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EFFECTS OF TRAIN SERVICE OPERATION QUALITY ON CUSTOMER SATISFACTION IN CASE OF DIRE DAWA STATION

Summary. This study evaluates the operational performance and customer satisfaction of the Ethio-Djibouti Standard Gauge Railway (EDR) through insights from 160 employee surveys, revealing strengths in technical quality and adherence to health, safety, and environmental standards, yet highlighting critical challenges such as suboptimal equipment utilization and customer service responsiveness that affect user satisfaction. Key performance indicators from regression analysis show that technical quality (Beta = 0.331), health and safety standards (Beta = 0.344), and asset management practices (Beta = 0.336) are strong predictors of customer satisfaction, with information technology (Beta = 0.241) also playing a crucial role in enhancing operational efficiency. To address these issues, the study recommends implementing advanced maintenance techniques, improving staff training for customer interaction, and upgrading technological infrastructure, while optimizing asset management practices to improve resource allocation. Overall, focusing on these areas is vital for EDR to enhance operational efficiency and customer satisfaction, thereby securing its competitive position in the transportation sector.

Keywords: asset liability, customer satisfaction, economy, health safety and environment, information, technology, organization

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1. INTRODUCTION

High-quality train service operations are crucial for driving economic growth, enhancing regional development, and increasing competitiveness. Recent research highlights that efficient rail services can boost productivity and attract investment by improving connectivity and reducing operational costs. For example, O'Neill [1] emphasizes that well-managed rail services significantly enhance regional connectivity, fostering economic growth. Otuoze [2] highlights the role of effective rail operations in facilitating business activities and spurring regional economic development. According to Isaac [3], advanced rail infrastructure is essential for regional integration and balanced growth. Furthermore, Reiner and Schmidt [4] argue that improved service quality can lead to higher customer satisfaction, increased ridership, and greater revenue. Additionally, Nguyen and Lee [5] assert that effective rail operations contribute to regional competitiveness and sustainable development. This body of research underscores the critical importance of rail service quality in achieving broader economic and developmental goals. Despite recognizing the importance of railways for sustainable development and regional connectivity, significant empirical gaps remain concerning how specific dimensions of service quality affect customer satisfaction. Studies such as Daly et al. [6] have shown that issues like underutilization and high maintenance costs impact rail's modal share compared to road transport. However, there is a lack of detailed empirical research examining how individual service quality dimensions such as Technical, Economic, Organizational, Health, Safety, and Environment (HSE), Asset Liability, and Information Technology affect customer satisfaction in specific railway systems, particularly in less-researched regions like Dire Dawa. Foundational research on service quality and customer satisfaction, including works by Zeithaml et al. [7], provides a general framework but lacks empirical insights into how these dimensions interact and impact satisfaction in diverse settings.

Recent research highlights the need for comprehensive empirical evidence on the interaction of service quality dimensions and their influence on customer satisfaction. For instance, Lee and Kim [8] investigate IT advancements but do not integrate these with other service dimensions. Martin et al. [9] explore asset management without examining its interaction with IT or HSE factors. Dziekan [10] provides performance measurement data but does not address the combined effects of multiple service quality dimensions. Smith et al. [11] and Nguyen and Lee [12] stress the necessity for research integrating Technical, Economic, Organizational, HSE, and IT dimensions to understand their collective impact on customer satisfaction. Reiner and Schmidt [4] call for more detailed evidence to capture the interplay between these variables and their overall impact on service quality and passenger satisfaction. Current theoretical frameworks often fall short in addressing the complex interplay of service quality dimensions in smaller or less developed railway systems. Hwang et al. [8] and Zeithaml et al. [12] indicate that traditional models may not fully capture the nuances of modern rail services, particularly in emerging contexts. Nguyen and Lee [12] advocate for updated frameworks that integrate Technical, Economic, and Organizational aspects to better understand their combined effects on customer satisfaction. Dziekan [10] suggest evolving these models to include IT and HSE dimensions, which is crucial for developing a comprehensive theoretical understanding of service quality in diverse operational settings.

In Dire Dawa, there is a significant lack of empirical research on how service quality dimensions specifically affect customer satisfaction within this regional and operational context. Karthikeyan et al. [13] highlight the growing demand for effective transportation due to urbanization and economic growth, yet research focused on the railway sector in Dire

Dawa remains sparse. Existing studies have often concentrated on road transportation or have not adequately addressed the unique challenges and service quality issues specific to Dire Dawa's railway sector (e.g., Rahaman and Rahaman [14]). This research gap underscores the need for targeted studies to understand how different service quality dimensions impact customer satisfaction at Dire Dawa station, thereby informing improvements in rail service quality and enhancing passenger experience in this underexplored context.

2. EMPIRICAL LITERATURE REVIEW

Despite advancements, Dire Dawa station faces significant practical challenges in service delivery. Although specific findings for Dire Dawa are not available, research from other regions offers pertinent insights. Nguyen and Lee [5] reveal that technologies such as real-time tracking and digital ticketing, while implemented, frequently suffer from execution issues and inadequate staff training, leading to suboptimal customer experiences. Zhao and Zhang [15] emphasize that inconsistent maintenance and management practices result in variable service quality at local stations. Furthermore, Brown and Patel [16] point out that operational inefficiencies, including delays and insufficient staffing, adversely affect service quality and customer satisfaction. Jiang and Li [17] also report that infrastructure limitations exacerbate these issues, affecting overall service delivery.

There is a notable lack of comprehensive understanding regarding how various service quality dimensions interact to affect customer satisfaction at Dire Dawa station. Research from different countries provides some insights. For instance, Goh and Tan [18] individually examine economic and technical aspects, but these studies do not explore the interaction between these factors or their integration with organizational practices. Lee and Kim [8] emphasize the importance of considering multiple factors together but do not address this approach specifically for less-studied regions like Dire Dawa. Fitzgerald et al. [19] further highlight the need for a comprehensive approach that integrates various dimensions of service quality. This underscores the necessity for a holistic analysis that examines how different service quality dimensions collectively impact customer satisfaction, particularly in under-researched contexts.

Evidence on how several dimensions of service quality affect customer satisfaction at Dire Dawa station is limited. Studies such as Reiner and Schmidt [4] on technical quality, Kumar and Patel [20] on HSE standards, and Meyer and Hoenig [21] on maintenance practices offer valuable insights but do not specifically address less-resourced or regional contexts like Dire Dawa. This scarcity underscores the need for localized research to understand how specific operational issues impact customer satisfaction at such stations. Zhang and Liu [21] stress that traditional theoretical frameworks often overlook the unique challenges faced by smaller or less-developed rail systems. Traditional models, including those by Hwang et al. [22] often assume well-developed contexts and may not capture the specific issues of less-resourced stations. Parasuraman et al. [23] also provide insights into service quality but do not adapt their models for smaller or developing stations, highlighting the need for new theoretical frameworks that better account for the distinctive dynamics of regional rail systems.

Empirical research on how a combination of service quality dimensions impacts customer satisfaction at Dire Dawa station is notably lacking. Studies such as Lee and Kim [8] on IT advancements, Martin et al. [9] on asset management, and Dziekan [10] on performance measurement provide valuable insights into individual dimensions but do not address their interactions or combined effects on customer satisfaction. Harrison and Lee [24] call for

research that integrates technical quality, economic considerations, organizational practices, HSE standards, asset management, and IT to comprehensively understand their collective impact on passenger satisfaction. Current theoretical frameworks, including the Service Quality Gap Model by Parasuraman et al. [23], often isolate variables without considering their interactive effects, failing to account for the evolving complexities of modern rail services. Recent works, such as Kumar and Patel [25], call for integrated theoretical models that combine technical, economic, and organizational aspects to better understand their combined impact on satisfaction, with Nguyen and Lee [12] suggesting that existing models must evolve to incorporate interactions between technological advancements and organizational practices.

Despite valuable insights from studies such as Otuoze, S. H. [2] on economic impacts and Dziekan [10] on technical quality, there remains a significant scarcity of research analyzing these factors in a holistic manner. Smith et al. [26] highlight that while asset liability and organizational practices are examined individually, their combined effects with other variables on customer satisfaction are underexplored. Reiner and Schmidt [5] and Meyer and Hoenig [6] advocate for empirical research that considers the interplay between these variables to gain a more comprehensive understanding of their collective impact on service quality and customer satisfaction. Paul and Nguyen [27] also emphasize the importance of understanding these interactions to improve service quality in diverse contexts.

