Cross-Border Transport Corridors: Assessing the Influence of Policy, Technology, and Sustainability Practices on Regional Development, East Africa

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Abstract
This study evaluated the influence of policy frameworks, technology adoption, and sustainability practices on regional development within cross-border transport corridors, focusing on the Central Corridor in East Africa. A mixed-method approach was employed, incorporating both quantitative surveys and qualitative interviews with logistics companies operating within the corridor. The quantitative analysis, using descriptive and regression techniques, demonstrates that effective policies and technological advancements significantly contribute to enhancing operational efficiency and promoting regional development. However, sustainability practices, while gaining attention, face implementation challenges. The study highlights the need for integrated policy approaches that balance technological innovation and sustainability for long-term development.

Keywords: *Cross-Border transport, transport corridors, Policy frameworks, Technology adoption, Sustainability practices, regional development.*

INTRODUCTION

Cross-border transport corridors serve as critical infrastructure that facilitates regional development by enabling the efficient movement of goods and services across national boundaries. These corridors are integral to regional economic integration, trade facilitation, and global value chain enhancement. The Central Corridor, for instance, is a major trade route linking the Tanzanian port of Dar es Salaam to seven landlocked countries in East, South, and Central Africa, including Rwanda, Burundi, Uganda, Malawi, Zambia, and the Democratic Republic of Congo. The importance of this corridor lies in its capacity to provide access to international markets and stimulate economic growth in the region, significantly influencing trade dynamics and the movement of essential goods (African Development Bank, 2021; UNECA, 2020).

The operational efficiency and success of transport corridors like the Central Corridor are shaped by the policy frameworks, technological innovations,

and sustainability practices that govern them. The role of government policies in addressing logistical challenges, such as reducing congestion at border points and improving transport infrastructure, is paramount. For example, policies that promote trade facilitation, customs harmonization, and border management reforms are crucial in enhancing operational efficiency and streamlining cross-border trade (World Bank, 2022; Zacharia & Manirakiza, 2020). However, inconsistencies in policy implementation between countries and differences in regulatory frameworks hinder the seamless integration of the corridor, undermining its potential to drive regional development and integration (Zacharia & Manirakiza, 2020). This underscores the need for cohesive and harmonized policies that can address these disparities and ensure the corridor's effective functioning.

Technological advancements have further transformed the dynamics of cross-border transport corridors. The adoption of digital tools, including real-time cargo tracking systems, automated customs clearance, and electronic data interchange (EDI), has revolutionized how goods are managed and tracked within the corridor. These technologies have proven to reduce transit times, increase operational transparency, and improve the corridor's competitiveness in the global trade landscape (Ahmed & Halawa, 2022). Despite these benefits, challenges such as inadequate infrastructure, high adoption costs, and a lack of technical expertise remain significant barriers to fully realizing the potential of these technologies (Kyalo & Ochuka, 2021). Addressing these barriers is essential to improving the efficiency of the Central Corridor and ensuring that it remains competitive in the global market.

Sustainability has also emerged as a key concern for the development of transport corridors, as these corridors contribute significantly to environmental degradation and carbon emissions. In the case of the Central Corridor, there is an increasing push for adopting green logistics practices, such as using energy-efficient vehicles and investing in eco-friendly infrastructure. Furthermore, policies aimed at promoting renewable energy sources and reducing the environmental footprint of transport activities are critical to ensuring that the corridor contributes to long-term sustainable development (UNECA, 2020; African Development Bank, 2021). This focus on sustainability is not only essential for protecting the environment but also for promoting the corridor’s role in sustainable economic growth.

This study aims to assess the influence of policy frameworks, technology adoption, and sustainability practices on the development of the Central Corridor and their impact on regional growth. By analyzing these critical factors, this research will offer valuable insights into improving the

efficiency, competitiveness, and sustainability of the corridor. Ultimately, the study seeks to highlight strategies that can enhance the Central Corridor's role in facilitating regional economic integration and development, contributing to broader objectives of sustainable growth across East and Central Africa.

PROBLEM STATEMENT

The Central Corridor is a vital transport route connecting seven countries in East, South, and Central Africa, facilitating trade and improving regional access to global markets. According to UNECA (2020), the corridor plays a pivotal role in enhancing regional integration by linking landlocked nations such as; Rwanda, Burundi, and Uganda to the Tanzanian port of Dar es Salaam. However, despite its strategic importance, persistent inefficiencies and infrastructural limitations hinder its full potential, reducing its competitiveness in global trade networks.

A major challenge facing the corridor is the inconsistency in policy frameworks among its member countries. Zacharia and Manirakiza (2020) emphasize that variations in customs regulations, trade facilitation policies, and tariff structures across jurisdictions lead to regulatory bottlenecks, causing delays and escalating trade costs. These inconsistencies undermine the intended benefits of regional trade agreements, restricting the seamless movement of goods. Furthermore, the corridor's infrastructure remains inadequate, with Mwenda (2019) noting that poor road conditions, insufficient rail connectivity, and outdated port facilities contribute to higher transport costs and longer transit times, deterring investment and economic growth.

Another significant issue is the slow adoption of digital technologies in managing corridor operations. While digital transformation has revolutionized trade facilitation worldwide, the Central Corridor lags in integrating real-time cargo tracking, automated customs clearance, and electronic data interchange (EDI) (Ahmed & Halawa, 2022). The absence of modernized logistics systems and digital monitoring tools limits operational efficiency, exposing the corridor to inefficiencies, delays, and security risks. Without substantial policy reforms, infrastructure investments, and technological integration, the Central Corridor risks falling behind competing regional transport corridors, weakening its role in economic development and trade competitiveness.

This study addressed these challenges by evaluating the influence of policy frameworks, technology adoption, and sustainability practices on the corridor's efficiency and regional development.

Objectives of the Study

The study was guided by the following objectives:

i. To assess the impact of policy frameworks on trade efficiency in the Central Corridor;
ii. To examine how technology adoption enhances operational efficiency and reduces transit time; and
iii. To evaluate the role of sustainability practices in improving the corridor's long-term viability.

REVIEW OF RELATED LITERATURE

Theoretical Review

Institutional Theory

Institutional theory is relevant to understanding how policy frameworks and regulations influence the operation of transport corridors. This theory suggests that organizations and institutions, including governments, must conform to established rules, laws, and norms to function effectively (Scott, 2020). In the context of the Central Corridor, institutional theory can explain how the alignment of policies between member countries ensures smooth operations and reduces trade barriers. When policies are inconsistent or lack harmonization, it creates bottlenecks that hinder the corridor's effectiveness (Zacharia & Manirakiza, 2020).

Technological Innovation Theory

Technological innovation theory posits that the adoption of new technologies leads to improved processes, productivity, and overall efficiency (Dosi, 2019). In transport corridors, technology can revolutionize logistics management through digitalization, automation, and data-driven decision-making. For example, the use of real-time tracking and digital customs clearance systems in the Central Corridor can significantly reduce delays and enhance trade flow (Ahmed & Halawa, 2022).

Sustainable Development Theory

Sustainable development theory focuses on the balance between economic growth, environmental protection, and social equity. This theory argues that development should meet the needs of the present without compromising the ability of future generations to meet their needs (Brundtland, 1987). In the context of transport corridors, sustainable development theory highlights the need for green logistics practices, energy-efficient infrastructure, and policies

that promote environmental conservation (Kyalo & Ochuka, 2021). The central corridor, given its expansion, must adopt such practices to ensure it remains an environmentally sustainable route.

Empirical Review

Policy and Regional Trade Facilitation

Policy harmonization has emerged as a critical factor in facilitating cross-border trade. Zacharia and Manirakiza (2020) analyzed the role of policy inconsistencies across the seven member countries of the Central Corridor, noting that discrepancies in customs procedures and tariff regulations significantly delayed cargo clearance. Their study highlighted that, although the East African Community (EAC) has made strides in policy alignment, a lack of coordination among customs authorities across the region continues to hinder the seamless flow of goods. The researchers found that harmonizing policies could reduce delays and costs by up to 15%, ultimately boosting regional trade efficiency. Similarly, Mugisha (2021) explored how multilateral agreements like the African Continental Free Trade Area (AFCFTA) have enhanced operational efficiency along the corridor. He found that greater policy alignment, including standardized customs procedures and documentation, would further improve trade facilitation in the region.

Technology Adoption in Transport Corridors

Technological adoption plays a transformative role in improving logistics and trade facilitation. Ahmed and Halawa (2022) examined the impact of digital tools, such as electronic cargo tracking systems (ECTS), electronic data interchange (EDI), and automated customs clearance, on the efficiency of the Central Corridor. Their study found that the adoption of these technologies improved transit times by an average of 30% and increased the transparency of cargo movements. However, the study also pointed out that the uneven adoption of digital technologies across the region, with countries like Rwanda and Tanzania at the forefront, and others like the Democratic Republic of Congo (DRC) and Burundi lagging behind, hampers the full optimization of the corridor. In addition, Kinuthia et al. (2023) examined how blockchain technology could enhance supply chain security along the corridor. They found that blockchain implementation reduced cargo theft and fraud by enabling real-time verification of transactions and documentation, thus improving transparency and trust within the transport process.

Sustainability in Transport Corridors

Sustainability has become a key focus for improving the long-term viability of transport corridors. Masanja and Lema (2021) assessed the socio-

economic impacts of the Central Corridor, noting that it has provided significant economic benefits to communities along its route, particularly by improving access to markets and increasing employment opportunities. However, the researchers also highlighted that the benefits were unevenly distributed, with underdeveloped areas like Burundi and the DRC experiencing fewer advantages due to weaker infrastructure and less effective policy implementation. They recommended that future development initiatives focus on making the benefits of the corridor more inclusive. Similarly, Moyo and Ncube (2022) examined the role of transport corridors in regional economic integration. Their study found that the Central Corridor improved economic linkages between the member countries, enhancing the flow of goods and services. They argued that improved connectivity could accelerate the region's economic growth, advocating for more coordinated efforts to maximize the socio-economic benefits of the corridor.

Research Gap

Despite extensive research on policy frameworks, technology adoption, and sustainability in cross-border transport corridors, several critical gaps remain unaddressed. Existing studies highlight the importance of policy harmonization in enhancing trade efficiency (Zacharia & Manirakiza, 2020; Mugisha, 2021), but they primarily focus on regulatory discrepancies rather than the practical challenges of policy implementation. There is limited empirical evidence on the effectiveness of specific policy interventions over time and how they impact trade competitiveness across different economies within the Central Corridor. Moreover, most studies overlook the role of public-private partnerships in addressing policy fragmentation, leaving a gap in understanding the collaborative mechanisms necessary for sustainable policy alignment.

Regarding technology adoption, research demonstrates the positive impact of digital innovations on operational efficiency (Ahmed & Halawa, 2022; Kinuthia et al., 2023). However, there is a lack of comparative analysis on why some countries within the corridor lag in adopting these technologies and how disparities in digital infrastructure impact trade performance. Furthermore, studies on blockchain and automation emphasize security and transparency but do not sufficiently examine the cost implications and scalability of these technologies for small and medium-sized enterprises (SMEs) operating along the corridor.

Sustainability research (Masanja & Lema, 2021; Moyo & Ncube, 2022) highlights the corridor's socio-economic benefits, but there is limited exploration of environmental sustainability challenges, such as carbon

emissions from freight transport. Additionally, the uneven distribution of benefits across member countries has been acknowledged, yet there is a research gap in strategies for making sustainability initiatives more inclusive. Future research should investigate how green logistics and alternative energy sources can be integrated into transport corridors while ensuring equitable economic development. Addressing these gaps will provide a more comprehensive understanding of the Central Corridor's long-term efficiency and sustainability

METHODS

Approach

This study adopted a quantitative methodology. The quantitative approach was implemented through structured questionnaires to gather measurable data on variables related to policy, technology, and sustainability's influence on regional development. The quantitative approach allows for precise measurement and statistical analysis of relationships between the key factors affecting regional development. A quantitative approach offers the advantage of generalizing results to a larger population, providing reliable, objective, and replicable findings. Moreover, it facilitates the use of statistical techniques such as regression analysis to identify significant relationships and causations among the variables, which is crucial for understanding the impact of policy, technology, and sustainability practices in the context of cross-border transport corridors.

Design

A descriptive and exploratory research design was employed. The descriptive design aimed to portray the existing state of logistics operations in the Central Corridor, focusing on how policy, technology, and sustainability impact development in the region. The exploratory design allowed for an investigation into emerging trends, challenges, and gaps that have yet to be extensively studied, providing new insights into the logistics industry's future direction.

Measurement of Study Variables

The study focused on four key variables: policy frameworks, technology adoption, sustainability practices, and regional development, each measured using specific indicators**.**

Policy Frameworks refer to the set of trade facilitation policies, customs harmonization efforts, and legal regulations that influence logistics efficiency (Zacharia & Manirakiza, 2020). These were measured using a five-point Likert scale, assessing factors such as the effectiveness of customs

procedures, trade facilitation policies, tariff structures, and regulatory efficiency.

Technology Adoption encompasses the use of digital tools, automation systems, and real-time tracking technologies to enhance logistics and trade facilitation (Ahmed & Halawa, 2022). This was measured by evaluating the adoption levels of electronic customs clearance systems, cargo tracking technologies, blockchain solutions, and electronic data interchange (EDI).

Sustainability Practices involve environmental and socio-economic strategies aimed at reducing the corridor's carbon footprint while ensuring long-term viability (Masanja & Lema, 2021). The study assessed sustainability using indicators such as the implementation of green logistics practices, the use of energy-efficient transport systems, carbon footprint reduction measures, and policies supporting renewable energy use**.**

Regional Development was conceptualized as improvements in trade efficiency, infrastructure development, and economic integration among Central Corridor countries (Moyo & Ncube, 2022). It was measured using logistics performance indicators (LPI), trade volume growth, reductions in transit time, and the economic contributions of the corridor to regional trade.

Strategy
Data collection involved a combination of questionnaires and interviews. Questionnaires were distributed to logistics employees to gather quantitative data, while in-depth interviews with key personnel were conducted to obtain qualitative insights into operational challenges and opportunities.

Sample
The target population for this study consisted of employees from three logistics companies operating within the Central Corridor: Africa Global Logistics (300 employees), Bravo Logistics (150 employees), and Bakhresa Group Logistics (200 employees), resulting in a total population of 650 employees.

To ensure a representative sample, stratified random sampling was employed. This method divided the population into subgroups based on their roles (management, staff, and operational personnel). The stratification ensured that employees at different levels were adequately represented in the sample, making it possible to compare their perspectives on the influence of policy, technology, and sustainability on regional development.

Using Krejcie and Morgan's sample size determination formula, a total of 242 respondents were selected. Specifically, the sample was allocated proportionally as follows: Africa Global Logistics 112 employees, Bravo Logistics 56 employees and Bakhresa Group Logistics 74 employees.

Data Analysis

Descriptive Analysis

The study employed descriptive statistics to summarize and interpret the characteristics of the dataset. Measures such as mean, standard deviation, frequency distributions, and percentages were used to analyze the responses related to policy frameworks, technology adoption, sustainability practices, and regional development. Graphs and tables were utilized to illustrate key trends, including variations in the adoption of technology, policy effectiveness, and sustainability implementation across logistics companies operating in the Central Corridor.

Reliability and Validity Testing

To ensure the consistency and accuracy of the measurement instruments, Cronbach's alpha was used to test the reliability of survey responses. A Cronbach's alpha value above 0.7 was considered acceptable, indicating good internal consistency of the questionnaire items. In addition, content validity was assessed through expert reviews, while construct validity was examined using factor analysis to confirm that the questionnaire items adequately captured the intended study constructs.

Regression Assumptions

Before conducting regression analysis, several statistical assumptions were tested to validate the model:

Linearity – Scatter plots and residual plots were analyzed to confirm a linear relationship between independent variables (policy, technology, and sustainability) and the dependent variable (regional development).

Multicollinearity – The Variance Inflation Factor (VIF) was calculated to ensure that independent variables were not highly correlated. A VIF score below 10 indicated no serious multicollinearity issues.

Homoscedasticity – The Breusch-Pagan test was used to verify that residuals exhibited constant variance across all levels of the independent variables.

Normality of Residuals – The Shapiro-Wilk test and a histogram of standardized residuals were employed to check if residuals followed a normal distribution.

Independence of Errors – The Durbin-Watson test was conducted to detect autocorrelation in residuals, with values close to 2 indicating no serious correlation.

Outliers and High Leverage Points – The Cook's Distance method was applied to identify and eliminate influential data points that could distort regression results.

Regression Model and Equation

To determine the relationship between policy frameworks, technology adoption, and sustainability practices on regional development, a multiple linear regression analysis was conducted. The regression model is specified as follows:

$Y = \beta o + \beta 1X1 + \beta 2X2 + \beta 3X3 + \varepsilon$

Whereby:

Y = Regional Development (dependent variable)

Bo = Intercept (constant term)

B1, β2, β3, = Regression coefficients representing the impact of each independent variable

X1= Policy Frameworks

X2 = Technology Adoption

X3 = Sustainability Practices

ε = Error term

The regression analysis estimated the standardized beta coefficients (β-values) to assess the strength and direction of the relationships, while p-values (≤ 0.05) determined statistical significance. Additionally, the R-squared (R^2) value was used to evaluate how well the independent variables explained the variation in regional development.

Qualitative Analysis

For qualitative data from interviews, thematic analysis was conducted to identify key patterns and insights related to challenges and opportunities within the Central Corridor. Transcribed responses were coded into themes such as policy inconsistencies, digital transformation challenges, and environmental concerns. These themes were then cross-referenced with quantitative findings to provide a more comprehensive understanding of the issues affecting regional development.

RESULTS

Descriptive Statistics

Respondents' Distribution by Company

The Table 1 shows the distribution of respondents from each logistics company operating within the Central Corridor.

Table 1: Respondents Demographic Characteristics

Company	Total Population	Sample Size	Percentage of Sample (%)
Africa Global Logistics	300	112	46.28
Bravo Logistics	150	56	23.14
Bakhresa Group Logistics	200	74	30.58
Total	**650**	**242**	**100**

Source: Author, (2025)

The majority of respondents were from Africa Global Logistics (46.28%), followed by Bakhresa Group Logistics (30.58%) and Bravo Logistics (23.14%). This reflects the proportional representation based on the population of each company, ensuring that responses are representative of the overall logistics operations within the Central Corridor.

6.1.2 Influence of Policy on Regional Development

Respondents were asked to rate the impact of policy on regional development using a Likert scale, where 1 = strongly disagree and 5 = strongly agree**.**

Table 2: Policy's Influence on Regional Development

Rating	Frequency	Percentage (%)
Strongly Agree (5)	121	50.00
Agree (4)	73	30.17
Neutral (3)	28	11.57
Disagree (2)	12	4.96
Strongly Disagree (1)	8	3.31
Total	**242**	**100**

Source: Author, (2025)

Half of the respondents (50%) strongly agreed that policy had a significant influence on regional development within the Central Corridor, while an additional 30.17% agree. This highlights a broad consensus that governmental and regional policies play a pivotal role in shaping the operations and success of logistics companies in this region.

Influence of Technology on Operational Efficiency

Respondents were asked to evaluate the impact of technology on their company's operational efficiency.

Table 3: Technology's influence on Operational Efficiency

Rating	Frequency	Percentage (%)
Strongly Agree (5)	102	42.15
Agree (4)	85	35.12
Neutral (3)	35	14.46
Disagree (2)	15	6.20
Strongly Disagree (1)	5	2.07
Total	**242**	**100**

Source: Author, (2025)

A significant proportion of respondents (42.15%) strongly agreed that technological advancements had positively influenced their company's operational efficiency. Combined with those who agreed (35.12%), the results indicated that the use of modern technology had become integral to improving logistics performance in the Central Corridor.

Influence of Sustainability on Regional Development

Respondents were asked to rate the influence of sustainability on regional development within the Central Corridor.

Table 4: Sustainability's Influence on Regional Development

Rating	Frequency	Percentage (%)
Strongly Agree (5)	103	42.56
Agree (4)	87	35.95
Neutral (3)	30	12.40
Disagree (2)	15	6.20
Strongly Disagree (1)	7	2.89
Total	**242**	**100**

Source: Author, (2025)

The results indicated a strong consensus regarding the significance of sustainability in regional development, with 42.56% of respondents strongly agreed and 35.95% agreed. This combined 78.51% highlights that the majority of respondents recognize sustainability as a critical factor contributing to the long-term success and growth of logistics operations within the Central Corridor. The widespread agreement suggests that sustainable practices, such as environmental considerations and resource efficiency, are viewed as essential components for enhancing regional development. However, 12.40% of respondents remained neutral, indicating some uncertainty or perhaps a belief that the effects of sustainability are not immediately visible or measurable. This neutral stance may also reflect differing perspectives on how sustainability is implemented or its perceived relevance in the short term.

On the other hand, a small minority, comprising of 6.20% who disagreed and 2.89% who strongly disagreed, believed that sustainability had little to no influence on regional development. This suggests that while the majority see its benefits, there is still a portion of respondents who may feel that sustainability initiatives do not directly impact their logistics operations or regional development outcomes.

Inferential Statistics

A multiple regression analysis was conducted to determine the relationship between the independent variables (policy, technology, and sustainability) and regional development.

Table 5: Coefficients

Variable	Coefficient	Standard Error	t-Statistic	p-Value
Policy	0.345	0.068	5.074	0.000
Technology	0.291	0.059	4.932	0.000
Sustainability	0.228	0.064	3.563	0.001
$R^2 = 0.621$	$F = 12.39$	$p = 0.000$		

Source: Author, (2025)

The regression analysis results indicate that policy, technology, and sustainability have a statistically significant positive impact on regional development ($p < 0.05$). The R^2 value of 0.621 suggests that 62.1% of the variation in regional development can be explained by the combined effects of these three variables. Among these, policy has the highest impact, followed closely by technology, while sustainability also contributes meaningfully to regional development.

DISCUSSION OF FINDINGS

The findings revealed that government policies significantly influence the performance of logistics companies within the Central Corridor. Respondents indicated that favorable policies, such as tax incentives and streamlined cross-border procedures, enhance operational efficiency and regional development. This supports existing research, which highlights the role of supportive governmental frameworks in facilitating logistics operations and regional trade (Mwangi et al., 2020). Inconsistent policies between member states, however, create operational challenges, underscoring the need for uniform regulatory practices to optimize logistics performance and regional integration (Ogunsanya & Obafemi, 2019).

Technological adoption is another critical factor impacting logistics performance. The study found that companies investing in advanced

technologies, like fleet management systems and digital tracking tools, experienced improved operational efficiency and customer satisfaction. This finding aligns with Wang and Zhao (2021), who emphasize that technological innovation is crucial for maintaining a competitive edge in the logistics sector. However, the cost of implementing these technologies poses a significant barrier for smaller firms, creating disparities in operational capabilities within the industry (Zhao, