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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.

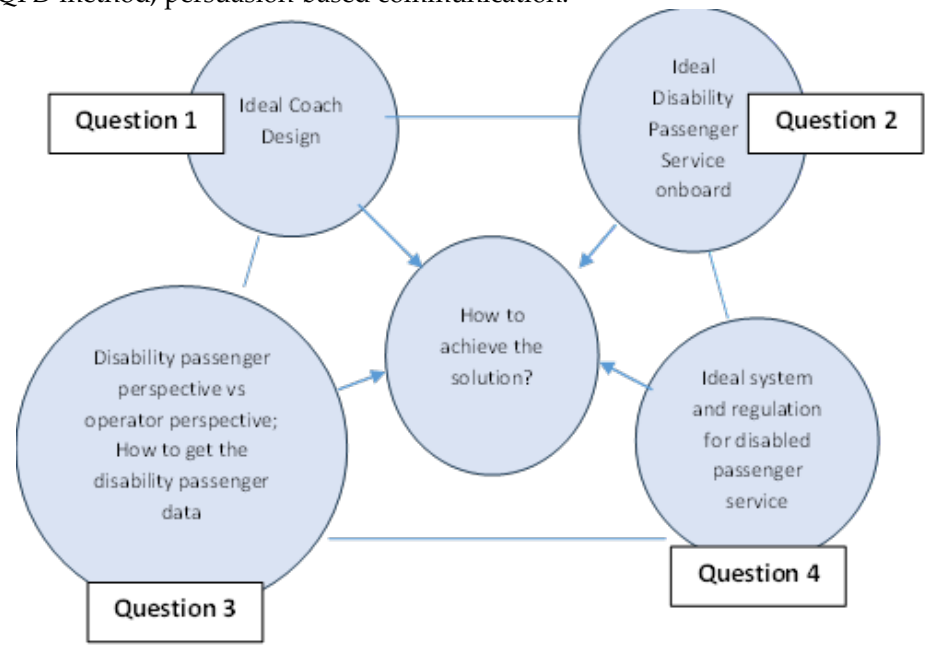


Figure 1 Questionary Research Gap Diagram

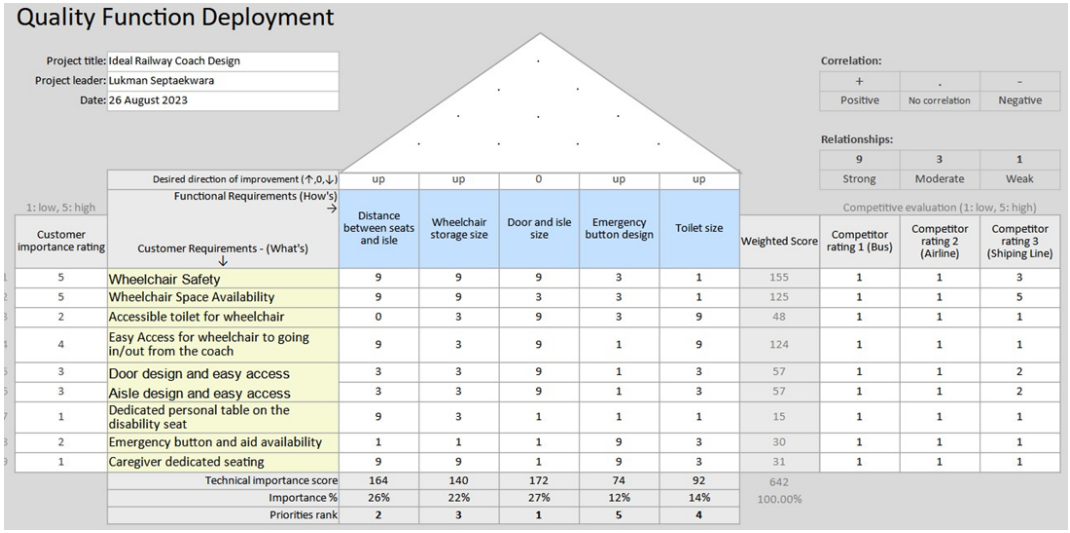
3.1. Question 1: Ergonomic Principle in Coach Design with Quality Function Deployment Method

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	



Quality Function Deployment

Project title: Ideal Railway Coach Design
Project leader: Lukman Septaekwara
Date: 26 August 2023

Correlation:

+	.	-
Positive	No correlation	Negative

Relationships:

9	3	1
Strong	Moderate	Weak

	Desired direction of improvement (↑,0,↓)	up	up	0	up	up				
1: low, 5: high	Functional Requirements (How's) →							Competitive evaluation (1: low, 5: high)		
Customer importance rating	Customer Requirements - (What's) ↓	Distance between seats and isle	Wheelchair storage size	Door and isle size	Emergency button design	Toilet size	Weighted Score	Competitor rating 1 (Bus)	Competitor rating 2 (Airline)	Competitor rating 3 (Shiping Line)
5	Wheelchair Safety	9	9	9	3	1	155	1	1	3
5	Wheelchair Space Availability	9	9	3	3	1	125	1	1	5
2	Accessible toilet for wheelchair	0	3	9	3	9	48	1	1	1
4	Easy Access for wheelchair to going in/out from the coach	9	3	9	1	9	124	1	1	1
3	Door design and easy access	3	3	9	1	3	57	1	1	2
3	Aisle design and easy access	3	3	9	1	3	57	1	1	2
1	Dedicated personal table on the disability seat	9	3	1	1	1	15	1	1	1
2	Emergency button and aid availability	1	1	1	9	3	30	1	1	1
1	Caregiver dedicated seating	9	9	1	9	3	31	1	1	1
	Technical importance score	164	140	172	74	92	642			
	Importance %	26%	22%	27%	12%	14%	100.00%			
	Priorities rank	2	3	1	5	4				

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.

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