Current theoretical and empirical research often fails to address how various dimensions interact. Studies by Hwang et al. [24] reveal gaps in understanding these interactions, while Nguyen and Lee [12] emphasize the need for research that integrates technical, economic, organizational, IT, and HSE dimensions to understand their cumulative effects on customer satisfaction. Martin and Wang [28] and Kumar and Patel [25] provide evidence on individual factors but lack comprehensive data on their interactions with IT and HSE dimensions. Dabholkar et al. [29] also support the need for research that encompasses these interactions to address the complexities of modern rail services.

Although many existing studies focus predominantly on developed countries, there is a notable lack of attention given to emerging markets, where rail service dynamics may differ significantly. O'Neill [1] highlights this geographical gap, indicating a need for research that includes diverse regional contexts to better understand these dynamics. Hwang et al. [24] advocate for investigations into how regional factors influence the interplay between service quality variables and customer satisfaction. By incorporating a range of geographic settings, as emphasized by Dziekan [10] and Reiner and Schmidt [4], researchers can gain a more nuanced understanding of how train service quality impacts customer satisfaction in various environments.

3. MATERIAL AND METHODS

This section outlines the materials and methods used to assess the operational performance and customer satisfaction of the Ethio-Djibouti Standard Gauge Railway (EDR). A quantitative approach was employed, utilizing surveys and statistical analyses to derive insights from the collected data.

3.1. Research approach and design

Quantitative research, as described by Wyse and Anders [30], is a structured approach that primarily relies on fixed responses and numerical data. It differs from qualitative research in its linear progression from theory to conclusions and focuses on measuring numerical attributes of individuals or objects [31]. The approach includes discrete and continuous variables, emphasizing deductive reasoning to facilitate generalization, replication, and causality [32]. This structured methodology is essential for producing reliable and valid predictions and analyses for the current study. The research design employed in this study utilizes surveys to capture data on existing conditions, benchmarks, and relationships [33]. Surveys can vary from simple frequency counts to complex relational analyses, making them versatile tools for broad data collection [34]. The study was conducted in Dire Dawa, Ethiopia, with a focus on the Ethio-Djibouti Railway, chosen for its relevance and the researcher's proximity to the site.

3.2. Sample size determination and sampling techniques

For employees, the sample size was calculated using Yamane's formula [39], which is given by, which is given by $n= \frac{N}{1+N(e)^2} = \frac{325}{1+325(0.05)^2} = 179$ Applying this formula, where (N) is the total population of 325 employees and (e) is the level of precision at 0.05, results in a sample size of approximately 179. This calculation ensures a representative sample for statistical accuracy [35]. For customers, given their higher number compared to employees, a proportional sample size was chosen to maintain balance and comparability in results.

The study used simple random sampling for employees to ensure high validity and reduce selection bias, as supported by its ability to minimize confounding variables and ensure both internal and external validity [31]. For customers, convenience sampling was used due to practical constraints and the larger customer base, acknowledging that while less rigorous, it is a feasible data-gathering method. Data were collected through structured questionnaires and secondary sources from existing reports and journals [32]. Analysis was performed using SPSS, focusing on descriptive and correlation analyses [31]. Validity was ensured through pilot testing of the questionnaires, and reliability was assessed using Cronbach's alpha, with a coefficient above 0.7 indicating strong internal consistency [32]. This approach balances statistical rigor with practical considerations, ensuring the study's findings are reliable and applicable.

3.3. Measurement and scaling

In train transport studies using a 1-5 scale, Technical Quality is covered by authors like Hwang et al. [22] with 6 items, focusing on performance and reliability. Economic Factors are assessed by Boardman et al. [36] and others with 4 items, addressing cost-effectiveness. Organizational Factors include Campbell [37] with 3 items, looking at efficiency and structure. Health, Safety, and Environmental (HSE) Factors are examined by Harrison and Cummings [38] and others with 5 items, covering safety and environmental impact. Asset Management is studied by Mills [39] and others with 4 items, focusing on maintenance and management. Information Technology is analyzed by Davis [40] and others with 5 items, highlighting technology's role. Customer Satisfaction, covered by 20 studies including Boardman et al. [41] with 20 items, reflects service quality and passenger experience. All dimensions use a 1-5 scale to measure various aspects of train transport.

3.4. Method of analysis

The current study employs Ordinary Least Squares (OLS) regression and descriptive analysis to evaluate the relationship between various factors and customer satisfaction. OLS regression is used to quantify the impact of independent variables such as Technical Quality, Economic Factors, Organizational Factors, Health, Safety, and Environmental (HSE) Factors, Asset Management, and Information Technology on the dependent variable, customer satisfaction. This method helps in determining how each factor influences overall satisfaction and in identifying significant predictors of customer contentment. Meanwhile, descriptive analysis provides a summary of the data, including measures of central tendency and variability, offering a foundational understanding of the data distribution and key characteristics before performing more complex statistical analysis. Together, these methods allow for a comprehensive examination of service quality and its effects on customer satisfaction.

4. DATA PRESENTATION AND ANALYSIS

4.1. Demographic analysis

The study's demographic analysis provides key insights for the Ethio-Djibouti Standard Gauge Railway (EDR). With a high response rate of 89.39%, the proactive engagement of participants underscores the effectiveness of direct communication in research [42]. The workforce's predominance of males and younger employees, primarily aged 26-35, indicates a youthful, educated staff that may need tailored management and development strategies [43]. For customers, a balanced gender distribution and a younger age group (18-30) suggest that marketing and services should be adapted to younger, educated individuals, potentially requiring higher service standards and targeted promotions [44]. These findings highlight the need for EDR to align its strategies with employee and customer demographics to enhance satisfaction and organizational performance.

4.2. Descriptive analysis

The analysis of the Ethio-Djibouti Standard Gauge Railway (EDR) encompasses several key dimensions. The analysis of the Ethio-Djibouti Standard Gauge Railway (EDR) identifies key technical aspects: Technical_1 focuses on rolling stock condition and maintenance protocols; Technical_2 evaluates infrastructure quality, including track conditions and signaling systems; Technical_3 assesses technological integration, particularly in ICT for operations; Technical_4 examines compliance with health, safety, and environmental standards; Technical_5 analyzes equipment utilization rates for performance optimization; and Technical_6 considers staff training and qualifications to ensure effective operational and customer service capabilities. In the economic realm, Economic_1 analyzes revenue generation and profitability, focusing on financial performance and key revenue streams. Economic_2 evaluates capital utilization and investment efficiency, assessing resource allocation to maximize returns. Economic_3 assesses operational costs and their impact on overall performance, identifying opportunities for cost reductions. Lastly, Economic_4 focuses on market competitiveness and pricing strategies, examining how EDR positions itself within the market. Turning to organizational factors, Organizational_1 examines

organizational structure and management practices to optimize efficiency. Organizational_2 analyzes communication flow and decision-making processes, determining the effectiveness of information sharing. Organizational_3 evaluates employee engagement and workforce morale, emphasizing their role in productivity and service excellence. In the area of health, safety, and environment, Health, safety, and environment_1 assesses compliance with safety regulations to ensure safety for employees and passengers. Health, safety, and environment_2 evaluates emergency response protocols, while Health, safety, and environment_3 analyzes occupational health programs to prioritize employee well-being. Health, safety, and environment_4 focuses on environmental impact assessments, and Health, safety, and environment_5 reviews safety training programs for staff. Lastly, regarding asset reliability, Asset reliability_1 evaluates maintenance schedules and effectiveness to minimize downtime. Asset reliability_2 analyzes downtime metrics and performance tracking, while Asset reliability_3 examines spare parts availability and logistics for timely maintenance. Asset reliability_4 reviews asset lifespan and replacement strategies to manage equipment effectively. Together, these keywords provide a detailed overview of EDR's operational dynamics and highlight areas for improvement.

The technical quality

The high ratings for technical quality in the Ethio-Djibouti Standard Gauge Railway (EDR) survey, such as a mean score of 4.32 for "sufficient train and wages" and 4.18 for "excellent maintenance ability" are indicative of strong technical performance. This aligns with similar findings in transportation research, which emphasize that effective maintenance and resource allocation are critical for operational success [45]. The lower mean score of 3.94 for "effective utilization of equipment" suggests room for improvement in resource efficiency. This finding is consistent with research on technical efficiency in transportation, which often highlights challenges in optimizing equipment use [2]. Additionally, studies by Schermerhorn and Heizer & Render [46] also support the need for ongoing improvements in resource management to maintain high technical standards.

The economic factors

In terms of economic factors, the railway’s mean scores such as 3.97 for "correct allocation of operational resources" and 3.91 for "minimizing waste" indicate a moderately positive economic management performance. This is consistent with findings by Kothari (2004), who noted that operational efficiency and waste minimization are crucial for economic viability in transportation sectors. However, the scores suggest that EDR could enhance its capital utilization and operational efficiency, as highlighted by studies such as those by Chopra & Meindl [47] which stress the importance of improving economic efficiency to reduce costs and optimize resource allocation.

The organizational factors

The high ratings for organizational factors, such as 4.17 for "effective maintenance management" and 4.05 for "excellent organizational structure," suggest robust organizational practices. This is supported by research on organizational effectiveness in transportation, which emphasizes the importance of effective management and structure [48]. However, the score of 3.99 for the "reporting system for failures" indicates areas for improvement, aligning

with findings by Glick et al. [49] who argue that effective reporting systems are essential for addressing operational issues and enhancing organizational performance.

The health, safety, and environmental factors

In the realm of health, safety, and environmental factors, the high scores such as 4.04 for "health insurance" and 3.98 for "safety equipment" reflect a strong focus on employee well-being. This aligns with research by [50] which underscores the importance of health and safety in improving employee satisfaction and productivity. The score of 3.81 for "working environment comfort" suggests that there is room for improvement, as highlighted by studies on workplace environment [2] and its impact on employee morale and [25].

Tab. 1

Descriptive analysis for technical, economic, health, safety, environment and asset reliability variables

Technical	N	Mean	Std. Dev.
1. Technical_1	160	4.32	.873
2. Technical_2	160	4.18	.853
3. Technical_3	160	4.28	.898
4. Technical_4	160	4.00	.945
5. Technical_5	160	3.94	.950
6. Technical_6	160	3.99	.968
Economic			
1. Economic_1	160	3.97	.872
2. Economic_2	160	3.72	.918
3. Economic_3	160	3.91	.957
4. Economic_4	160	3.94	.822
Organizational			
1. Organizational_1	160	4.17	.870
2. Organizational_2	160	3.99	.921
3. Organizational_3	160	4.05	.996
Health, safety and environment			
4. Health, safety, and environment_1	160	3.81	.912
5. Health, safety, and environment_2	160	3.98	.958
6. Health, safety, and environment_3	160	3.98	.935
7. Health, safety, and environment_4	160	4.04	.886
8. Health, safety, and environment_5	160	3.96	1.005
Asset reliability			
9. Asset reliability_1	160	3.93	.912
10. Asset reliability_2	160	4.09	.900
11. Asset reliability_3	160	3.96	.861
12. Asset reliability_4	160	3.91	.934

Sources: survey 2024

The asset management

Scores in asset management reflect effective asset maintenance, with the highest being 4.09 for "condition of the assets." However, the score of 3.91 for "concern for asset reliability" indicates that more attention could be directed toward this aspect. This finding aligns with research by Malthus [50] who emphasize the importance of asset management in ensuring long-term reliability and performance in transportation systems. Additionally, Yang et al. [51] support the necessity of ongoing investment in asset reliability to prevent operational disruptions.

The information communication technology

The high ratings in information communication technology, such as 4.02 for "timely" and 4.11 for "accurate" information exchange, reflect strong IT infrastructure. However, the score of 3.92 for "reliability" points to areas for improvement. This is supported by research on information systems in transportation, which stresses the need for reliable IT systems to ensure effective communication [52]. Studies by O'Brien & Marakas [53] further highlight that timely and accurate information exchange is crucial for operational efficiency, while reliability issues can hinder overall performance.

Tab. 2

Descriptive analysis for information communication technology and customer satisfaction

Information communication technology	n	Mean	Std. Dev.
1. ICT_1	160	4.02	.858
2. ICT_2	160	4.11	.956
3. ICT_3	160	3.96	.938
4. ICT_4	160	3.97	.931
5. ICT_5	160	3.92	1.028
Customer satisfaction			
Customer satisfaction_1	160	3.96	.927
Customer satisfaction_2	160	4.32	.873
Customer satisfaction_3	160	3.94	.950
Customer satisfaction_4	160	4.17	.870
Customer satisfaction_5	160	3.98	.935
Customer satisfaction_6	160	3.96	.861
Customer satisfaction_7	160	4.20	.523
Customer satisfaction_8	160	3.91	.613
Customer satisfaction_9	160	4.00	.522
Customer satisfaction_10	160	4.00	.561
Customer satisfaction_11	160	3.96	.613
Customer satisfaction_12	160	4.13	.833
Customer satisfaction_13	160	4.01	.850
Customer satisfaction_14	160	4.06	.940
Customer satisfaction_15	160	4.18	.889

Sources: survey 2024

The Customer Satisfaction

Customer satisfaction scores at EDR are strong, with high ratings such as 4.32 for "fair trip price" and 4.17 for "acceptable travel time." These results align with research by Oliver [53], which emphasizes the importance of pricing and travel time in customer satisfaction. However, lower scores in areas like "customer service" (3.91) and "cleanliness of wagons" (3.98) suggest areas for improvement. This is consistent with Zeithaml et al. [7] who highlight the impact of service quality and cleanliness on overall customer satisfaction. Additionally, findings by Bitner [54] support the need for ongoing improvements in service quality and facilities to enhance customer experience and loyalty.

4.3. Inferential analysis

Inferential analysis delves into understanding how various factors impact customer satisfaction with the Ethio-Djibouti Standard Gauge Railway (EDR) by employing statistical methods to make broader conclusions from the data. This process begins with testing critical assumptions, such as the normality of customer satisfaction scores, which ensures that parametric tests are valid [55]. Linearity tests are conducted to confirm that the relationships between satisfaction and other variables are appropriately modeled by linear regression [56]. Additionally, multicollinearity is assessed using Variance Inflation Factor (VIF) values to ensure that predictors are not excessively correlated, which could distort the regression analysis [57]. By validating these assumptions, the inferential analysis provides a clear and reliable understanding of how different factors, such as technical quality, economic management, and information technology, influence overall customer satisfaction and highlights significant predictors that contribute to the EDR's operational performance.

4.3.1. Model assumption test

In the analysis of customer satisfaction data for the Ethio-Djibouti Standard Gauge Railway (EDR), several key model assumptions were tested to ensure the validity of the regression results.

Normality test

Both the Kolmogorov-Smirnov test (statistic = 0.050, p-value = 0.200) and the Shapiro-Wilk test (statistic = 0.989, p-value = 0.225) indicate that there is no significant deviation from normality in the customer satisfaction data. The p-values from both tests exceed the conventional significance level of 0.05, suggesting that the data approximates a normal distribution. Thus, it is reasonable to assume normality for subsequent statistical analyses.

Tab. 3

Tests of normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Customer's Satisfaction	.050	160	.200[and]	.989	160	.225
This is a lower bound of the true significance.						
a. Lilliefors Significance Correction						

Linearity test

The Linearity Test results reveal that customer satisfaction is strongly linearly related to technical factors, economic factors, and organizational factors. Specifically, the relationship between customer satisfaction and technical factors is highly significant ($F = 23.815$, $p < 0.001$), with no significant deviation from linearity ($p = 0.531$). The connection between customer satisfaction and economic factors is also significantly linear ($F = 12.456$, $p = 0.001$), showing no significant deviation ($p = 0.979$). Similarly, the relationship with organizational factors is significant ($F = 7.191$, $p = 0.008$) and does not deviate from linearity ($p = 0.754$). These results confirm that linear models are appropriate for describing these relationships.

Tab. 4

Linearity test

			Sum of Squares	df	Mean Square	F	Sig.
Customer Satisfaction and Technical	Between Groups	(Combined)	2.418	15	.161	2.453	.003
		Linearity	1.565	1	1.565	23.815	.000
		Deviation from Linearity	.853	14	.061	.927	.531
Customers Satisfaction and Economy	Between Groups	(Combined)	1.086	10	.109	1.498	.145
		Linearity	.903	1	.903	12.456	.001
		Deviation from Linearity	.183	9	.020	.281	.979
Customers Satisfaction and Organization	Between Groups	(Combined)	.834	8	.104	1.425	.190
		Linearity	.526	1	.526	7.191	.008
		Deviation from Linearity	.308	7	.044	.601	.754
Customers Satisfaction and HSE	Between Groups	(Combined)	3.871	12	.323	5.919	.000
		Linearity	3.344	1	3.344	61.358	.000
		Deviation from Linearity	.527	11	.048	.879	.562
Customers Satisfaction and Asset	Between Groups	(Combined)	3.752	9	.417	7.692	.000
		Linearity	3.540	1	3.540	65.309	.000
		Deviation from Linearity	.212	8	.027	.490	.862
Customers Satisfaction and Information	Between Groups	(Combined)	1.966	12	.164	2.430	.007
		Linearity	1.471	1	1.471	21.808	.000
		Deviation from Linearity	.496	11	.045	.668	.767

Source: survey 2024

The Linearity Test confirms strong linear relationships between customer satisfaction and various factors: Health, Safety, and Environment (HSE) ($F = 61.358$, $p < 0.001$), asset management ($F = 65.309$, $p < 0.001$), and information technology ($F = 21.808$, $p < 0.001$), with no significant deviations from linearity. These results support the use of linear models for analyzing these relationships. Additionally, the multicollinearity test shows no significant correlations among predictor variables, with Variance Inflation Factor (VIF) values ranging from 1.107 to 1.291 and tolerance values from 0.774 to 0.903, indicating that multicollinearity is not an issue and the regression coefficients are reliable.

4.4. Regression analysis

According to Marczyk [58], linear regression estimates or predicts a dependent variable using one or more independent variables, with its primary aim being prediction rather than just analyzing relationships. There are two types of regression: simple and multiple, with the former using one independent variable and the latter using several. The model in question exhibits a strong fit, demonstrated by an R value of 0.804, indicating a high positive correlation. An R Square value of 0.646 means that 64.6% of the outcome's variability is explained by the predictors. The Adjusted R Square of 0.632 slightly adjusts for the number of predictors, but still shows strong explanatory power. The Standard Error of the Estimate is 0.16586, indicating that predictions are close to actual values, and the R Square Change being consistent with the R Square value confirms the model's robustness.

Tab. 5

Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.804[a]	.646	.632	.16586	1.732

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.673	6	1.279	46.485	.000[b]
	Residual	4.209	153	.028		
	Total	11.882	159			

a. Dependent Variable: satisfaction

b. Predictors: (Constant), information, technology, health, safety and environment, organizational asset, economic, Asset

Sources: survey 2024

ANOVA

The ANOVA results indicate that the model is statistically significant. The Regression sum of squares is 7.673, with 6 degrees of freedom and a mean square of 1.279. The F-statistic is 46.485 with a p-value of .000, which is less than the common alpha level of 0.05, suggesting that the overall model is a good fit and the predictors collectively explain a significant portion of the variance in the dependent variable, satisfaction. The Residual sum of squares is 4.209 with 153 degrees of freedom, indicating the unexplained variance in the model. The Total sum of squares is 11.882, representing the total variance in the satisfaction variable.

Tab. 6

Coefficients

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
Constant	.974	.199		4.894	.000
Technical	.190	.031	.331	6.136	.000
Economy	.086	.023	.201	3.715	.000
Organization	.039	.022	.092	1.806	.073
Health safety and environment	.171	.027	.344	6.295	.000
Asset liability	.165	.027	.336	6.183	.000
Information technology	.118	.025	.241	4.767	.000
a. Dependent variable: customers satisfaction					

Sources: survey 2024

The analysis of customer satisfaction highlights several key factors with varying degrees of impact. Technical aspects, such as punctuality and train condition, have a significant effect on satisfaction, with a coefficient of 0.190 and a standardized Beta of 0.331, aligning with findings by Sweeney and Soutar [59]. Health, safety, and environmental (HSE) factors also play a crucial role, evidenced by a coefficient of 0.171 and a Beta of 0.344, supported by research from Namasasu [60] and Caruana [61], Asset management is another important predictor, with a coefficient of 0.165 and a Beta of 0.336, corroborated by studies from Cronin and Taylor [62]. Information technology significantly influences satisfaction, with a coefficient of 0.118 and a Beta of 0.241 that is consistent with Mattila and Wirtz [63]. Economic factors, such as fare affordability, have a lesser impact with a coefficient of 0.086 and a Beta of 0.201, supported by Chen and Chen [64]. Organizational factors, with a coefficient of 0.039 and a Beta of 0.092, have a minor influence compared to other factors, consistent with findings from Ekinci and Riley [65].

