development time, product trials, and certification from the Ministry of Transport. It also requires a manufacturing period and requires a large budget from KAI. This also includes replacing existing rolling stock with new ones. It will require 3-5 years for implementation.
5. The goal phase is the culmination of the entire roadmap where in this phase, all ideal conditions have been achieved which are expected to answer all problems for passengers with disabilities.

4. Conclusions

In Indonesia today, Passengers with disabilities are a category of passengers who are struggling to be able to enjoy intercity rail travel safely and comfortably. Currently, they feel that the services onboard the trains for intercity service are inadequate, such as no dedicated passenger assistance, less convenience for moving between platforms and trains, no dedicated wheelchair spaces, limited space for wheelchair movement on trains, etc. Many of them join the disabled passenger organization and often raise their concerns to TOC and regulators. On the other hand, both TOC and regulators have also carried out and established regulations that support disability services and routinely carry out controls through regular checks. The 2 perspectives that occur make the author feel the importance of conducting research that can overcome these things.

Based on the research conduct by the Author through several literature studies and interviews, it was found that:

1. The difference in perspective is quite sharp between the 2 parties, namely disability passengers who are supported by disability organizations with KAI as the operator and DGR as the regulator who has prepared the facilities that comply with the standard and regulation.
2. There is a comparison between Indonesia and the UK regarding railway statistical data, rollingstock specification, laws, and regulations as well as plans for their railway industry. An adjustment is needed to overcome the differences because considering the K is a country that is quite good at implementing EDI.

After going through a series of analyzes and discussions, several strategic steps are needed to improve the quality of services for passengers with disabilities which are outlined in the form of a road map which is divided into several phases. This phase emerged after analyzing the gaps that occurred and narrowing it down into 4 questions: “how to make an ideal coach design”, “what is the ideal disability passenger service onboard the train”, “how to bridge differences in perceptions between the parties”, and “how to make regulations that accommodate ideal needs”. These phases become important milestones

that will be able to bring about changes in service quality and become new standards for the future.

Author Contributions: Conceptualization, methodology, validation, formal analysis, investigation, writing—original draft preparation L.S.; supervision, validation, D.H and K.H; review and editing, A.A.

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Filter Cleaning System Modification to Improve Dust colletor

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Abstract: The filter cleaning system is a vital part of dust collectors, acting as a crucial barrier between dirty and clean air. Blockages in dust collectors often stem from insufficient maintenance affecting filter cleaning elements like valves, jetspray tubes, and bagcloth. Inadequate air pressure from the jetspray can worsen blockages by hindering dust removal from the bagcloth. Solving this issue requires a thorough reconditioning of filter cleaning components and optimizing jetspray pressure. To improve system efficiency, the capacity of the jetspray tube is carefully determined, following compressor specifications and complying with the ASME VIII Div I (Pressure Vessel) standard. The jetspray tube has dimensions of 1400mm x 8inch SCH20. A feasibility test evaluates the tube's allowable thickness and safety factor based on operational pressure. Precise calculations and adherence to industry standards ensure the structural integrity and safety of the jetspray tube. Using Solidworks 2020, stress simulations are conducted on the SCH20 pipe with a thickness of 6.35mm, operating under a pressure of 7 bar. The simulation results confirm the pipe's safety for use, validating its structural strength and compliance with safety standards. This comprehensive approach, involving both component reconfiguration and structural assessment, guarantees the dependable and secure operation of the filter cleaning system in dust collectors.

Keywords: Dustcollector; Filter cleaning system; Jet spray

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1. Introduction

A dust collector is a system employed to enhance the air quality resulting from industrial processes, capturing dust and other contaminants in air or gas. Blockages in a dust collector pose significant issues, particularly when dealing with flammable dust, as they can potentially lead to explosions [1-2]. The operational concept involves creating a reduced pressure on the suction side below atmospheric pressure [3]. In this process, contaminated air near the suction hole is drawn in, and subsequently, a filter is employed to separate dust from clean air. Dust Collector P1 utilizes the jet pulse cleaning system for filter cleaning, and you can observe its mechanism in Figure 1.

The operational process involves a running fan generating suction to pull in air mixed with dust from the foundry process in the Plant 1 area. This contaminated air flows through the ducting inlet to reach the filtration room within the dust collector. Inside the dust collector, the air undergoes filtration using bagcloth. The bagcloth allows clean air to escape through its pores, while the dust particles get trapped on the exterior of the bagcloth. To clean the dust adhered to the bagcloth, a high-pressure air spray is employed through a nozzle aimed at the bagcloth. The pressurized air causes the bagcloth to expand and vibrate, leading to the detachment of the dust particles, which then fall into the hopper for collection. This process ensures the effective removal of dust from the bagcloth, maintaining the dust collector's efficiency [4].

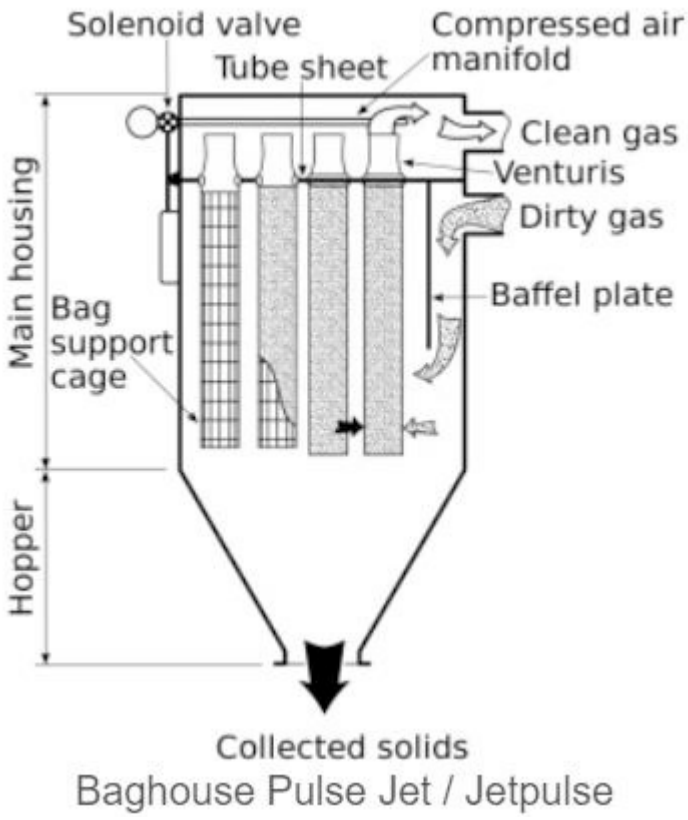

Figure 1. Working Principle of Jet Pulse Cleaning System

Deka Tech: https://www.dekafilter.com/

The filter cleaning system components are situated within the baghousing in the clean air area directly above the tubesheet. Unfortunately, this placement poses a significant challenge for maintenance as it complicates the inspection and control of all filter-cleaning system components. The filter cleaning system relies on maintaining an ideal air pressure, as insufficient pressure, below the standard requirement of 7 bar, can lead to blockages. Blockages occur when dust fails to fall properly into the hopper, sticking instead to the bagcloth, thereby obstructing the filtration flow. To address this, it is essential to standardize the jetspray pressure, commonly set at 7 bar, based on both table data and actual requirements.

To optimize the filter cleaning system's performance, this study aimed at modifying the number of nozzles, resizing the pipe from the tube to the nozzle, and adapting the air volume in the jetspray tube. These measures aim to ensure the system operates at the specified air pressure, minimizing the risk of blockages and enhancing the overall efficiency of the dust collector in the Plant.

2. Materials and Experiment Methods

The jetspray tube, functioning as a pressure vessel, stores air from the compressor and directs it to the purging pipe through a valve with adjustable open and close times. To align the jetspray tube's capacity with the intended 7 bar pressure, adjustments in its dimensions are necessary. This adjustment is essential for optimal functionality [6]. The calculation of the jetspray tube's capacity involves considerations such as compressor

specifications, the open-close time of the pulse jet valve, and the pressure drop occurring in the jetspray tube. This relationship is expressed mathematically in equation (1):

$$\boldsymbol{V = \frac{t \times C \times pa}{(p_1 - p_2)}} \quad (1)$$

In the design of Jetspray Tubes, particularly high-pressure vessels, it is crucial to calculate and select the appropriate material to prevent potential failures such as leaks or explosions. To ensure safety and reliability, the initial step in the design process involves the careful determination of the material. In this case, we have chosen 304 stainless steel, aligning with the properties of the SCH20 ASME B36.10 pipe [7]. The selection of 304 stainless steel is based on considerations such as the design temperature of the pressure vessel. This material exhibits a maximum allowable stress of 30,000 psi and incorporates a corrosion allowance of 3 mm. The corrosion allowance assumes a growth of 3 mm every 20 years. The mechanical data sheet summarizing the design parameters for the jetspray tube is provided in Table 1. This meticulous selection of material ensures that the jetspray tube is well-suited for its intended application, promoting both safety and longevity.

Table 1. Mechanical Data Sheet (MDS) of Jetspray Tub

DESIGN CODE : ASME VIII Div.1	
Design Pressure	7 [bar] ≈ 101.526 [psi]
Thickness	0,25 [in] ≈ 6.35 [mm]
Internal Diameter (ID)	206.40 [mm]
Operating Pressure	7 [bar] ≈ 101.526 [psi]
Corrotion Allowance	0,13 [in] ≈ 3 [mm]
Design Temperature	122 [°F] ≈ 50 [°C]
Capacity	72.24[L/min]
Maximum Allowable Stress (304 Stainless Steel pipe)	16000 [psi] ≈110.3161 [Mpa]
Length (Panjang)	1400 [mm]
Radius (R)	4.0629 [in] ≈103.2 [mm]

Certainly, the calculation of shell and head thickness in pressure vessel design typically follows the guidelines provided by ASME VIII for shell thickness calculation as shown in Eq. 2.

$$\boldsymbol{t_{design} = \frac{P \times R}{S \times E - 0.6\,P}} \quad (2)$$

$$\boldsymbol{t_{design} = \frac{P \times D}{2 \times S \times E - 0.2\,P}} \quad (3)$$

Validate the selected thickness using the following formula:

$$\boldsymbol{MAWP} = \frac{\boldsymbol{2 \times S \times E \times (t\,use - CA)}}{\boldsymbol{D + 0.2\,(t\,use - CA)}} \quad (4)$$

The Factor of Safety (*FOS*) is a measure that indicates the material's capability to withstand external loads, whether in the form of compressive or tensile forces. The determination of the Factor of Safety is typically done using the following formula:

$$\boldsymbol{FOS} = \frac{\boldsymbol{S_{yield\ strength}}}{\boldsymbol{\sigma_{equivalent\ stress\ Von - mises}}} \geq \boldsymbol{1.5} \quad (5)$$

Simulation analysis using structural loading operated on jetspray tube components with the help of Solidworks 2020 software using the static simulation method. [9]. This stress analysis simulation process aims to determine the resistance of the jetspray tube design results that have been made to the provision of 7 bar air pressure stored in the jetspray tube.

