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Mapping Passenger Voice About Light Rail Transit Feeder Service Potential Operational Hazards: Evidence of Palembang City, Indonesia

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Abstract

The Light Rail Transit (LRT) Feeder service is a critical component of urban transportation systems, providing connectivity between passengers and the main LRT network. In Palembang City, Indonesia, operational safety remains a significant concern, as incidents and congestion affect passenger perception and service reliability. This study aims to evaluate passenger perceptions of safety quality and translate these insights into operational priorities for hazard mitigation using the Safety Quality Function Deployment (SQFD) approach through the House of Quality (HoQ) method. Primary data were collected from 420 passengers through structured surveys assessing expectation and satisfaction across SERVQUAL-based safety attributes, while expert assessments from 25 drivers and 8 operators evaluated operational hazards and event correlations. The analysis calculated expectation-satisfaction gaps, relative weights of passenger voice indicators, and mapped them into potential hazards using the HoQ matrix. Results show that all safety attributes had negative gaps, with the largest deficits in boarding and disembarking area safety, protection of vulnerable passengers, and stable driving behavior. Operational priorities identified include passenger surges, risks at stops and accessibility, and traffic disruptions. This study concludes that safety improvements should focus on passenger access, vulnerable user protection, congestion management, and operational reliability, demonstrating the practical application of SQFD for urban feeder service enhancement.

INTRODUCTION

LRT Feeder services are a crucial component of an integrated urban public transportation system, given their direct role in influencing the effectiveness of passenger accessibility to the main LRT network. Therefore, these services serve not only as a support mode, but rather as an integrated operational element that contributes to the continuity of travel, the utility of the service, and the overall passenger experience. Recent studies on feeder modes confirm that passengers' evaluations of these services are based on attributes such as reliability, convenience, security, and ease of access. The implication is that feeder operations need to be assessed as a self-service system, not just as a secondary extension of public transport (Farooz et al., 2025).

In this context, the quality of safety emerges as a central issue. Safety in public transportation is not only defined as the absence of incidents, but also includes the condition of facilities, driver behavior, safety during the boarding and disembarkation process, emergency preparedness, and the travel environment in a comprehensive manner (Deepak et al., 2024; Hystad et al., 2016; Infant & Priyanka, 2025; Sarvari et al., 2019). A recent literature review indicates that passenger perceptions of safety are the main determinants of passenger volume, satisfaction levels, and overall public transportation quality evaluations (Agrawal et al., 2025).

This issue is directly relevant to the context of the LRT Feeder service in Palembang City. This study explains that the service operating in 2022 as a supporting mode of the city LRT system, with the aim of increasing accessibility and strengthening urban transportation integration (Klopp & Cavoli, 2017; Oliveira et al., 2020; Singh et al., 2021). However, the study also indicates that safety remains a significant operational concern: data shows that traffic accidents in Palembang increased by 9.61% in 2024 compared to the previous year, and minor incidents were still recorded in the operation of the LRT Feeder in 2023, which caused damage to body panels, lights, doors, and other components of the facility. This condition indicates a persistent operational safety risk in the LRT Feeder service. (PT Transportasi Global Mandiri)

To address this gap, this study uses Safety Quality Function Deployment (SQFD), which is an extension of Quality Function Deployment (QFD) that translates user safety needs into operational response priorities. In the SQFD literature, the House of Quality is used to connect customer voices with technical or operational variables (Shang et al., 2023) demonstrated that the SQFD can be developed through a three-stage House of Quality framework to translate passenger safety needs into hazard identification, management response, and safety culture priorities.

The study did not adopt the complete three-stage structure applied in the study. Instead, this study only focused on the first stage of the House of Quality, considering that this stage is the most direct analytical step to evaluate the safety quality of the LRT Feeder from the perspective of passengers. As described in the study, the first stage maps the safety attributes that passengers assess as the voice of the customer into hazards and operational events through a relationship matrix, thereby identifying priority safety issues that require attention. Thus, this article narrows down the broader framework of study to a more focused journal contribution: a passenger-centered evaluation of safety quality in LRT Feeder services through the first stage of hazard prioritization (Tun et al., 2020).

In the context of Palembang City, Indonesia, LRT Feeder services play an integral role in bridging urban mobility gaps. Despite the operational benefits of these services, incidents and safety concerns persist, as evidenced by a reported 9.61% increase in traffic accidents in 2024 and recurring minor operational incidents in LRT Feeder operations in 2023 (PT Transportasi Global Mandiri, 2025). Such operational risks underline a critical local issue: the alignment between passenger expectations of safety and the actual conditions encountered during transit remains insufficient, creating a tangible research gap.

Prior studies have investigated service quality in feeder and bus systems, often emphasizing efficiency, reliability, and user satisfaction (Farooz et al., 2025; Marazi et al., 2025). While these studies highlight relevant performance metrics, they largely overlook a systematic integration of passenger-perceived safety with operational hazard identification. This gap underscores the importance of combining qualitative perceptions from passengers with technical assessments of operational risks to generate actionable insights.

To address this research gap, the Safety Quality Function Deployment (SQFD) approach provides a structured framework for translating passenger safety expectations into operational priorities. Utilizing the House of Quality method, SQFD aligns the voice of the customer with technical or operational variables, enabling a clear mapping of hazards to passenger safety needs (Shang et al., 2023). This methodology has been underexplored in the Indonesian urban context, particularly regarding LRT Feeder services, providing an opportunity for methodological innovation.

The novelty of this research lies in applying the first stage of the SQFD framework to focus exclusively on passenger-centered evaluation. By mapping safety attributes directly assessed by passengers into potential operational hazards, this study prioritizes actionable areas for safety improvement. Unlike traditional service assessments that concentrate on technical compliance or operational efficiency, this approach centers on the lived experience of commuters, thus bridging the gap between subjective perception and operational reality.

This study is urgent given the increasing reliance on LRT Feeder services in Palembang and the potential societal costs of unaddressed safety risks. As feeder services expand and passenger volumes rise, gaps in safety quality can exacerbate congestion, reduce trust in public transport, and contribute to avoidable incidents. Understanding how passengers perceive safety and how these perceptions correlate with operational hazards provides timely evidence to guide effective interventions.

The primary purpose of this research is to evaluate passenger perceptions of safety quality in LRT Feeder services and to translate these perceptions into operational priorities for hazard mitigation. This involves assessing expectation-satisfaction gaps, weighting passenger voice indicators, and mapping them to potential hazards and operational events using the HoQ framework. By doing so, the study provides a structured and empirical basis for prioritizing improvements.

The contribution of this study is twofold. Academically, it extends the SQFD literature by demonstrating its applicability in urban transit safety assessment, particularly in emerging metropolitan contexts. Practically, it informs transit operators and city planners about priority areas for safety enhancements, including congestion management, access-point safety, and protection for vulnerable passenger groups, ultimately improving service quality and operational reliability.

The research objectives are to identify critical safety gaps perceived by passengers, determine their relative importance, and link these gaps to operational hazards through the HoQ method. The expected benefits include providing a systematic evaluation tool for transit operators, enhancing passenger satisfaction and safety perception, and contributing to safer, more reliable urban mobility in Palembang and similar urban environments.

METHOD

This study applied Safety Quality Function Deployment (SQFD) first stage as an integrative framework to connect passenger voice indicators with potential hazards and operational events in LRT Feeder services in Palembang. Through this approach, the safety quality attributes perceived by passengers are associated with operational aspects that can affect service safety. Thus, safety assessments from the perspective of passengers can be transformed into more targeted and real operational hazard priorities (Shang et al., 2023).

The methodological framework in this study is designed through three main steps. The first step is the formulation of indicators, which consist of two components, namely the quality of safety attributes of SERVQUAL-based services and potential hazards and operational events. Safety quality attributes serve as the basis for forming passenger voice indicators, while potential hazards and operational events are used as operational elements to be further mapped.

The second step is assessment by passengers, which is the measurement of the level of expectation and perception of service conditions on each safety attribute. This measurement aims to obtain the gap value and the relative weight of each passenger voice indicator. The results at this stage are used to understand the position of safety attributes from the passenger's point of view before the indicator is placed in the WHATs section of the House of Quality (HoQ).

The third step is the integration of the House of Quality (HoQ). At this step, passenger voice indicators are placed as WHATs, while potential hazards and operational events are placed as HOWs. The relationship between WHATs and HOWs is assessed by drivers because they have first-hand experience of service operating conditions, interactions with passengers, and traffic situations. In addition, operators assess the relationship between HOWs through a roof matrix to see the relationship between operational indicators. This integration results in operational safety priorities that indicate the most relevant elements of hazards and events for the improvement of LRT Feeder services.

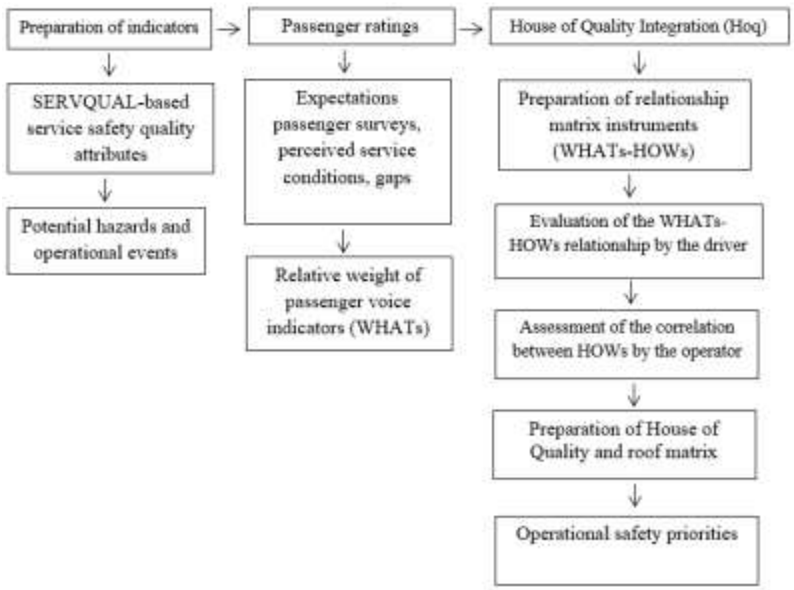

Figure 1. SQFD Framework for Mapping Passenger Safety Perceptions to Operational Safety Priorities in LRT Feeder Services

Research object and Scope

This research was conducted on the LRT Feeder service in Palembang City, with 8 corridors connecting to LRT stations. The LRT feeder operates through a Buy-the-Service (BTS) scheme and represents a road-based urban public transport service. In the context of this study, the safety characteristics of services are understood through vehicle operations, passenger boarding and disembarkation activities, access to stopping points, passenger movement, and interaction with urban traffic.

The scope of this study focuses on mapping service safety quality attributes based on passengers' perspective on potential hazards and relevant operational events. Safety quality attributes are analyzed through passenger expectations levels, perceived service conditions, and gaps between the two. Meanwhile, potential hazards and operational events are used to represent safety aspects that have the potential to arise in the service process and can affect the quality-of-service safety. This research was carried out in the period September 2025 to February 2026.

The indicators from the passenger side were prepared by adapting the SERVQUAL concept to the safety context of LRT feeder transportation services. In this study, SERVQUAL is not used as an instrument for measuring the overall quality of service, but rather as a conceptual basis for formulating safety attributes that are relevant to the passengers' travel experience. These attributes describe the safety conditions felt by passengers when waiting, boarding the vehicle, being on the way, and getting off the service. The assessment is carried out based on two dimensions, namely hope and satisfaction. Through this approach, passenger perception can be translated into Voice of Customer (VOC) elements which are then used in the House of Quality (HoQ) analysis.

Assessment At the stage of assessing the quality of passenger safety, the service attributes in the survey are compiled based on the development of the SERVQUAL dimension. Although SERVQUAL covers various aspects of service quality, this study only selects attributes that are relevant to the passenger safety experience on LRT Feeder services. The five dimensions of SERVQUAL, namely tangibles, reliability, responsiveness, assurance, and empathy, are used as the basis for grouping service safety quality attributes. The attributes used to assess the quality of passenger safety in this study are presented in Table 1. Passenger Safety Quality.

Table 1 Passenger Safety Quality Assessment Indicators

Dimensions	Indicator	Description	References
Tangibles	Vehicles appear well-maintained and fit for operation	Vehicles appear well-maintained and fit for operation	Çelİk (2024)
	Boarding and disembarking areas are safe	Boarding and disembarking areas are safe	Suria dkk. (2019)
Reliability	Service arrivals are fairly regular	Service arrivals are fairly regular	Chau dkk (2024)
	Driving behavior is safe and stable	Driving behavior is safe and stable	Çelİk (2024)
Assurance	Passengers feel safe from crime or harassment	Passengers feel safe from crime or harassment	Shang dkk. (2022)
(guarantee)	Safety equipment in vehicles is available and functioning	Safety equipment in vehicles is available and functioning	Wu dkk. (2016) Astuti dkk. (2021) Shang dkk. (2022)
	Drivers are polite and respectful, so passengers feel comfortable reporting any safety concerns	Drivers are polite and respectful, so passengers feel comfortable reporting any safety concerns	Astuti dkk. (2021) Shang dkk. (2022)
Empathy	Services are considerate of the safety of female passengers, vulnerable groups, and those with special needs	Services are considerate of the safety of female passengers, vulnerable groups, and those with special needs	Astuti dkk. (2021)
	Drivers assist passengers who need assistance	Drivers assist passengers who need assistance	Suria dkk. (2019) Astuti dkk. (2021) Shang dkk. (2022)
	Drivers respond quickly and provide clear directions or safety information	Drivers respond quickly and provide clear directions or safety information	Astuti dkk. (2021)

Source: Literature, passenger survey, operator data

The attributes listed in Table 1 were assessed through passenger surveys to obtain two forms of assessment, namely the level of expectation and the perceived condition of service. The expectation level describes the extent to which the safety aspect of the service is considered important by the passenger, while the perceived service condition represents the passenger's assessment of the actual service experience. The assessment was carried out using a five-level Likert scale. In the aspect of expectation, the scale ranges from 1 = very unexpected to 5 = very expected, while in the aspect of perceived service conditions, the scale ranges from 1 = very dissatisfied to 5 = very satisfied.

The average expectation and average perceived service conditions are calculated based on the distribution of the frequency of response responses in each indicator. The calculation is done using the following method:

$$\overline{H}_j = \frac{\sum_{k=1}^{5} f_{jk}^{H} s_k}{\sum_{k=1}^{5} f_{jk}^{H}}$$

$$\overline{K}_j = \frac{\sum_{k=1}^{5} f_{jk}^{K} s_k}{\sum_{k=1}^{5} f_{jk}^{K}}$$

Next, the gap value of each indicator is calculated as the difference between the average perceived service condition and the expected average:

$$Gapj = \overline{Kj} - \overline{Hj}$$

With $\overline{Hj}$ shows the average passenger expectations on the jth indicator, $\overline{Kj}$ shows the average perceived service conditions on the jth indicator, and each shows the frequency of answers on the k scoref_{jk}^{H} for the expected aspects and perceived service conditions, shows the Likert score to s_kk and k=1,...,5. A negative value gap indicates that the service conditions felt by passengers have not met their expectations. The greater the negative difference obtained, the higher the safety quality gap in the indicator. Meanwhile, the gap with a value close to zero indicates that actual service conditions are increasingly in line with passenger expectations. The results of this assessment are the basis for seeing the position of each safety attribute based on the perspective of the passenger. In this study, the value of expectations, perceived service conditions, and gaps was used to interpret the quality-of-service safety, while the relationship with potential hazards and operational events was analyzed at the level of passenger voice indicators.

Hazard and Safety Operations

Potential hazards and operational events are used to represent operational aspects in the safety quality of LRT Feeder services. These indicators were compiled through a triangulation process involving a review of transportation safety literature, internal operator data, and initial observation of service conditions in the field. The literature acts as a conceptual basis in the formulation of indicators, while operator data and observation results are used to adjust the indicators to the operational characteristics of the LRT Feeder.

In this study, the hazard category refers to the condition or source of risk that has the potential to affect service safety. Meanwhile, the category of events refers to operational events that may occur during the service process. A list of potential hazards and operational events used in the mapping process is presented in Table 2.

Table 2 Hazard and Occurrence Indicators

Item	Category	Dimensions	Description	References
H_1	Danger	Fleet condition/airworthiness	The roadworthiness and physical condition of the fleet related to operational safety during service.	Sam dkk. (2018)

Item	Category	Dimensions	Description	References
H_2	Danger	Risky driving behavior	Driving behavior patterns that increase the risk of incidents or injuries, such as inappropriate speeds, sudden braking, and aggressive maneuvers.	Jiao dkk (2024)
H_3	Danger	Risks at stops/stop points and accessibility	Conditions at boarding and alighting points or stops that potentially increase passenger safety risks, including confined spaces, slippery surfaces, and conflicts with traffic flow.	Sha dkk. (2022)
H_4	Danger	Fleet readiness and emergency response procedures	The availability, functionality, and readiness of safety equipment and emergency response procedures in the fleet.	Shang dkk. (2022)
E_1	Incident	Damage or component failure during operation	Technical disruptions or failures of fleet components during operation that could potentially disrupt service and increase safety risks.	Kofi dkk. (2024)
E_2	Incident	Traffic disruptions, road conditions, and conflicts with other vehicles.	Increased passenger numbers or congestion that increase the risk of boarding and alighting and service control.	Mohamed dkk. (2022)
E_3	Incident	Surge in passengers or congestion	Operational events such as increased demand or congestion that cause more congested feeders or stops, increasing the risk of boarding and alighting and safety control.	Shang dkk (2022)

Source: Literature, passenger survey, operator data

These indicators are identified from the literature and aligned with the operational characteristics of the Palembang LRT Feeder service. These variables make up the HOW in the HoQ matrix because they represent operational safety issues that can affect the perceived quality of safety of passengers. The same HOW element is also used in roof analysis to evaluate whether operational risk factors are mutually supportive, neutral, or potentially conflicting.

Integration of Passenger Voice Indicators with Potential Hazards and Operational Events through House of Quality

The integration between passenger voice indicators with potential hazards and operational incidents is carried out through the House of Quality (HoQ) method. In this study, the passenger voice indicators in Table 1 are placed as WHATs, which are service safety quality attributes that are assessed based on the passenger's point of view. Meanwhile, potential hazards and operational events in Table 2 are placed as HOWs, which are operational aspects that have the potential to affect the safety of LRT Feeder services. This structure is used to describe the relationship between the safety attributes perceived by passengers and the source of danger as well as operational events that occur in the service process.