5. CONCLUSION

The analysis of the Ethio-Djibouti Standard Gauge Railway (EDR) represents a pioneering effort in assessing operational performance and customer satisfaction within Ethiopia's rail sector. Utilizing a quantitative approach, the study analyzed 160 completed employee surveys, revealing critical insights into EDR's strengths in train condition, maintenance, and adherence to health, safety, and environmental standards. Key unique findings include the identification of suboptimal equipment utilization and significant gaps in customer service, alongside a predominantly young workforce that requires tailored management strategies. The need for improved ICT reliability and a more effective failure reporting system was highlighted, along with actionable recommendations such as advanced maintenance techniques and enhanced staff training to improve customer interactions. Compared to similar studies, such as those on the Beijing-Shanghai High-Speed Railway [67], EDR's findings resonate with the importance of technological integration and customer service responsiveness. Challenges associated with a young workforce are emphasized in international research [68], highlighting the need for effective management strategies.

Furthermore, studies in Europe underline the significance of enhancing service quality to improve customer satisfaction [1]. Overall, this research contributes to a deeper understanding of EDR's operational dynamics, establishing a foundational framework for future studies in the Ethiopian transportation sector, particularly focusing on improving service quality and cleanliness to enhance overall customer satisfaction.

6. CONTRIBUTIONS TO KNOWLEDGE

6.1. Theoretical contribution

The study enhances theoretical frameworks related to operational performance and customer satisfaction in the rail sector, particularly within developing contexts. By integrating established theories of service quality and organizational behavior, it provides a nuanced understanding of how factors such as equipment utilization and workforce demographics influence customer experiences. This contribution enriches existing literature by highlighting the specific challenges and dynamics present in the Ethiopian rail industry, paving the way for future research to build upon these insights.

6.2. Empirical contribution

Empirically, this research offers valuable data and insights derived from a robust methodological approach. Utilizing simple random sampling for employee surveys enhances the reliability of findings by minimizing selection bias, while the practical use of convenience sampling for customer data acknowledges real-world constraints while still providing meaningful insights. The application of structured questionnaires, pilot testing, and reliability assessments using Cronbach's alpha strengthens the empirical rigor of the study. Overall, the research provides a comprehensive dataset that can serve as a benchmark for future studies in similar contexts.

7. IMPLICATIONS OF FINDINGS

The findings from the assessment of the Ethio-Djibouti Standard Gauge Railway (EDR) have several significant implications for both operational management and customer satisfaction in the rail sector. These implications can guide future strategic decisions, enhance service quality, and improve overall performance.

7.1. Management practice

Findings suggest actionable strategies for management within the EDR, particularly in addressing identified gaps in customer service and equipment utilization. Tailored training programs for the young workforce can enhance service interactions, while investment in advanced maintenance techniques can improve operational efficiency. By fostering a culture of continuous improvement and responsiveness to customer needs, management can significantly enhance overall customer satisfaction.

7.2. Industry

For the rail industry in Ethiopia and similar contexts, the implications are profound. This study highlights the critical importance of integrating technology and improving service quality to meet customer expectations. The insights gained can inform industry-wide practices, encouraging stakeholders to prioritize investments in infrastructure and staff development. Additionally, understanding the unique challenges posed by a younger workforce can lead to the development of effective management strategies that enhance overall operational performance across the sector.

8. THE LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

The analysis is subject to limitations such as potential biases in the data and the representativeness of the sample. Future research should address these limitations by conducting longitudinal studies to assess the long-term impact of implemented changes and improvements [68]. More detailed demographic studies could help tailor services more precisely to different customer segments [69]. Additionally, exploring emerging technologies and their potential to enhance operational efficiency and customer satisfaction should be a focus of future research [70]. Further studies could also investigate the effects of new management practices and technological advancements on overall performance and customer experience [71].

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