3. Results and Discussion

Final Results

The design steps to overcome the above problems are as follows:

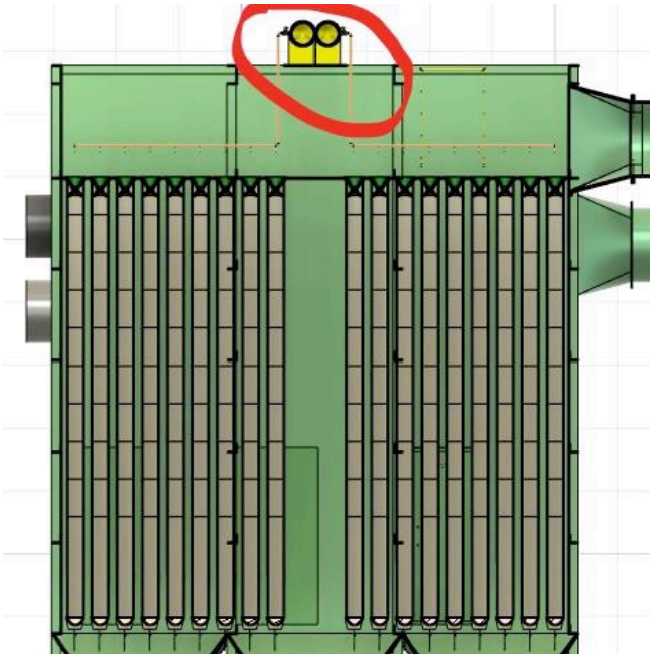

Figure 2. Filter Cleaning design before reconditioning

Adjustment of Filter Cleaning System Location

The adjustment of the location of the filter cleaning component is based on the previous location inside the bagfilter, which is a challenge as well as a difficulty for operators to perform maintenance or control the filter cleaning components, such as checking valve conditions, jet pulse tube pressure, and the condition of the PLC circuit inside. The actual layout of the filter cleaning system before adjustment can be seen in Figure 2.

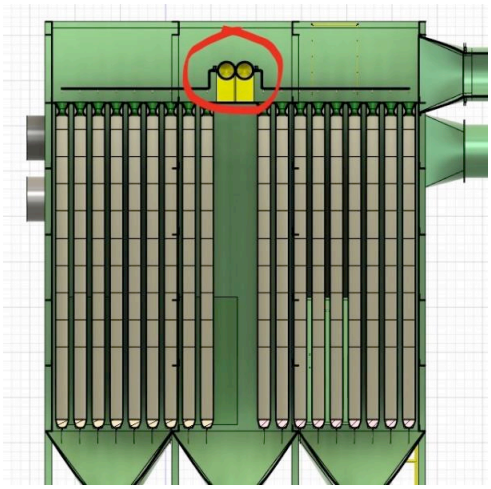

Figure 3. After adjusting the location of filter cleaning components

In the process of layout adjustment, a pivotal step involves relocating the filter cleaning component to a conveniently accessible area for both inspection and maintenance. This strategic placement involves situating the component on the external side of the upper door of the bag filter. The decision to position the filter cleaning component at the apex of the bag filter door is motivated by a noteworthy consideration—specifically, the cost reduction associated with minimizing the need for extending or modifying the Programmable Logic Controller (PLC) circuit and pipe arrangement during the installation phase [5]. The post-adjustment status of the filter cleaning component is visually represented in Figure 3.

Jetspray Tube Capacity Calculation

In determining the capacity of the jetspray tube, we use equation (1) in measuring the ideal air receiver tank for the compressor system with a jetspray volume of 36.12 liters. Where these results are the substitution of equation (1) with the data in Table 1.

Structure Analysis of Jetspray Tube

Pressure vessels, subjected to pressures higher than atmospheric, are categorized based on wall thickness into two main types: thin-walled and thick-walled vessels. Thin-walled vessels experience stress primarily in the circumferential and longitudinal directions. Conversely, thick-walled pressure vessels undergo stress in the circumferential, longitudinal, and radial directions. The stress distribution in the radial collar of thick-walled pressure vessels is particularly pronounced due to the substantial thickness of the vessel wall. Consequently, radial direction stress becomes a critical consideration in thick-walled vessels, in contrast to thin-walled vessels where radial stress is assumed to be uniform due to its less distinct nature.

These pressure vessels typically consist of four main components: shell, head, nozzle, and support. Together, they form a container designed to contain pressurized fluid. The nozzle serves as both the inlet and outlet for pressurized fluid, while the support functions to uphold the pressure vessel. The design parameters for the jetspray tube adhere to the standards outlined in the ASME VIII Div.1 Boiler and Pressure Vessel Code.

Calculation of shell thickness,

Calculation of shell thickness using the substitution of formula (2) with the data in Table 1.

$$t_{design} = \frac{101.526\ [psi] \times 4.0629[in]}{16000\ [psi] \times 1 - 0.6\ 101.526\ [psi]}$$

$$t_{design} = 0.02587[in] = 0.657[mm]$$

$$t_{design} + CA = 0.657\ [\mathrm{mm}] + 3\ [\mathrm{mm}] = 3.657[\mathrm{mm}](\mathbf{minimum})$$

Because a shell made from SCH20 pipe with a thickness of 6.35 mm is used, the shell design is categorized as safe.

Select Thickness by using formula (4) as follows:

Shell MAWP Calculation:

$$MAWP = \frac{2 \times 16000 \times 1 \times (0.25 - 0.13)}{8.1259 + 0.2\ (0.25 - 0.13)}$$

$$MAWP = 471.1714\ [psi] = 32.4861\ [bar]$$

MAW$471.1714\ [psi]$ =P = → $32.4861\ [bar]$

$P_{max.\,allowable\ working\ presure} > P\ design$

$32.4861\ [bar] > 32.4861\ [bar] \ggg safe$

Head thickness calculation:

Calculation of head thickness using the substitution of formula (3) with the data in Table 2.1.

$$t_{design} = \frac{101.526\ /\mathrm{psi}/ \times 8.058\ [\mathrm{in}]}{2 \times 16000\ [\mathrm{psi}] \times 1 - 0.2\ (101.526)\ [\mathrm{psi}]}$$

$$t_{design} = 0.02558/\mathrm{in}/ \approx 0.6497\ [\mathrm{mm}]\ (\mathbf{minimum})$$

$$t_{design} + CA = 0.6497\ [\mathrm{mm}] + 3\ [\mathrm{mm}] = 3.6497\ [\mathrm{mm}]\ (\mathbf{minimum})$$

Because a shell made from SCH20 pipe with a thickness of 6.35 mm is used, it means that the head design is categorized as safe.

Safety Factor Calculation

Based on ASME section VIII Div.1 for its safety factor ≥ 1,5 [8]. Calculation of factor of safety using formula (5) with substitution of yield strength and equivalent maximum stress.

$$SF = \frac{30000[psi]}{12348.315\ [psi]} \geq 1.5$$

$SF = 2.4294 \geq 1.5$ (Simulasi Stress Solidworks 2020)

Since the Factor of Safety value is greater than 1.5 in accordance with the ASME section VIII Div.1 standard, the design used is categorized as safe.

Stress Analysis of Jetspray Tube Structure

Following the utilization of SolidWorks 2020 software for both 2D and 3D modeling, a simulation process was undertaken using 304 stainless steel material. The simulation aimed to analyze the structural behavior, with a specific focus on identifying the maximum stress within the purging pipe hole. The output of this simulation is presented in terms of the maximum stress distribution, visualized through a color map. The simulation results showcase a distinctive color gradient, transitioning from dark blue to yellow across the model. This color spectrum represents varying levels of von Mises stress, with dark blue indicating areas of low stress and yellow signaling regions of maximum stress concentration. The color diagram associated with this simulation serves as a valuable tool for interpreting stress distribution, providing a comprehensive understanding of the structural response in the purging pipe hole [8].

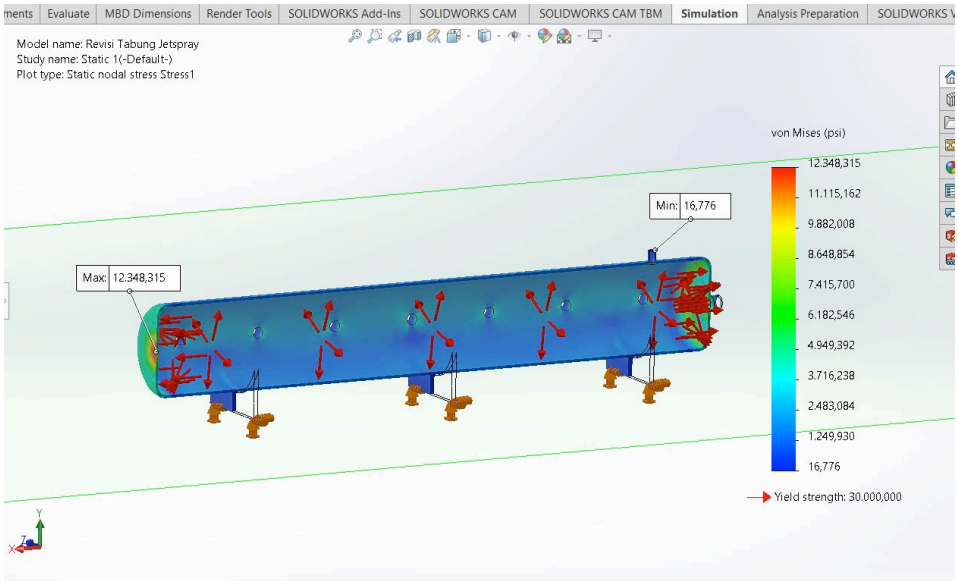

Figure 4. Stress simulation results using solidworks 2020

Working Image of Jetspray Tube

Once the design process has been conducted within the established safety limits, the subsequent phase involves creating a detailed working drawing or General Arrangement Drawing (GAD). The primary objective of this drawing is to articulate the outcomes of the design process while ensuring compliance with safety standards. In this context, the drawing specifically focuses on a 1400mmx8inch SCH20 Pipe featuring seven nozzles designated for purging purposes, as illustrated in Figure 5.

The working drawing provides a comprehensive representation of the design, incorporating precise dimensions and specifications. It serves as a crucial document for communicating the intricacies of the design to various stakeholders involved in the manufacturing and implementation phases. By offering a detailed visual depiction, the working drawing facilitates a seamless transition from the design phase to the practical realization of the purging pipe system, maintaining alignment with safety considerations throughout the

entire process.

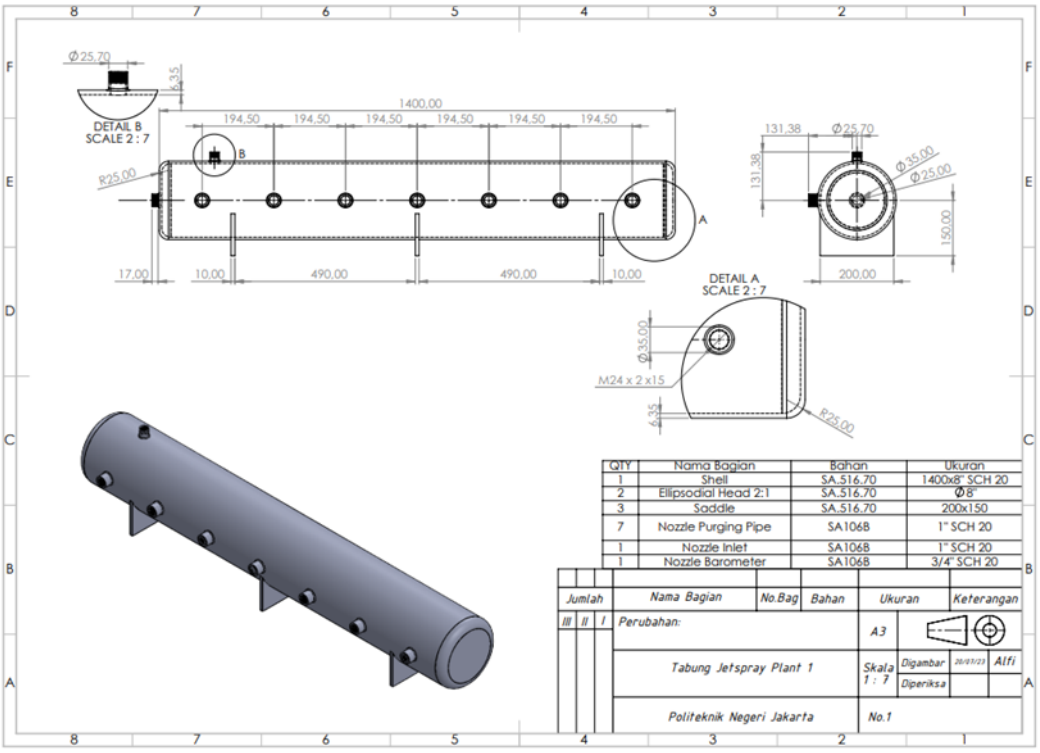

Figure 5. Jetspray Tube Working Diagram

4. Conclusions

The jet spray tube inside the filter bag was causing problems for operators during maintenance. To fix this, we moved the tube to the top of the filter bag, making it easier to reach. When the filter is clogged or blocked, it's because the jet spray tube doesn't have enough pressure. To solve this, we adjusted the tube's dimensions to handle a pressure of 5-7 bar and calculated that it should have a capacity of 40L. We then used SolidWorks 2020 and manual calculations to check the tube's safety. The tube, made of stainless steel 304 with dimensions 212.75 mm x 1400 mm and a thickness of 6.35 mm (SCH20 pipe), has been confirmed as safe. This whole process ensures that the filter system works well and meets safety standards.

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ISODUS Application Design for Web-Based School Academic Administration Operational System Information. Case Study: Al Alaq Islamic Middle School

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Abstract: The aim of the research is to support technological independence in educational units in processing data archives and general finances at the Al Alaq Islamic Middle School and what are the obstacles encountered in implementing such a system. In addition, the authors hope that readers can understand the use of this academic administration information system application known as ISODUS. During the research, the authors found that the Al Alaq Islamic Middle School did not have a computerized academic administrative and financial data processing system so that it could help find information quickly and effectively. This is due to the lack of human resources who know about information systems. After conducting some research, the authors conclude that Al Alaq Islamic Middle School requires a computerized system so that it can assist teachers in making administration. The author tries to create an Academic Administration system using the PHP programming language.

Keywords: Information systems; Web; Applications; Administration; Finance.

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1. Introduction

The development and execution of the web-based Academic Financial Administration Information System application for Junior High Schools initiated in response to challenges within the academic setting of Al Alaq Islamic Middle School. The absence of a functional academic data processing system led to manual handling of various tasks involving administration, finance, and assessments. This proposed information system, designed as a web application, aims to streamline the processes related to the mentioned activities. It leverages informatics technology within data communication networks, aiming to expedite and enhance data processing accuracy, while also addressing redundancy issues [1].

The realm of information technology in the domain of computers has consistently witnessed rapid advancements. Modern information technology has enabled individuals to create diverse tools to support their everyday tasks. This expansion of information technology has made its way into various sectors, including education. Many institutions, encompassing educational, governmental, and private bodies, require computer tools to facilitate their daily operations [2].

Al Alaq Islamic Middle School stands as one educational institution that has fallen behind in terms of adopting information technology. However, integrating information technology holds substantial potential to elevate the educational quality at Al Alaq Islamic Middle School. This integration extends beyond mere data processing; it encompasses managing all educational data, ranging from school and student details to faculty records, correspondence, tuition payments, and generating various reports. As computer technol-

ogy continues to advance, educational institutions aspire to effectively implement education methodologies to enhance educational quality, nurture intelligence, and prepare capable future generations. The incorporation of academic information systems within schools can be approached through several facets that influence the efficiency and efficacy of school administration [3]. The establishment of a coherent and efficient academic information system within Al Alaq Islamic Middle School will play a pivotal role in fostering educational activities, ultimately enhancing the teaching and learning processes. The academic information system encompasses the processing of diverse entities such as students, parents/guardians, teachers, staff, and principals. It also covers subjects, schedules for both students and teachers, student grades, attendance records, as well as financial aspects like payroll for teachers and staff, and monthly school fees (SPP) [4].

2. Materials and Experiment Methods

In the process of crafting and executing the ISODUS Web-Based Academic Administration Information System Application within the context of the Al Alaq Islamic Middle School case study, a range of research materials is required:

Initial Data: Information pertaining to the school's administrative framework, Data concerning students, teachers, staff, and school administrators, Details about the curriculum, subjects, and lesson timetables, Records of student and teacher attendance, Assessment data of students and their academic records, Financial data related to the school, encompassing tuition payments and salaries of teachers and staff, 1) Technological Components and Software: Programming languages (such as PHP, Java, HTML), Framework for the development of web applications (Laravel), Database Management System (DBMS) (like MySQL), Markup languages and scripting (HTML, CSS, JavaScript) for constructing the user interface, 2) Research Approaches: During the course of the research, centered on the construction and deployment of the ISODUS Web-Based Academic Administration Information System Application within the Al Alaq Islamic Middle School case study, the following approaches were employed, 3) Requirements Analysis: Identification of the principal necessities of the academic administration information system, Thorough examination of school administration workflows, encompassing procedures for managing student and teacher data, class schedules, evaluations, attendance, and financial matters, 4) System Blueprint: Designing the architecture of the database, devised to store the requisite data, Development of an intuitive and responsive user interface, Specification of application functionalities, encompassing capacities to handle student data, manage schedules, input grades, and oversee financial aspects 5) Application Creation: Selection of suitable programming languages and frameworks to create the ISODUS web application, Implementation of features that were meticulously designed, including modules for student and teacher management, evaluations, and financial tracking 6) Testing and Assessment: Rigorous testing of applications to ensure optimal performance and identification of potential errors or glitches, Utilization of simulated data prior to actual data entry, Critical assessment of interface responsiveness, speed of access, and comprehensiveness of functionalities 7) Deployment and Training: Integration of the application into the school environment, involving the establishment of necessary infrastructure (servers, network components, etc.), Provision of training sessions to acquaint school personnel with the operation of the application 8) Monitoring and Upkeep: Vigilant monitoring of application performance post-launch, with prompt resolution of any emergent issues, Routine maintenance activities, encompassing minor troubleshooting or enhancements of features in response to user feedback, This research methodology facilitates the creation and deployment of the ISODUS Web-Based Academic Administration Information System Application, tailored to the specific needs and aspirations of the school, while concurrently bolstering the efficacy of academic administration at Al Alaq Islamic Middle School.

Analysis of Hardware Requirements, Hardware refers to the tangible components of a computer system encompassing input, processing, and output functions. The hardware necessary for the development of a Web-Based Academic Administration Information

System for Al Alaq Islamic Middle School involves a computer equipped with the subsequent specifications: Intel (R) Pentium (R) 4 Mobile Processor, CPU clocked at 1.70 GHz, a memory capacity of 512 MB RAM, a hard disk drive with a storage capacity of 40 GB, and a monitor with a size of 17 inches [5].

Software requirements analysis, software plays a crucial role in facilitating the functioning of this application program. Software constitutes a collection of instructions intended for the operation of hardware. This software encompasses both the operating system and application programming language. The software prerequisites to initiate the operation of this application, prior to establishing an internet connection, encompass the following components: Windows XP Professional SP2 as the operating system, PSP HTML Editor, MySQL serving as the database system, PHP and HTML for programming, as well as a selection of browsers including Mozilla Firefox, Opera, Netscape, and Internet Explorer. Furthermore, the web server utilized is XAMPP for Windows32 - version 1.7.3. Design Input (input), Process, and Output (output). Input design for the World Operational System Information ISODUS School consists of: a) Admin login, b) Profile input, c) Archive data classification input, d) Announcement input, e) Student data input, f) Education personnel data input, g) Input teacher data, h) Teacher data input, i) Financial data input, j) Billing data input, and k) Class data input.

The design of the World Operational System Information Process School employs the PHP (Hypertext Preprocessor) programming language with the incorporation of HTML. This system is structured as follows: 1) When visitors access the website of Al Alaq Islamic Middle School in Bekasi City, the browser will present the primary webpage. 2) Within the main page, visitors can select links on the left to reveal concealed information accessed through the link buttons. 3) Prior to gaining access to the primary administrative menu, the administrator in charge of managing the Al Alaq Islamic Middle School website must first log in. 4) After successful login, administrators possess the ability to oversee various aspects of the website, including entering student data, recording student attendance, inputting teacher details, and more. They can also review the outcomes derived from data input. The concerned output design pertains to the appearance of the interface. The output design within ISODUS encompasses: 1) Profile viewing, 2) Agenda viewing, 3) Announcement viewing, 4) Student data viewing, 5) Financial report management, 6) Teacher data viewing, 7) Archive management, 8) Viewing student savings data, and 9) Viewing class data.

3. Results and Discussion

Al Alaq Islamic Middle School encounters obstacles in effectively and cohesively handling academic, administrative, and financial information. Consequently, the current approach encounters substantial challenges in promptly accessing real-time information. Moreover, the project team will actively engage with a range of stakeholders, including school principals, educators, administrative personnel, and school committees, in order to grasp their requirements and aspirations for the academic information system. The Objective of Initiating a System Project [6].

3.1. Project Planning

Thorough project planning for an academic information system is essential to ensure the project's scope is managed effectively, resulting in a system that is both high-quality and efficient in its utilization. Furthermore, meticulously defining the project's timeline is crucial to prevent exceeding the allocated time limit, thereby preventing budgetary inflation due to delays in project completion.

The research steps are shown in the following figure 1

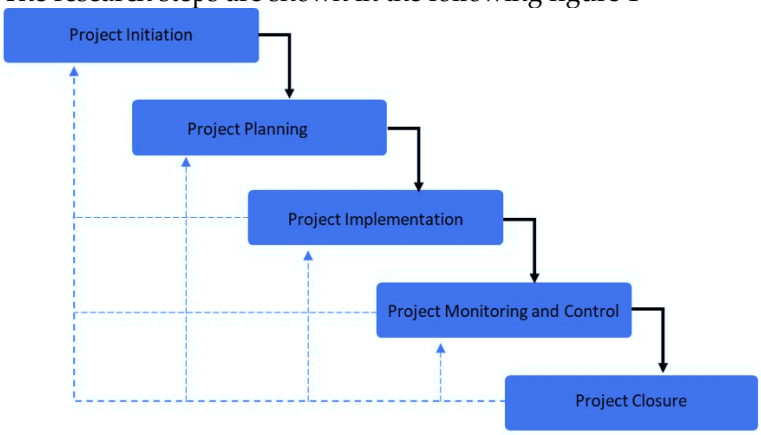

Figure 1. Research Stages - Waterfall model [7]

1. The project initiation phase examines the requirements and demands of an academic information system that is tailored to the school's needs.;
2. The project planning stage changes the software representation requirements before implementing ERD and LRS in the program code. This research uses the Unified Modeling Language (UML) to design the software system. UML is a standard set of diagrams for describing object-oriented software. Use case diagrams, activity diagrams, class diagrams, sequence diagrams are used as UML diagrams. The database design process uses Entity Relationship Diagram (ERD) and Logical Record Structure (LRS) [3];
3. Implementation Phase, that is prototyping software deployment of the Isodus World Operational Information System within Al Alaq Islamic Middle School;
4. At the project control and monitoring stage, researchers carry out system testing and system improvements to be adjusted and developed;
5. Launch and full implementation of the Academic Information System at Al Alaq Islamic Middle School.

3.1.1. Research Subjects

Research subjects can provide information about research data that can explain the characteristics of the subjects studied. The subject consists of direct subject data and indirect subject data, namely where the author can get information on the research subject without a second person intermediary [8]. Indirect subjects usually get information from other parties or other people who know the characteristics of research subjects clearly, in detail and based on existing facts.

1. Population
   The population in this study were 103 teachers, education staff and students at Al Alaq Islamic Middle School, who were directly involved in using academic information systems.
2. Sample
   The samples taken were samples that were in accordance with research needs, namely users of academic information systems
3. Sampling technique
   The sampling technique in this research uses a simple random sampling technique or a random sampling technique in the population. To measure the sample size, researchers used the Slovin formula.

   Note: n = Number of Samples

N = Number of Population

e = Critical value (error limit)

The author's desired error limit is 10%

From the formula above, the following numbers are obtained:

$$n = \frac{103}{103.(0{,}1)^2 + 1}$$

$$n = \frac{103}{103.0{,}01 \quad + 1}$$

$$n = \frac{103}{1{,}03. + 1}$$

$$n = \frac{103}{2{,}03}$$

$$n = 50{,}73$$

So the number of samples used, after rounding up, was 50 people. The operational technique for sampling is to take respondents every day for 1 week according to the respondent's working hours.

Table 1. Research Sample

Sample	Number of Samples
Educators	11
Staff	2
Student	37
Amount	**50**

3.2. System Description

In general, Al Alaq Islamic Middle School academic information system users are divided into 4, including:

- Administrator
- Mail Admin/Letter Archives
- Finance Admin/Treasurer
- Student

The technology used to build this academic information system can be broadly divided into the following sections:

Server Computer : Intel Core i3

User Computer : Intel Celeron or Android

Server Computer Operating System : Windows 10

Client Computer Operating System: Window 7

Software Development : Laragon Web Server or XAMPP.

Database : MySql 5.6.51 Up To.

3.2.1. Work Breakdown Structure (WBS)

In working on the academic information system design project at Al Alaq Islamic Middle School, a Work Breakdown Structure (WBS) was formed to make it easier to map work time so that the academic information system at Al Alaq Islamic Middle School could be completed on time [9]. The following is the Work Breakdown Structure (WBS) table.

Table 2. Work Breakdown Structure

WBS	PROJECT TASK FORCE (TASK).
1.	Analyze
	Steps: 1. Identifying Problems a. Identify the cause of the problem b. Identify decision points c. Identify key personnel 2. Understanding the Working of the Running System a. Planning a Schedule b. Make Assignments c. Create an Interview Agenda 3. Analyzing Results a. Analyze system weaknesses b. Analyze user/management information needs c. Create analysis results reports 4. Defines the scope of the new system and information collection
2.	**Design**
	Designing software applications that will be created based on the analysis that has been carried out previously. Design planning focuses on representing the interface design, data structures, software architecture in the application to be created. Produce documents that programmers use to carry out system creation activities.
3.	**Coding Testing/Writing Program Code (Implementation)**
	• Translating the design into a language that the computer can recognize • Translate transactions requested by the user • Testing the system and finding errors then correcting them.
4.	**Implementation/Testing (integration & testing) (user)**
	Use of the finished system by users is supervised by a team of system analysts
5.	***Operation* & *Maintenance***

In implementing this project, time is limited, so the author is required to effectively utilize the available time and use time management which is expected to be able to sharpen priorities and also be able to increase the efficiency and effectiveness of managing this project, in order to achieve maximum results with the available resources.

A. Use Case Diagram

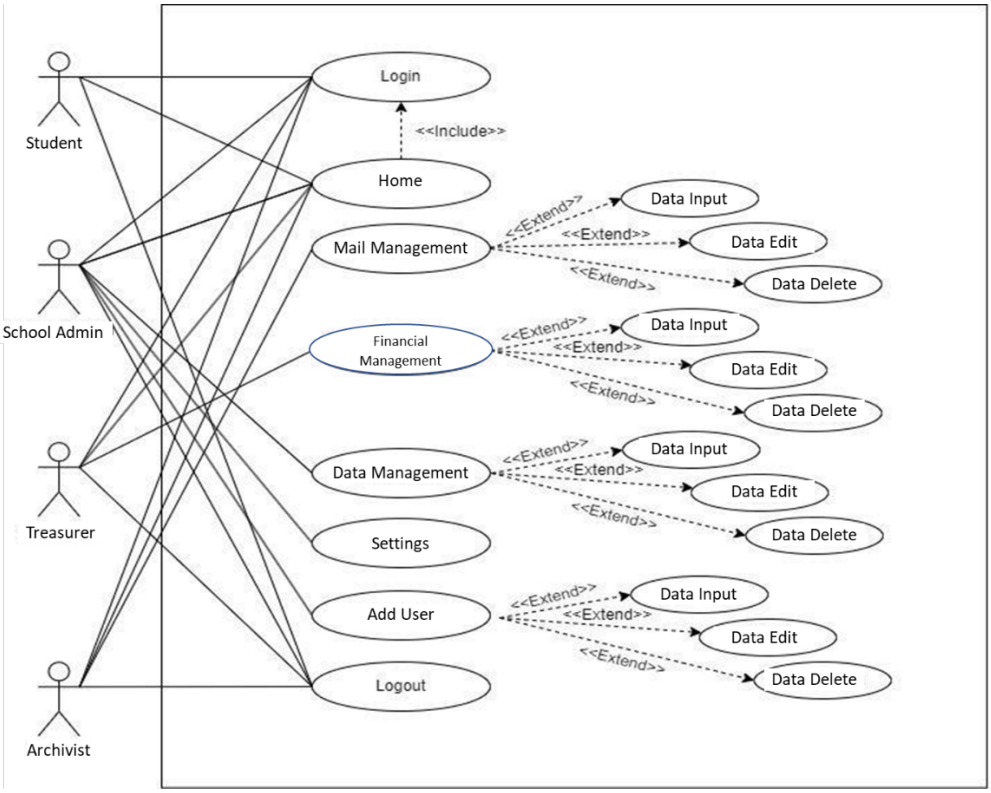

Figure 2. Use Case Diagram

The Use Case diagram consists of 4 actors, namely school admin (administrator), treasurer, archivist and students. School admins have access rights to log in, view the homepage, manage school data, settings and add users. The treasurer has access rights to login, view the homepage and financial management. The archivist has access rights to login, homepage viewing and mail management. Students have access rights to log in and view the homepage [10].

B. Flowchart

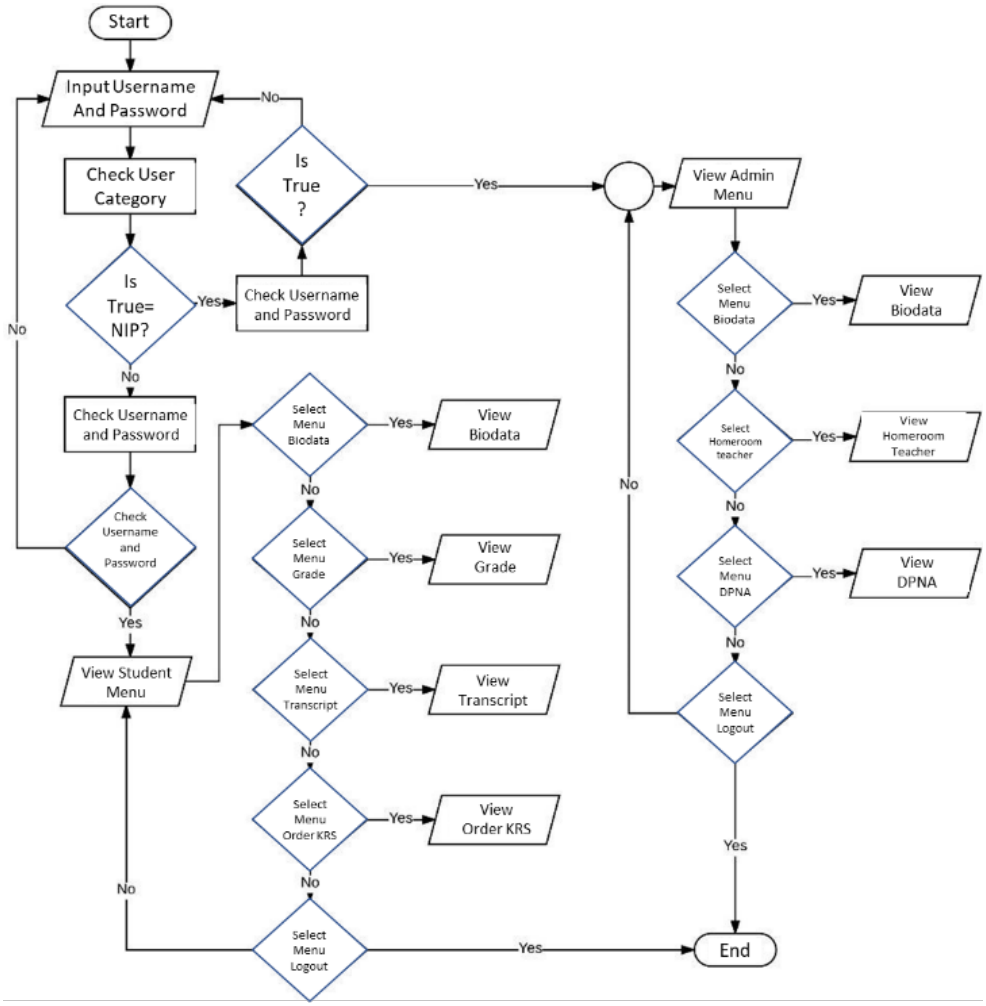

Figure 3. Flowchart

The data I have obtained through interviews and observations of users, namely teachers, parents and school operators, below is the system design.

3.3. Project control

The author tested the application used and tested its feasibility using a questionnaire which was distributed to several related parties including staff, teachers and students. The following is a recapitulation of the resulting questionnaire data (https://docs.google.com/spreadsheets/d/1p51N6TX-VXsWPWn-BLCYn6VlP9UtYcFdBdtsrTTsop34/edit?usp=sharing).

***USABILITY* QUESTIONNAIRE SHEET**

Answer the following questions by placing a tick (√) on each question in the answer column provided.

Information:		
STS : Strongly Disagree	**TS** : Disagree	**RG** : Undecided
ST : Agree	**SS** : Strongly Agree	

	STS	**T.S**	**RG**	**ST**	**SS**
1. I think I will use this system again.					
	1	2	3	4	5
2. I find this system complicated to use.					
	1	2	3	4	5
3. I find this system easy to use.					
	1	2	3	4	5
4. I need help from other people or technicians in using this system.					
	1	2	3	4	5
5. I feel that the system features work as they should.					
	1	2	3	4	5
6. I feel there are many things that are inconsistent (not harmonious in this system).					
	1	2	3	4	5
7. I feel like others will figure out how to use this system quickly.					
	1	2	3	4	5
8. I find this system confusing.					
	1	2	3	4	5
9. I feel there are no obstacles in using this system.					
	1	2	3	4	5
10. I need to get used to it first before using this system.					
	1	2	3	4	5

Figure 4. Usability Questionnaire Sheet

From the results of the questionnaire distributed above, it can be concluded that the academic information system running at Al'Alaq Islamic Middle School has experience using academic information systems that is easy to use and can provide useful feedback on teacher performance and student academic development [11].

Furthermore, the effectiveness of this academic information system meets the needs of users and users are satisfied in using the academic information system and makes it easier to create academic reports. The impact of academic information systems can provide relevant feedback in helping to improve users' academic performance and meet user expectations. Apart from that, the academic information system does not experience technical problems or errors in its use[12].

4. Conclusions

Based on the results of the implementation and the level of satisfaction measured in a questionnaire, an academic information system has become a necessity in the educational environment, especially at Al Alaq Islamic Middle School, Bekasi City. From the results of the research and discussions that have been carried out, it can be concluded that the existence of an academic information system at Al Alaq Islamic Middle School, Bekasi City makes various things easier, including;

1. Receiving incoming and outgoing mail is organized, easy to access and avoids data loss.
2. Tuition fees payments can be checked directly by students or guardians without needing to go to administration or wait for circulars.
3. Student savings can also be monitored in the academic information system, making it easier for students to save and check their savings balance and help admins when they want to reconcile their records.
4. School finances can also be monitored in the academic information system, so that it can be seen how the school's finances are healthy, which makes it easier for school principals and foundation heads to make policies.
5. School data which includes teacher, staff and student data can also be displayed in the academic information system, which can be used according to needs.
6. Announcements related to school policies and related matters can also be displayed on the academic information system homepage, so that all parties can directly receive the information

4.1. Suggestion

Even though this academic information system is able to provide good results, there are several things that need to be followed up after this academic information system project is completed, including:

- Managerial Aspect

    a. It is necessary to hold seminars or Focus Group Discussions (FGD), so that the academic information system that has been created can be understood and used by admin staff, teachers and students in accordance with operational technical instructions.

    b. The implementation of academic information systems is expected to be efficient so as to reduce costs and time

- System Aspects

    a. Academic information systems must be implemented or used immediately, so that problems that arise (bugs) can be immediately seen and resolved.

    b. The academic information system that has been created certainly still has shortcomings, both in terms of the system and in terms of system completeness, but this academic information system can continue to be developed and equipped according to needs.