The initial weight of the passenger voice indicator is calculated based on the average expectation and average perceived service conditions on each attribute. This weight is used to show the relative contribution of each passenger safety attribute on the side of the WHATs. The initial weight calculation is carried out with the following equation:

$$w_{sj} = \frac{\bar{K}_j}{\sum_{j=1}^{J} \bar{X}_j} \; x \; \bar{H}_j$$

with w_{sj} indicates the initial weight of the passenger safety attribute to-j, $\bar{K}_j$ shows the average perceived service condition on the attribute to-j, $\bar{H}_j$ indicates the average expectation on the th attribute, and indicates the number of safety attributes assessed. The initial weight is then normalized to obtain the relative weight of the passenger voice indicator as shown in the following equation:jJ

$$\bar{W}_{sj} = \frac{w_{sj}}{\sum_{j=1}^{J} w_{sj}}$$

with $\bar{W}_{sj}$ indicates the relative weight of the passenger safety attribute to-. This relative weight is placed on the jWHATs side in the HoQ as a representation of the relative importance of the passenger voice indicator based on the passenger's assessment.

On the side HOWs, the value of the initial importance of potential hazards and operational events was obtained from the driver's assessment as an expert respondent. Drivers are involved because they have first-hand experience of service operational conditions, interaction with passengers, traffic conditions, and potential hazards that arise during the trip. The value of the initial importance of each potential hazard or event is then normalized to obtain the following priority weights:

$$\bar{W}_{hk} = \frac{w_{hk}}{\sum_{k=1}^{K} w_{hk}}$$

with $\bar{W}_{hk}$ indicates the priority weight of potential hazards or events to-k, w_{hk} indicates the value of the initial significance of the potential hazard or occurrence to, and indicates the number of potential hazards and events analyzed. This weight represents the initial priority of the operational element based on the driver's assessment.kK

The relationship between WHATs and HOWs was assessed in the HoQ matrix by drivers as expert respondents. The relationship scale used is 0 for no relationship, 1–3 (Δ) for weak relationships, 4–7 (■) for moderate relationships, and 8–9 (●) for strong relationships. Because the assessment was conducted by more than one expert respondent, the relationship values of each pair of WHATs–HOWs were aggregated using averages. The aggregation results are then categorized into the same relationship level, while values below 1.00 are treated as no relationships in the calculation.

In addition to the main relationship matrix, roof analysis is used to identify linkages between HOWs. The roof assessment was also carried out by expert respondents and aggregated using averages to obtain the final value of the relationship between the indicators. The roof scale is 1 to 5, with a value of 5 (++) indicating a very linear relationship, a value of 4 (+) a direct relationship, a value of 3 (0) a neutral relationship, a value of 2 (−) an opposite relationship, and a value of 1 (−−) a very opposite relationship. Thus, the HoQ in this study is used to integrate safety quality assessment from the passenger side with the priority of hazards and operational events from the driver's side, thus producing a systematic picture of operational safety issues that need attention in improving LRT Feeder services.

Data Collection and Sampling

This study used both primary and secondary data. Primary data is collected through passenger questionnaires and expert assessments. The passenger survey was conducted to obtain an evaluation of safety-related service attributes based on two dimensions, namely expectation and satisfaction. Expert assessments were used to evaluate the relationship between passenger safety attributes and hazards and operational events in the HoQ relationship matrix, while additional expert assessments were used to evaluate correlations between rooftop HOWs. Secondary data is obtained from operational documents, including passenger volume data, route information, and supporting incident records, which are used to support indicator development and sampling design. This research was conducted on LRT Feeder services in Palembang City in eight service corridors. The target population for the passenger survey consists of LRT Feeder users recorded from January to September 2025, with a total population of 2,247,270 passengers. The minimum sample size was determined using the Slovin formula with a margin of error of 5%, so a minimum of 400 respondents were required. To reduce the risk of unusable responses, 450 questionnaires were distributed. After the data screening and cleansing, 420 valid questionnaires were retained for analysis. Passenger respondents were selected using random sampling, meaning passengers who were encountered during the use of the service and were willing to participate were included in the survey.

To ensure representation across operational service areas, passenger samples are distributed proportionally across the eight LRT Feeder corridors. In addition to passenger respondents, the study engaged driver experts to assess the relationship between passenger safety attributes and hazards and operational events in the HoQ matrix. Following the structure adopted in the study, operator experts were also engaged to assess the correlations between the HOWs in the matrix. This combination of passenger survey data, driver assessments, and operator assessments allows the study to integrate user-based safety perceptions with operational assessments in a structured manner.

RESULTS AND DISCUSSION

Demographic Statistics and Expert Respondent Profiles

A total of passenger questionnaires was distributed to 450 respondents using LRT Feeder in 8 corridors of Palembang City. After checking the completeness and consistency of the answers, as many as 30 responses were declared unfit for use. Thus, as many as 420 passenger questionnaires were declared valid and used in the next analysis. In addition, this study also involves a panel of experts for the assessment of the relationship matrix in the first stage of the House of Quality as well as the correlation assessment of the roof.

Table 3 Passenger respondent profile

Variable	Category	Frequency (people)	Percentage (%)
Gender	Male	87	21
	Women	333	79
Age	<17 Year	20	5
	18-25 Year	148	35
	26-40 Year	112	27
	41-55 Year	94	22
	>55 Year	46	11

Variable	Category	Frequency (people)	Percentage (%)
Ultimate Education	Others	77	18
	SMA	149	35
	D3	45	11
	S1	145	35
	S2	4	1
	S3	0	0
Work	Student	96	23
	Housewife	67	16
	Private Employee	79	19
	Civil Servant	29	7
	Self-Employed	47	11
	Other	102	24
Long time user	Just started (<1 month)	23	5
	1-3 months	59	14
	4-6 months	47	11
	7-9 months	78	19
	>9 months	213	51
Safety incident experience	Never	96	23
	Ever	324	77

Source: Primary survey and expert assessment, Palembang LRT Feeder

Table 3 shows the composition of passenger respondents used in the assessment of service safety quality. In addition to demographic characteristics, length of service use and experience of safety-related events are presented to show respondents' exposure to the operational conditions of the LRT Feeder. Based on Table 4, the expert operator respondents involved in this study have sufficient operational experience and safety understanding to support the assessment process in the first stage of the House of Quality and roof analysis.

Table 4 Profile of Expert Respondents in HoQ analysis

Expert Group	The role of the analyst	Number of respondents	Relevant Characteristics
Drivers	Assessment of the relationship matrix between passenger voice indicators and potential hazards/operational events	25	Directly involved in daily operations and safety conditions in the field
Operators	Assessment of the roof matrix between potential hazard indicators and operational events	8	Involved in operational management and implementation of service safety.

Source: Primary survey and expert assessment, Palembang LRT Feeder

The expert respondents in Table 4 are used to provide an operational perspective on the results of passenger assessments. The driver represents the day-to-day operational experience, while the operator represents the aspects of service management and safety implementation.

Passenger Assessment of the Safety Quality of Passenger Service

The assessment of the quality of passenger safety is carried out by comparing the average expected value and perceived service conditions in each safety attribute. The preparation of Table 5 follows the sequence of indicators in Table 1 to remain in harmony with the assessment structure. In addition, gap ratings are added to identify the attributes with the largest negative gap values. The results of the calculation show that all attributes have a negative gap, so it can be concluded that the service conditions felt by passengers are not fully in accordance with expectations in all aspects of safety quality assessed.

Table 5 Passenger Assessment of Service Safety Quality Attributes and Service Safety Quality Gap

Service Safety Quality Attributes	Mean Hope	Mean Satisfaction	Gap Value	Gap Stage
Vehicles appear well-maintained and operationally fit	4.28	4.09	-0.19	10
Boarding and disembarking areas are safe	4.62	3.29	-1.33	1
Arrival times are on schedule	4.45	3.90	-0.55	8
Driving behavior is safe and stable	4.59	3.60	-0.99	3
Passengers feel safe from crime around the stopping points	4.58	3.69	-0.89	4
Safety equipment in the vehicles is available and functioning	4.41	3.99	-0.42	9
Drivers are polite and respectful, so passengers feel comfortable reporting any safety concerns	4.41	3.69	-0.72	7
Passengers feel the service is considerate of the safety of women, vulnerable groups, and those with special needs	4.61	3.59	-1.02	2
Drivers assist passengers who need assistance	4.51	3.69	-0.82	5
Drivers respond quickly and provide clear directions/safety information	4.50	3.75	-0.75	6

Source: Passenger expectation and satisfaction survey, n=420

The largest gap was found in the attribute of safe passenger boarding and disembarkation area (-1.33), followed by the safety of female passengers, vulnerable groups, and special needs (-1.02), and safe and stable driver behavior (-0.99). These three attributes show that the most prominent safety quality gaps are in the aspects of service access, protection of vulnerable passengers, and a sense of security in the service room.

On the other hand, the smallest gap is found in the attribute Vehicle looks well-maintained and operational feasible (-0.19) Safety equipment in the vehicle is available and functional -0.42). Although both still show negative gaps, their value is smaller than the other attributes. This shows that aspects of the condition of the vehicle are relatively closer to the expectations of passengers, while the need for stronger improvement arises in the safety of the pick-up and down process, protection of vulnerable groups, a sense of security, orderliness of service, and driver behavior.

Priority Weight of Passenger Voices and Potential Operational Hazards

Priority weights are calculated to reflect the relative position of each element before it is integrated into the HoQ. In the aspect of WHATs, the relative weight shows the contribution of each passenger voice indicator based on the assessment of perceived expectations and service conditions. Meanwhile, in the aspect of HOWs, priority weights describe the level of importance of potential hazards and operational events based on the driver's assessment.

Table 6 Relative weight of passenger voice indicators

Service Safety Quality Attributes	Initial Weight	Relative weight	Rank
Vehicles are well-maintained and operationally fit	0,470	0,095	7
Passenger boarding and disembarkation areas are safe	0,441	0,089	10
Teman Bus arrivals are fairly regular	0,471	0,095	6
Drivers operate safely and consistently	0,501	0,101	4
Crime-free at stops and inside Teman Bus	0,468	0,094	8
Safety equipment is available and functioning	0,494	0,100	5
Drivers are polite and respectful of passengers	0,505	0,102	3
The safety of female passengers, vulnerable groups, and those with special needs is considered	0,463	0,093	9
Drivers are responsive to passengers in need	0,573	0,115	2
Drivers provide clear safety information and responses	0,573	0,116	1

Source: Passenger expectation and satisfaction survey, n=420

Based on Table 6, the highest relative weight is found in the indicator of passenger surge or density, with a relative weight of 0.24. The next priority is occupied by the risk of stops/stop points and accessibility with a relative weight of 0.19, as well as traffic disturbances and road conditions with a relative weight of 0.15. These findings show that in the first stage, expert assessments more associate passenger safety needs with operational events related to passenger density, the condition of stopping points and accessibility, as well as traffic disruptions and road conditions. In contrast, the lowest priority is the feasibility condition of the fleet, with a relative weight of 0.07. Relatively lower values were also seen in the readiness of emergency response equipment and procedures in the fleet with a relative weight of 0.10, as well as risky driving behavior with a relative weight of 0.11. These results show that in the first stage, the three components are still related to the safety needs of passengers, but the level of relationship is relatively lower than the elements of hazards and operational events that are ranked at the top.

Table 7. Priority weighting of potential hazards and operational events

Potential Hazards and Occurrences	Initial Weight	Relative weight	Rank
Fleet condition/airworthiness	15,00	0,07	8
Risky driving behavior	25,04	0,11	7
Risks at stops/stop points and accessibility	42,65	0,19	2

Fleet readiness and emergency response procedures	23,15	0,10	6
Damage/component failure during operation	32,00	0,14	4
Traffic disruptions, road conditions, and conflicts with other vehicles	34,27	0,15	3
Passenger surge/overcrowding	52,92	0,24	1

Source: Expert assessment of hazards and operational events

On the operational side, Table 7 shows a surge in passengers or density, with a relative weight of 0.24. The next priority is occupied by the risk of stops/stopping points and accessibility with a relative weight of 0.19, as well as traffic disturbances and road conditions with a relative weight of 0.15. These findings show that in the first stage, expert assessments more associate passenger safety needs with operational events related to passenger density, the condition of stopping points and accessibility, as well as traffic disruptions and road conditions. In contrast, the lowest priority is the condition of the fleet's viability, with a total relative weight value of 0.07. Relatively lower values were also seen in the readiness of emergency response equipment and procedures in the fleet with a relative weight of 0.10, as well as risky driving behavior with a relative weight of 0.11. These results show that in the first stage, the three components are still related to the safety needs of passengers, but the level of relationship is relatively lower than the elements of hazards and operational events that are ranked at the top.

Integration of HoQ Results and Roof Interpretation

The House of Quality integration is shown in figure 1. This matrix shows the relationship between passenger noise indicators, potential hazards and operational events, as well as the relationship between operational indicators through the roof matrix.

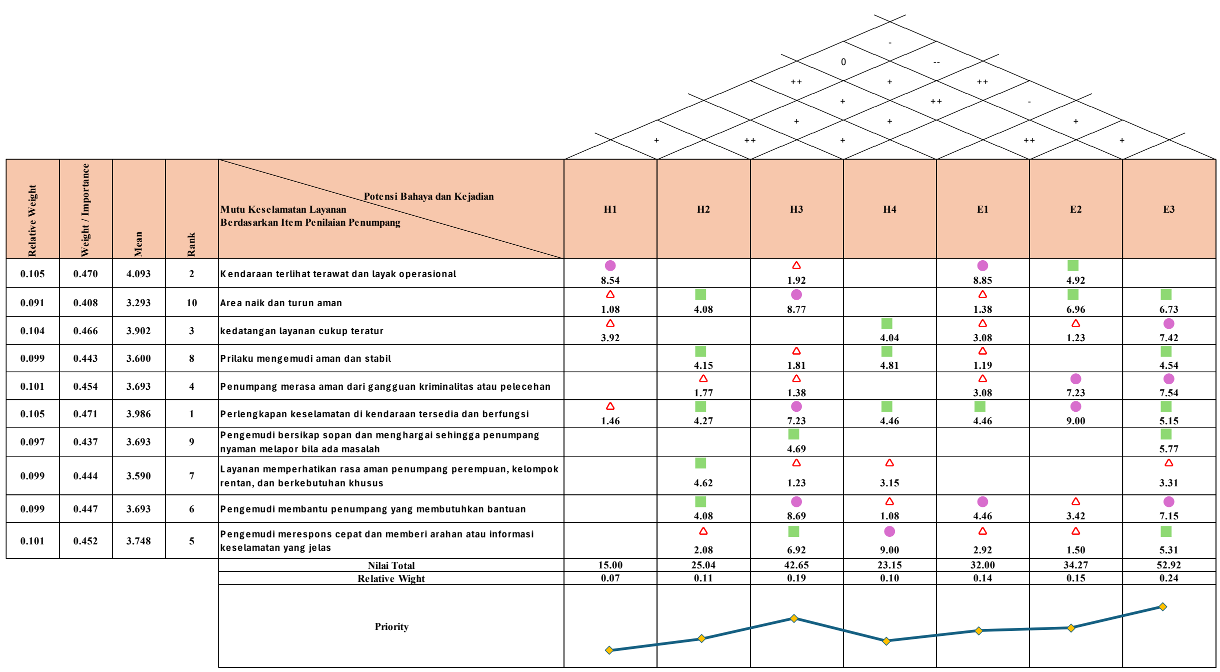

Figure 2 Relationship matrix House of Quality

The integration results show that the highest operational priorities are on surge in passengers/density, breakdowns or failures of components during operation, and the risk of stops/stop points and accessibility. These three elements show that the safety issue of Teman Bus is not only centered on driving behavior, but also on the service capacity, technical reliability of the fleet, and the quality of passenger access space.

The relationship matrix shows that passenger voice attributes related to the up-and-down area, regularity of service, sense of security, and driver response are related to more than one operational element. This pattern suggests that passenger safety experiences are shaped by a combination of service factors, rather than from a single source of danger. Thus, safety improvements need to be directed at operational points that affect multiple passenger attributes simultaneously.

The results of the roof analysis in the first stage are not used as the main component in the calculation of the relative weights of HOWs, but are used as complementary information to deepen the interpretation of the results in the main relationship matrix. Thus, the main conclusions in the first stage remain based on the priority of the HOWs obtained from the relationship matrix, while the roof serves to help explain the relationship between the potential hazards and the operational events that are priorities at that stage.

CONCLUSION

This study shows how Safety Quality Function Deployment can be used to link passenger-based safety quality evaluation with potential hazards and operational events of LRT Feeder services in 8 corridors of Palembang City. Through the House of Quality, passenger voice indicators composed of service safety quality attributes are integrated with operational elements that have the potential to affect service safety which conclude as three results. Firstly, the results of the passenger assessment showed that all safety quality attributes had a negative gap, which indicated that the perceived service conditions were still below the expectations of passengers. The largest gaps appear in the security aspects of the up-and-down area, the protection of female passengers, vulnerable groups, and special needs, and safety from criminal disturbances. In contrast, attributes related to driver responses show relatively smaller gaps. These findings confirm that the main issues from a passenger perspective are more related to service access spaces, protection of vulnerable groups and a sense of security in the service ecosystem. Secondly, the results of the HoQ integration show that the highest operational safety priority indicates that passenger safety needs are most associated with operational conditions that are directly felt during the journey, especially passenger spikes or congestion, the risk of stops or stopping points and accessibility, as well as traffic disruptions and road conditions. These results show that the safety of the LRT Feeder is not only influenced by driver behavior, but also by service capacity, fleet technical reliability, fleet technical reliability, and the risk of disturbances around the environment. The roof matrix also shows the interconnectedness between operational elements, so safety control needs to consider the relationship between the sources of danger, rather than handling each issue separately. Furthermore, the contribution of this research lies in the use of SQFD to translate passenger voices into operational hazard control priorities. With this approach, safety quality evaluation not only measures the perception of service but is also used to identify the operational elements that are most relevant to safety improvement. In practical terms, the results of the study provide direction for operators and stakeholders to prioritize congestion control, fleet technical readiness, pick-and-drop point safety, vulnerable passenger protection, and driver safety response. This research has several limitations. First, the research carried out was on the Palembang City

LRT Feeder service, data collected in the period September 2025 to February 2026, so that it has not captured changes in passenger perception and operational conditions from time to time. Third, the HoQ mapping is based on the assessment of passengers, drivers, and operators. Follow-up research can enrich the analysis with actual operational data, real-time incident data or evaluation before and after safety interventions so that the SQFD approach can be developed as a more adaptive and evidence-based general service safety evaluation system.

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