- Research Aspect

    a. Future researchers are expected to study more sources and references related to academic information systems so that their research results can be better and more complete.

    b. Future researchers are expected to be better prepared for the data collection and retrieval process, so that their research can be carried out better.

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Analysis of the Influence of the Number of Electrolytic Cells and Changes in Current Set on the Electrolysis Process in the Chlorination Plant of XYZ Gas Power Plant

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Abstract: The Priok PLTGU Block 4 Chlorination Plant had experienced component damage, which is the electrolysis generator B, to be precise in the 4th order electrolysis cell. The results of this study indicate that the concentration of chlorine resulting from the operation of the 3 cell mode is not much different from the normal 4 cell operation, and is able to meet the min-imumswitch over to the electrolysis generator A which has a standby status. In this study the authors aim to create simulation conditions, and see the feasibility of performance if the electrolysis generator is still running using only 3 cells. The feasibility of the performance is assessed based on a comparison of the concentration of chlorine produced, then compared with the minimum requirement for the generating unit's water purification system, and calculating the available residual chlorine. The results of this study indicate that the concentration of chlorine resulting from the operation of the 3 cell mode is not much different from the normal 4 cell operation, and is able to meet the min-imum requirement of chlorine for the generator, as well as the residual which is classified as safe limits so that the 3 cell operating mode is classified as feasible to operate.

Keywords: Chlorine; Chlorination Plant; Electrolysis; Sodium Hypochlorite (NaOCl)

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1. Introduction

The Chlorination Plant in the Gas Power Plant (PLTGU) is an auxiliary equipment unit that functions to produce Sodium Hypochlorite (NaOCl). NaOCl is used to inhibit the pro-liferation of marine life and microorganisms that may adhere to the inner walls of heat exchanger tubes, potentially causing disruptions in the heat transfer process[1]. The working mechanism of this chlorination plant is through electrolysis, which involves breaking down seawater injected by a DC current on the inner side of the electrolytic generator.

The Chlorination Plant at PLTGU XYZ has 2 electrolytic generators, namely A and B, and each electrolytic generator has 4 electrolytic cells. However, the electrolytic generator has experienced leakage issues. Electrolytic generator B suffered damage to the 4th cell, re-sulting in abnormal current and voltage. Due to this incident, electrolysis generator B cannot be operated and must be diverted to electrolysis generator A. Based on this event, the author aims to provide a simulation scenario if the generator continues to operate using 3 operating cells and compare it with the normal condition of operating with 4 cells. Therefore, adjustments to the current and voltage settings are needed for the safety of the electrolysis generator components. When the injected voltage and current are the same as in normal conditions, there is a concern about overvoltage or overcurrent in these electrolysis cells [2]. The reduction in the number of cells causes the current and voltage to be re-

duced by 25% or 1/4 of normal conditions. In normal conditions, a voltage of 95-98V and a current of 4134 A are used. When the number of cells is reduced, the voltage is lowered to 73-75 V, and the current is 3102 A. Adjusting these set point values will impact the result-ing concentration[3].

Therefore, in this research, the author aims to simulate the occurrence of damage or anomalies in one of its cells, leading to the operation of 3 cells. The simulation is conducted by analyzing the feasibility of performance and operation of the chlorination plant. This study aims to determine the influence of the number of electrolytic cells and changes in the current injection set point in the electrolysis process in the Chlorination Plant at PLTGU XYZ.

2. Materials and Experiment Methods

The research methodology is a description of the stages carried out in conducting the research[4] for this research, beginning with data management. The collected data consists of specifications and nameplate data from the Chlorination Plant components, the chlorination plant manual book, single-line diagram of the Chlorination Plant, chlorination plant commissioning data, and set point alarm parameter data.

After data management, the data is used for calculations using predefined formulas. The calculation process is conducted meticulously to minimize errors. The calculation results will be presented in the form of tables and graphs comparing voltage, current, and chlorine concentration.

The main formula used is based on Faraday's law, which studies the fundamentals of electromagnetism. Faraday's law is related to the process of chemical changes that produce electric current, or vice versa[5]. Additionally, formulas for supporting theories are presented, such as the formula for calculating the required power, the substance requirements for clean water treatment systems[6], and residual substances[7]. The combination of Faraday's laws 1 and 2 is obtained as follows:

$$W = (e \times i \times t)/F \quad \text{.....} (2.1)$$

And the method to find its concentration is:

$$\text{concentration} = (\text{Mass of Chlorine added (grams)})/(\text{volume of solvent (Liters)})$$

Data processing is carried out using Microsoft Excel for calculating the mass of the substance produced and the chlorine concentration obtained during the electrolysis process, both during the 4-cell operating mode and the simulation with the 3-cell operating mode. After obtaining the concentrations, they can be visually represented through graphs. The graphs created provide a comparison of voltage, current, and concentrations obtained.

After creating the graphs, the next step is to examine the alarm parameters for the 3-cell operation to determine whether the voltage used will result in overvoltage, whether the current is below standard operation, whether the concentration is below the minimum requirement for the power plant unit, or to observe the residuals from the 3-cell operation.

If it is considered safe, the study will then assess whether it aligns with the theories presented in previous research. If the results match the theories of previous research, the findings of this study, namely whether the operation using the 3-cell operating mode can be performed or not, will be presented, supported by supporting theories and data.

Once the calculation results are obtained, graphs are created, alarm set points are reviewed, and in accordance with previous research, the next step is to present supporting theories if the operation is carried out with the 3-cell simulation conditions. Supporting

theories, in addition to being based on matching alarm set points, involve calculating chlorine dosage, determining the minimum requirements for the power plant unit, and comparing chlorine residual substances.

Considering the alarm set points and adjusting to the theories from previous research, the final step is to draw conclusions and provide recommendations for the study. These recommendations are made to ensure that future research will be more successful

The steps of the above research can be presented in the form of a flowchart, as illustrated in the diagram below.

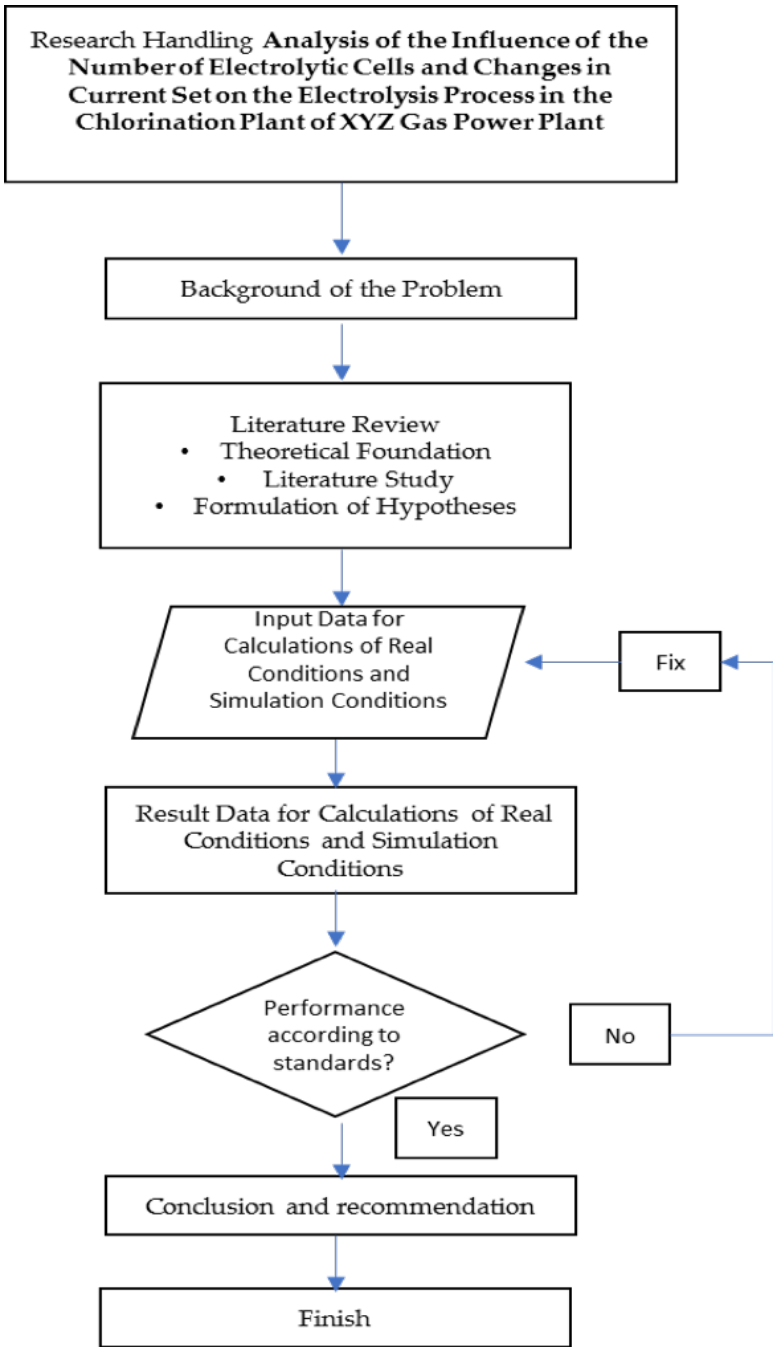

Figure 1. Research Flowchart

To find references or standards in assessing whether the 4-cell or 3-cell operating modes are suitable for operation, it is necessary to have formulas to determine minimum performance standards, the given dosage, and the available residual chlorine substance. The

formula used to determine the dosage given is the chlorine requirement formula as follows:

$$\textbf{Dosage} = \frac{\textbf{Mass of substance added}}{\textbf{Water capacity treated with the substance}}$$

Then, for the minimum chlorine requirement for the power plant:

$$\textbf{Minimum Chlorine Requirement} = \textbf{Dosage} - \textbf{Detected residual substance}$$

And the formula to find the chlorine residual is as follows:

$$\textbf{Residual} = \textbf{Dosage} - \textbf{Minimum Requirement}.$$

3. Results and Discussion

Here is the average operating data taken based on the operating time, presented in two conditions: operating with the 4-cell mode and 3-cell mode:

Table 1. Average Operating Data for 4-Cell Operation

Average operating data for 4-cell operation from November 18 to 28 November 2022.									
Operating hour	Transformer Rectifier B Voltage	Transformer / Rectifier B Ampere	Voltage Electrolytic Gen. B No. 1	Voltage Electrolytic Gen. B No. 2	Voltage Electrolytic Gen. B No. 3	Voltage Electrolytic Gen. B No. 4	Flow Used (m3/h	Mass Chlorine	Concentration
00.00	96,60	4135	24,18	24,09	23,97	24,40	1,60	5476	3423
03.00	96,26	4135	24,12	24,01	23,80	24,41	1,60	5476	3423
06.00	95,86	4134	24,05	23,89	23,73	24,32	1,60	5475	3422
09.00	96,04	4134	24,05	23,98	23,80	24,37	1,60	5475	3422
12.00	95,72	4134	24,08	23,98	23,77	24,35	1,60	5475	3422
14.00	96,46	4135	24,19	23,96	23,68	24,34	1,43	5476	3820
17.00	96,09	4136	24,13	23,68	23,95	24,37	1,53	5476	3571
20.00	97,00	4135	24,14	24,07	23,79	24,37	1,57	5474	3494
22.00	96,09	4042	24,09	23,97	23,78	24,40	1,70	5353	3149

Table 2. Average Operating Data for 3-Cell Operation

Average operating data for 3-cell operation from 15 to 25 October 2022.								
Operating hour,	Transformer Rectifier B Voltage	Transformer / Rectifier B Amper Ampere	Voltage Electrolytic Gen. B No.1	Voltage Electrolytic Gen. B No.2	Voltage Electrolytic Gen. B No.3	Flow used (m3/h)	Mass Chlorine	Concentratio(ppm)
00.00	73,48	3215	24,89	24,33	24,13	1,57	4258	2712
03.00	73,37	3101	24,53	23,92	23,79	1,52	4106	2701
06.00	73,72	3099	23,51	23,51	23,16	1,46	3650	2500
09.00	74,4	3102	24,63	23,97	2388	1,38	4106	2975
12.00	74,2	3101	24,65	23,95	23,91	1,54	4106	2666
14.00	73,86	3100	24,57	23,86	23,83	1,33	4108	3089
17.00	74,11	3100	24,3	23,88	23,88	1,54	4104	2665
20.00	74,31	3100	24,61	23,82	23,95	1,6	4105	2566
22.00	73,96	3103	24,71	23,98	23,96	1,4	4104	2931

Table *1* and **Table** *2* contain data for the operation of 4 cells and 3 cells, obtained from the average results per operating time over 11 days. The mass of chlorine produced is based

on equation (2.1), and the chlorine concentration is obtained based on equation (2.2). The calculations are as follows:

When using the 4-cell operating mode, the data used is from electrolysis generator A. The calculations are as follows:

$$W = \frac{e\ x\ i\ x\ t}{F}$$
$$W = \frac{Cl\ x\ 4133\ x\ 3600}{F}$$
$$W = \frac{35.5\ x\ 4133\ A\ x\ 3600\ s}{96500\ C}$$
$$W = 5.473{,}54818\ gram$$
$$W = 5474\ gram$$

When using the 3-cell operating mode, the data used is from electrolysis generator B. The calculations are as follows:

W = (e x i xt)/F
W = (Cl x 3102 A x 3600 s)/F
W = (35.5 x 3102 x 3600 s)/(96500 C)
W = 4.108,14093 gram
W = 4.108 gram

Once the mass of chlorine in grams produced is known, the chlorine concentration obtained through electrolysis can be determined. Based on equation 2.2:

$$\text{concentration} = \frac{Mass\ of\ Chlorine\ added\ (grams)}{\text{Flow rate of water used for electrolysis (liters/hour}}$$

With the known mass and volume of water used for electrolysis, with a water volume of 1.6 m^3/h, the concentration can be calculated. Here is the calculation of the concentration obtained during electrolysis in normal 4-cell operating mode.

With the known mass and volume of water used for electrolysis, with a water volume of 1.6 m^3/h, the concentration can be calculated. Here is the calculation of the concentration obtained during electrolysis in normal 4-cell operating mode.

$$\textbf{concentration} = \frac{\textbf{Mass of chlorine added (grams)}}{\textbf{Flow rate of water used during electrolysis (liters/hour)}}$$

= (5.474 gram)/(1600 liter/h)
= 3,42096759 gr/l per hour
= 3.42096759 gr/l x 1000 mg = 3420.96759 mg/L per hour

Here is the concentration calculation obtained during electrolysis in the simulated 3-cell operating mode:

$$\text{concentration} = \frac{\text{Mass of chlorine added (grams)}}{\text{Flow rate of water used during electrolysis (liters/hour)}}$$

= (4108 gram)/(1600 liter)
= 2,56758808 g/L
= 2,56758808 g/L x 1000 mg = 2.567,58808 mg/L
concentration = 2568 mg/L

Based on the operational data of both operating modes, both in 4-cell and 3-cell configurations, the graphs obtained are presented as shown in the following graph images:

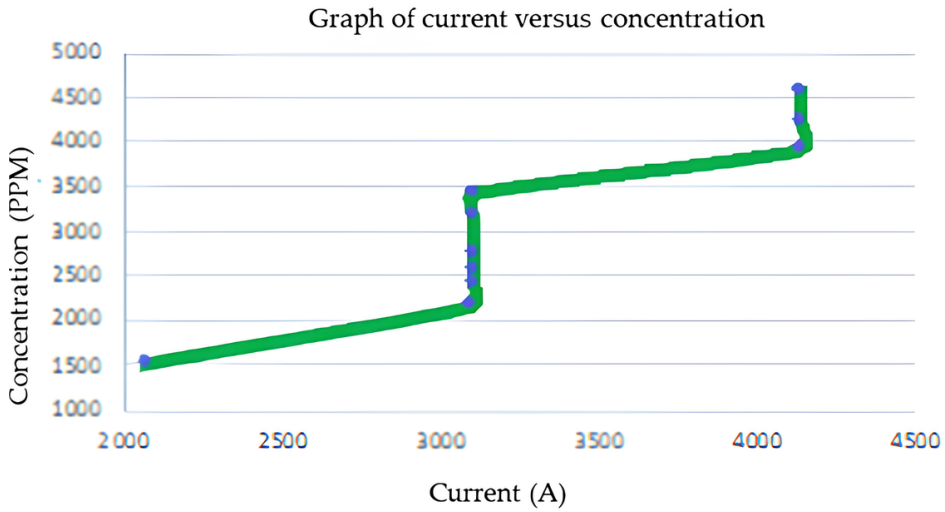

Figure 2. Graph of average current versus average concentration

In graph 3.1, it is obtained that the average current used in both modes is around 4134 Amperes for 4-cell operation and 3100 Amperes for 3-cell operation. Additionally, there is an anomaly or abnormality in the current, which is 2068 Amperes, due to a switch-over process on Saturday, October 17, 2022. This component exchange occurred a day before, and the current used in the electrolysis process had not been raised to the normal set point, which is around 3100 A for 3-cell operation or 4136 A for normal operation. Based on the trend or direction of the graph, the concentration strengthens as the current increases during the electrolysis process. Therefore, from the graph, it can be observed that the current influences the amount of concentration produced[8].

However, over time, it is known that the chlorine concentration produced varies each day depending on the situation and environmental conditions. As evidence, even though the current used is relatively stable, as explained in the operational data in tables 3.1 and 3.2, the chlorine concentration appears to depend on the amount of water flow used during the electrolysis process[9]. The following is a graph comparing the water flow rate and chlorine capacity produced.

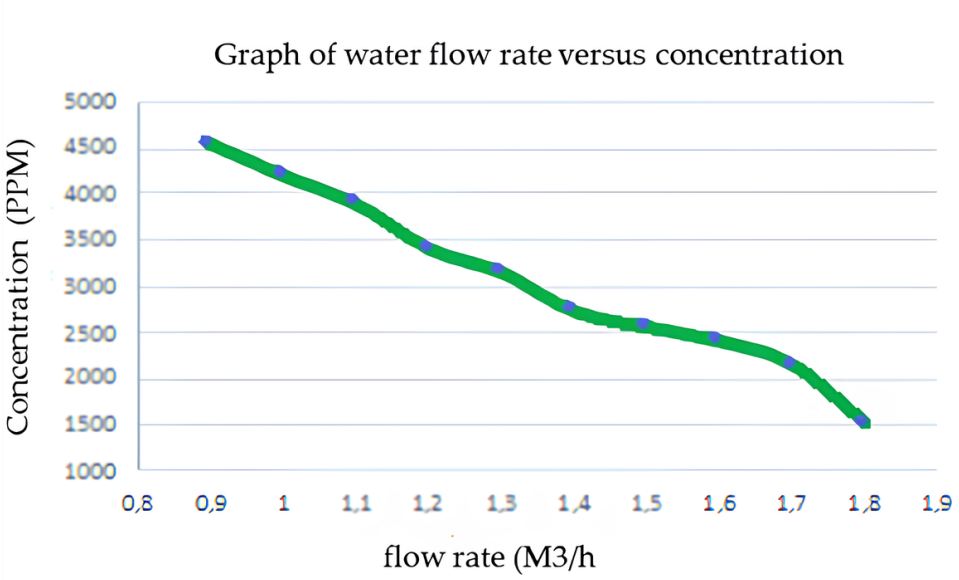

Figure 3. Graph comparing current and water flow rate used in electrolysis

Graph 3.2 is obtained based on relatively similar currents among each other, but differentiated based on the water flow rate used during the electrolysis process. By observing the graph, it is gathered that the amount of water flow used in electrolysis influences the strength of the concentration produced during electrolysis. This aligns with the theory that explains chlorine concentration, indicating that the strength or weakness of the concentration is influenced by the mass of chlorine added and the amount of water flow used in the electrolysis process[8]. From **Figure** *4* The average mass of chlorine obtained from the operation of the electrolysis generator in simulated 3-cell mode is 4065 grams, and the resulting concentration averages 2812 mg/L.

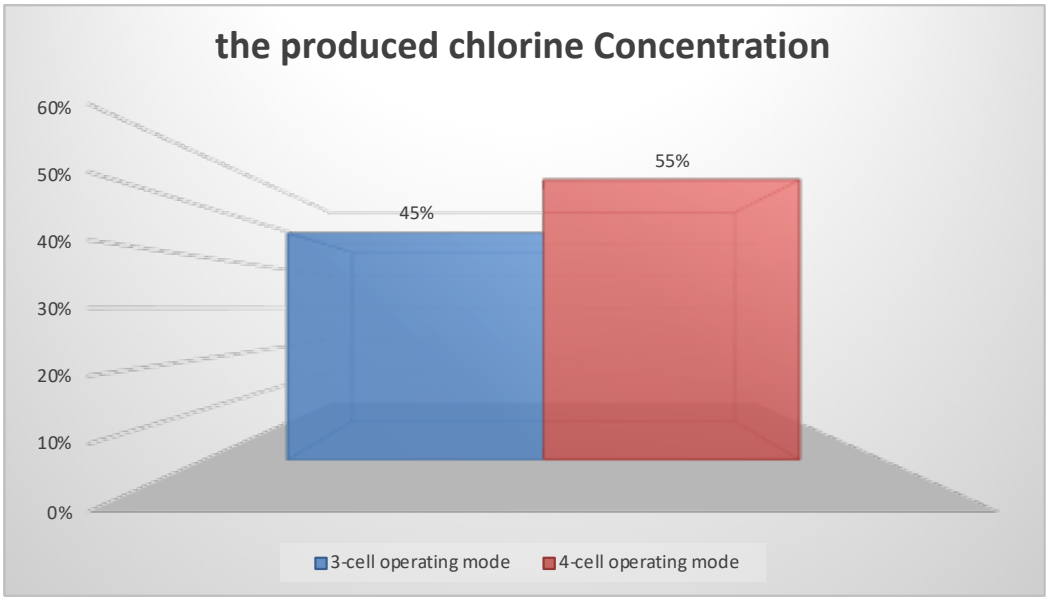

Figure 4. Percentage Comparison of Chlorine Concentrations

Table 3. Comparison of 4 Cell and 3 Cell

4 cell	*3 cell*
3476 mg/L	2812 mg/L
5465 gram	4065 gram

For comparison, the following are graphs and tables presenting the results of the comparison of chlorine concentrations produced between using the normal operating mode with 4 cells and the simulated operating mode with 3 cells. It can be observed that the concentration strength will differ between using the 4-cell operating mode and the 3-cell operating mode. However, the difference is not significant because both operating modes are still within the safe limits, as will be explained in the next section regarding the feasibility of operation based on chlorine dosage, minimum chlorine requirements for the power plant, and chlorine residuals at the power plant's output.

Chlorine Dosage Usage

The usage of chlorine dosage for the Closed Cooling Water (CCW) system of the power plant must be monitored to ensure it is within normal limits. Exceeding or falling below these reasonable limits could potentially impact chlorine residuals and production[10].

To determine the dosage used, the chlorine requirement formula is employed:

$$\boldsymbol{Dosage} = \frac{\textbf{Mass of chlorine added (grams)}}{\textbf{Water capacity treated with chlorine (liters)}}$$

Based on the formula, the dosage is the content of the substance per unit of solution capacity used. This addition is calculated based on grams, while capacity uses flow units (m^3 or liters). Therefore, based on this formula, it will result in a dosage that uses units of mg/L or commonly referred to as 1 PPM.

Given:

Water Flow: 35,000 m^3/hour

Mass of chlorine produced: 5474 grams (4 cells) / 4,108 grams (3 cells)

Residual chlorine (Normal operation): 0.1 PPM

Question: What is the chlorine dosage?

The formula or equation used is equation (2.3), and the equation is as follows:

$$\boldsymbol{Dosage} = \frac{\textbf{Mass of chlorine added}}{\textbf{Water capacity treated with chlorine}}$$

Here is the chlorine dosage given when using 4 cells:

$$Dosage = \frac{\text{Mass of chlorine added (grams)}}{\text{Water capacity treated with chlorine (liters)}}$$

$$Dosage = \frac{\text{Mass of chlorine added (grams)}(5474 \text{ grams} \times 1000 \text{ mg})}{(35{,}000 \text{ m}3/\text{h} \times 1000 \text{ L})}$$

$$Dosage = 0.1564 \text{ mg/L per hour}$$

Or, when converted with the theory that 1 mg/L = 1 PPM:

$$Dosage = 0.1564 \text{ PPM per hour}$$

When compared to operating with 3 cells:

$$Dosage = \frac{4108 \text{ grams} \times 1000 \text{ mg}}{35{,}000 \text{ m}3/\text{h} \times 1000 \text{ L}}$$

$$Dosage = 0.1174 \text{ mg/L per hour}$$

Or, when converted with the theory that 1 mg/L = 1 PPM:

$$Dosage = 0.1174 \text{ PPM per hour}$$

The minimum chlorine requirement for the power plant is the minimum dosage needed for a power plant's water purification system. Based on the operational data history, the average normal chlorine residual is 0.1 mg/L.

Using the formula or equation (2.4), the minimum chlorine requirement for the power plant can be found:

Minimum Chlorine Requirement:

$$Minimum\ chlorine\ requirement = Dosage - Detected\ chlorine\ residual$$

By substituting the dosage given during normal operation with 4 cells (0.1564 mg/L) and the normal chlorine residual (0.1 mg/L), we get:

$$Minimum\ chlorine\ requirement = Dosage - Normal\ chlorine\ residual$$
$$Minimum\ chlorine\ requirement = 0.1564 mg/L - 0.1 mg/L$$
$$Minimum\ chlorine\ requirement = 0.0564 \text{mg/L}$$

Converting 1 mg/L to 1 PPM based on equation (2.14):
$Minimum\ chlorine\ requirement = 0.0564\text{PPM}$

From the calculation, the minimum chlorine requirement for the power plant during normal operation is 0.0563 mg/L or 0.0563 PPM. Given that the chlorine dosage is sufficient, with 4 cells providing 0.1564 mg/L and 3 cells providing 0.1174 mg/L, the chlorine requirement for the power plant is well covered. Therefore, both operating modes, with 4 cells and 3 cells, are suitable for operation.

Chlorine Residual:
$Residual\ chlorine = Dosage - Minimum\ requirement$

As known from operational data, the residual chlorine during normal operation with 4 cells is 0.1 PPM. Assuming the chlorine requirement for the power plant is 0.0563 mg/L, when using the 3-cell operating mode, the residual is calculated as follows:

$Residual\ chlorine = Dosage - Minimum\ requirement$
$Residual\ chlorine = 0.1174\text{mg/L} - 0.0563\text{mg/L}$
$Residual\ chlorine = 0.0611 mg/L$

Or, when converted (1 mg/L = 1 PPM):
Residual chlorine = 0.0611PPM
Residual chlorine=0.0611PPM

Based on the calculation, the residual chlorine during normal operation with 4 cells is 0.1 PPM, and during 3-cell operation, it is 0.0611 PPM. According to the water quality standard values in the appendix, the permissible limit for chlorine to be discharged directly into the sea/environment is 0.5 mg/L or 0.5 PPM. The detected residual chlorine is within acceptable limits according to environmental regulations. Therefore, the operation of the electrolysis generator in both normal 4-cell and simulated 3-cell modes is allowed.

4. Conclusions

1. Based on the calculation results and operational feasibility considerations for both the normal 4-cell operating mode and the simulated 3-cell operating mode discussed in the previous sections, it can be concluded that even there was a 25% reduction in chlorine production due to use of 3-cell operating mode, this condition is considered safe for operation. Because with the allowable safe limit for chlorine residue being 0.5 mg/L, the 4-cell operating mode has a residue of 0.1 mg/L, and the 3-cell operating mode has a residue of 0.0611 mg/L. Therefore, it can be concluded that both operating modes are appropriated to use.

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Surface Morphology of GaN Films Grown on MoS2/Sapphire

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Abstract: This study presents a comprehensive analysis of the epitaxial growth and surface characteristics of GaN films on 2D MoS_2/c-sapphire substrates. Reflection High Energy Electron Diffraction (RHEED) patterns demonstrate the evolution of the substrate and GaN film surfaces during growth. The subsequent growth of GaN films results in the emergence of hexagonal spots, indicative of a single crystal structure. The brightness intensifies with longer growth times, confirming the improvement in GaN crystalline quality. Atomic Force Microscopy (AFM) images provide further insights into the surface texture. The 2D MoS_2/c-sapphire substrate exhibits a textured surface, while GaN films display similar features with bright colors corresponding to GaN clusters. The Root Mean Square (RMS) surface roughness values of GaN films have a higher roughness compared to the substrate. Scanning Electron Microscopy (SEM) confirms the uniform coverage of GaN films, revealing smooth growth and organized hexagonal structures. These findings collectively demonstrate the successful epitaxial growth of GaN films on 2D MoS_2/c-sapphire substrates, providing valuable insights into their surface morphology and crystalline structure.

Keywords: Gallium Nitride; Molydenum Disulfide; Surface Morphology, Heterostructure; Molecular Beam Epitaxy

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1. Introduction

Gallium nitride (GaN), also referred to as III-nitride, possesses remarkable attributes, including a direct and wide band gap, heightened electron mobility, high breakdown voltage, and exceptional thermal stability [1], [2]. These inherent characteristics position it as a compelling choice for any applications, such as high-performance power devices, high-brightness light-emitting diodes, and high electron mobility transistors (HEMT) [3][4], [5]. Despite its numerous benefits, the primary challenge faced by GaN lies in acquiring GaN bulk as a substrate. Typically, GaN is grown on Si and Sapphire substrates, which exhibit significant lattice differences [6], [7]. While substantial efforts have been dedicated to improving material quality on these substrates, the quest for an ideal, lattice-matched substrate for growing high-quality GaN remains ongoing. In this pursuit, molybdenum disulfide (MoS_2) emerges as a promising substrate for GaN, presenting minimal in-plane lattice mismatch [8]– [11]. Furthermore, the slight difference in the coefficient of thermal expansion between the two materials facilitates stable lattice alignment during the cooling-down process [12], [13]. Currently, researchers are directing their focus toward two-dimensional (2D) layered metal dichalcogenide (TMD), specifically MoS_2, due to its intriguing properties such as atom-scale thickness, a direct bandgap, and robust light-matter interactions [14], [15]. In devices designed with heterostructures comprising mono-MoS_2 and ultrathin GaN, exceptional optoelectronic and tunable electronic properties have been demonstrated [16], [17].

To date, limited investigations have been conducted on GaN film growth on MoS_2. Gupta et al. explored the growth of GaN on multiple layers of MoS_2 using metal-organic chemical vapor deposition (MOCVD) [15], while Tangi et al. examined the growth of GaN on monolayer MoS_2 via molecular beam epitaxy (MBE) [14]. Plasma-assisted molecular beam epitaxy (PA-MBE) stands out as a promising method for producing high-quality heteroepitaxial GaN layers due to its precision and environmentally friendly nature [18]. This technique offers several advantages, including an ultra-high vacuum (UHV) environment to prevent contaminants, in-situ monitoring enabling precise control of layer-by-layer growth, and a low growth temperature. Despite these benefits, there is a notable lack of extensive exploration into the surface morphology of GaN deposited on the 2D MoS_2 layer using PA-MBE.

In this investigation, we present an analysis of the surface morphology characteristics of GaN films grown on a 2D MoS_2 template on c-sapphire substrate, aiming to advance comprehension in this particular domain. Diverse growth times were scrutinized to discern the RHEED pattern mode types before, during, and after the growth of GaN films. In-depth examinations of both the MoS_2 template and the GaN films shed light on the surface morphology, enhancing our understanding of GaN growth on 2D MoS_2. The findings underscore the feasibility of employing PA-MBE in a hybrid GaN/MoS_2 system, showcasing the initial high-quality surface GaN formation on 2D MoS_2. This research opens up new possibilities for deploying related devices in the future.

2. Materials and Experiment Method

The experimental configuration for the growth of GaN films on the substrate (2D MoS_2/c-sapphire) is illustrated in Figure 1. 2D-MoS_2 is deposited onto the sapphire substrate using the pulsed laser deposition (PLD) technique by impinging Mo and S atoms. The layers of GaN films are synthetically cultivated on the surface composed of a 2D MoS_2/c-sapphire substrate through the utilization of the MBE ULVAC system [19-20]. The MBE chamber maintains a base pressure of $6x10^{-10}$ Torr, and the thermal cleaning process for the substrate occurs at 600 °C for a duration of 30 minutes. A pre-nitridation treatment on the substrate is executed at 700 °C for 5 minutes, providing a nitrogen layer conductive to the nucleation of GaN films. Subsequently, the epitaxial GaN film growth develope at 700 °C for 30 and 60 minutes. The K-cell at 800 °C supplies the atomic flux of Ga atoms, while a plasma nitrogen as N atoms source, operating at 500-Watt RF power with a 6N N_2 flux at 0.8 sccm, is employed.

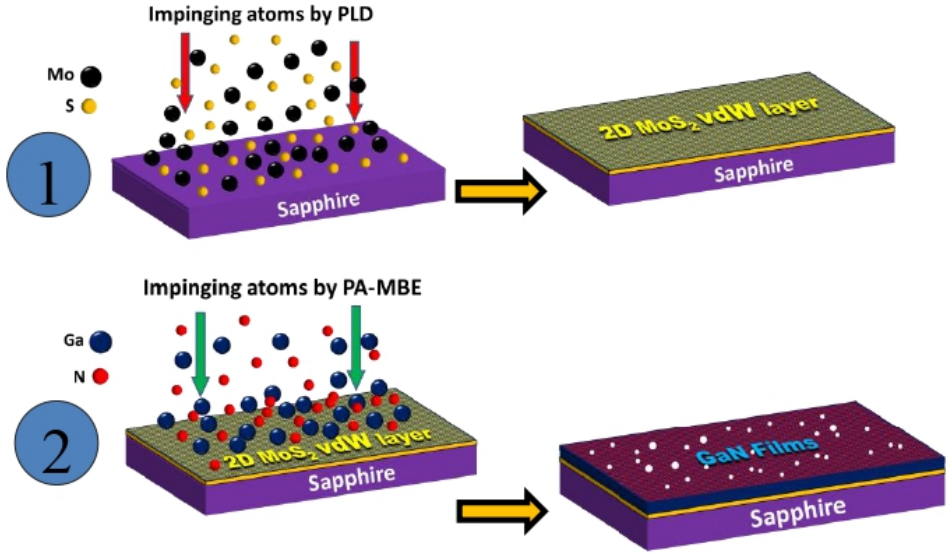

Figure 1. Growth GaN films on the substrate (2D MoS_2/c-sapphire)

Concurrently, the MoS_2 layer on a 2-inch c-sapphire substrate is generated through the Pulsed Laser Deposition (PLD) method, employing an ArF excimer laser at 800 °C

under a background pressure of 10^{-6} Torr. Throughout the growth process, in-situ characterization utilizing Reflection High-Energy Electron Diffraction (RHEED) at 20 kV monitors the structure of GaN films. Post-growth, a detailed investigation of the morphology texture of GaN films is examined using a field emission scanning electron microscope (SEM) with a 15 kV accelerating voltage. In addtional, atomic force microscopy (AFM) with Nano Surf C3000 AFM was applied to observe the surface roughness.

3. Results and Discussion

Figure 2 illustrates the RHEED pattern observed during the epitaxial growth of both the substrate and GaN films. In Fig 2(a), a foggy image is indicated by a RHEED pattern evaluating the surface of substrate with low crystalline structure. After thermal cleaning process in Fig 2(b), the high-intensity streaks pattern is evident on the surface structure of 2D MoS_2/c-sapphire. This pattern is attributed to the presence of a 2D surface constructed on the MoS_2 layer, with the bright intensity corresponding to the formation of a single crystal structure within the layers. It supports that thermal treatment led to clean out the oxide deposited on the surface. The monitoring process reveals that the MoS_2 substrate possesses a 2D surface with a crystalline structure. After 30 minutes of GaN layer growth, a spots pattern emerges in the RHEED in Fig 2(c), indicating the presence of 3D GaN layers. These spots are arranged in a hexagonal pattern, pointing to the formation of a single crystal of GaN. Continuing the growth for 60 minutes, the spots exhibit brighter patterns, signifying an improvement in the crystalline quality of the GaN structure shown in Fig 2(d). The spots pattern resembles that of the previous pattern in Fig 2(c), affirming the epitaxial growth of GaN films with a consistent structure. RHEED patterns confirm the growth of single crystals with a hexagonal structure in GaN films on 2D MoS_2/c-sapphire. Further validation of the films' morphology structure will be obtained both of AFM and SEM observations.

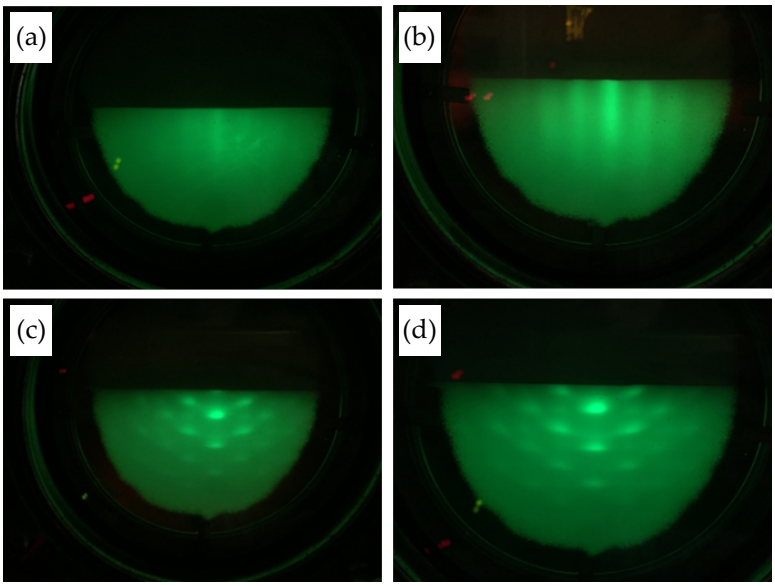

Figure 2. RHEED pattern of 2D MoS_2/c-sapphire (a), after thermal cleaning (b), grown GaN films for 30 min(c), and 60 min (d)

Fig. 3 displays Atomic Force Microscopy (AFM) images capturing the surfaces of 2D MoS_2/c-sapphire and Fig. 4 shows for GaN films. The surface scanned of 2D MoS_2 including to scan area 3 x 3 μm in Fig 3(a), scan amplitude peak Fig 3(b), and scan mean line peak in Fig 3(c), sequentially. AFM allows for a detailed analysis of surface texture. Bright colors represent high points, indicating protrusions or elevations, while dark colors may denote depressions or lower areas. In the AFM image of 2D MoS_2/c-sapphire, brown areas, representing the average surface, provide insights into the overall texture and smoothness of the material. Line scans, as shown in Fig. 3(c), involve taking measurements along a

straight path to analyze variations in surface height or roughness. Furthermore, GaN AFM images show in Fig 4, demonstrating the similar feature to 2D MoS_2/c-sapphire. Bright colors relate to GaN clusters attending on the surface in Fig 4(a). The evidence of its presence on the surface confirmed by the higher peak shown in line scans in Fig 4(c).

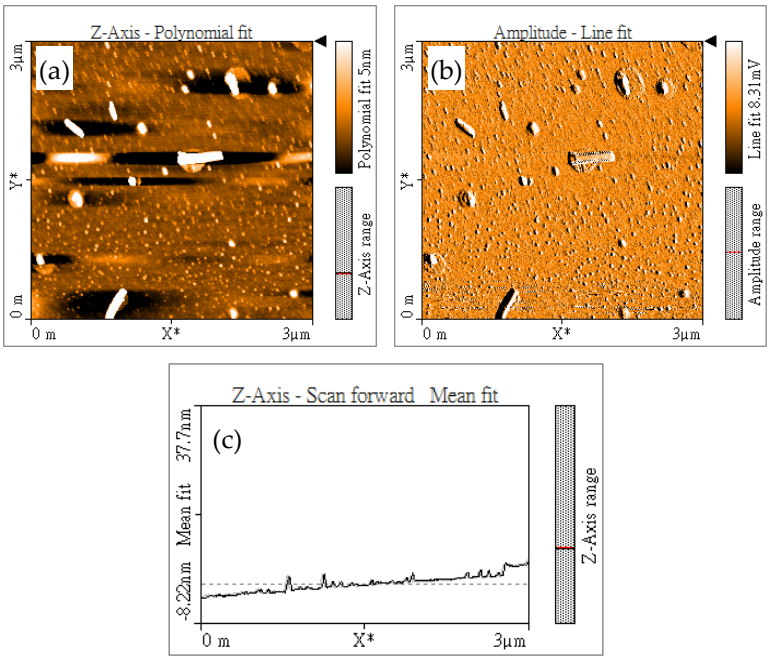

Figure 3. AFM images 2D-MoS_2/c-sapphire substrate (a). Scan area 3 x 3 µm, (b). Scan amplitude peak, (c). Scan mean line peak.

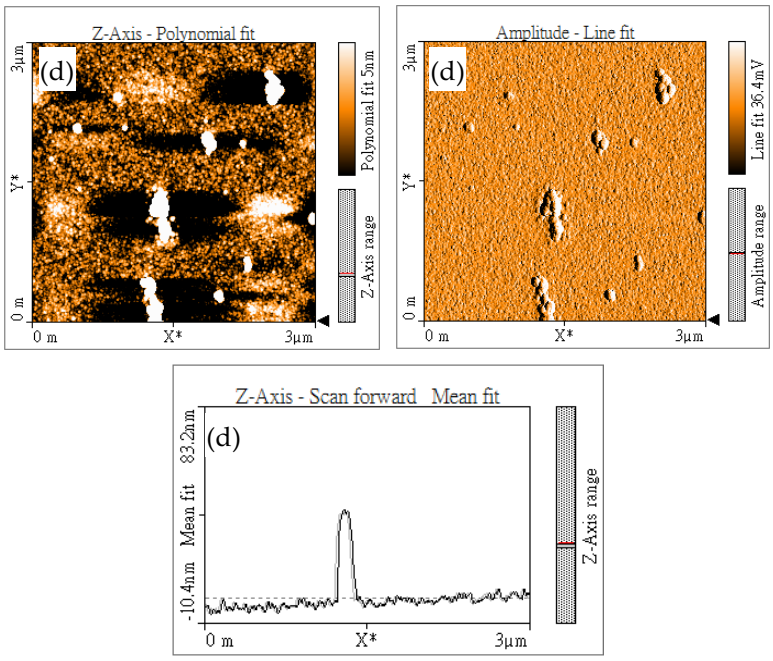

Figure 4. AFM images GaN/2D MoS_2/c-sapphire substrate (a). Scan area 3 x 3 µm, (b). Scan amplitude peak, (c). Scan mean line peak.

The Root Mean Square (RMS) surface roughness both of 2D MoS_2/c-sapphire substrate and GaN surface, calculated over scan areas of 3µm x 3µm. The Root Mean Square (RMS) value is a key parameter used to quantify surface roughness. In the described paragraph, the RMS value of GaN is calculated, providing a numerical measure of the surface roughness over a specific scan area. Details of surface roughness, including maximum surface

roughness (Sa), RMS, totally height (Sy), peak height (Sp) and valley depth (Sv), are provided in Table 1. AFM results are often used to compare different materials or assess the impact of specific growth processes. In the given context, a comparison between 2D MoS_2/c-sapphire and GaN films suggests that the growth of GaN films influences to an improved surface structure.

Tabel 1. Surface texture of substrate (2D-MoS_2/sapphire) and GaN films

No	Materials	Sa (nm)	RMS (nm)	Sy (nm)	Sp (nm)	Sv (nm)
1	Substrate 2D-MoS_2	0.79	2.26	53.53	37.68	-15.85
2	GaN Films	2.47	5.51	90.84	72.80	-18.04

The surface morphology of the GaN film is depicted in Fig. 5 through Scanning Electron Microscopy (SEM) images at a magnification of 15,000x. The SEM observations reveal a smooth and uniform coverage of GaN films on the substrate. This smooth growth indicates comparable epitaxial coalescence between gallium (Ga) and nitrogen (N) atoms during the layer's growth process. In addition to the continuous GaN layer, hexagonal structures of GaN with sizes ranging from 0.2 to 1 micrometer are also observed on the surface. These hexagonal features suggest a well-defined and organized arrangement of GaN structures. The SEM results affirm the presence of a hexagonal structure in the GaN films, covering the 2D MoS_2/c-sapphire substrate. This observation aligns with the RHEED monitoring, indicating the generation of a single crystal with hexagonal structure of GaN films are grown on the substrate. The SEM analysis provides valuable insights into the surface characteristics and crystal structure of the GaN films, highlighting their uniformity and well-defined hexagonal features.

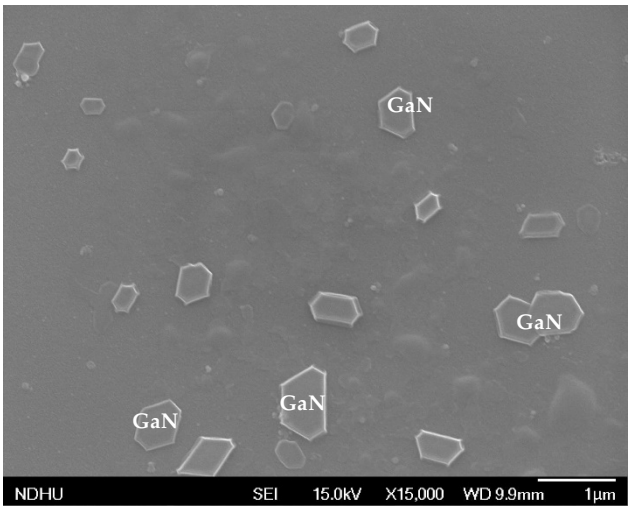

Figure 5. FE-SEM images of surface morphology of GaN films with 15.000x mangnification

4. Conclusions

In conclusion, the RHEED patterns provide a comprehensive view of the epitaxial growth process. The initial foggy pattern on the substrate transforms into high-intensity streaks after thermal cleaning, indicating the emergence of a well-defined 2D MoS_2 surface. The subsequent growth of GaN films results in hexagonal spots, evolving into brighter patterns over 60 minutes, confirming the formation of single-crystal GaN structures. AFM analysis details the surface textures of 2D MoS_2/c-sapphire and GaN films. Notably, GaN exhibits bright clusters on the surface, as confirmed by line scans. The RMS surface rough-

ness values quantify the differences between 2D MoS_2/c-sapphire and GaN films, indicating that GaN films contribute to an improved surface structure. SEM images reinforce these findings, showcasing the uniform coverage of GaN films with well-defined hexagonal structures. Overall, the combined results from RHEED, AFM, and SEM analyses provide a comprehensive understanding of the growth and morphology of GaN films on the 2D MoS_2/c-sapphire substrate, highlighting their single-crystal nature and improved surface structure.

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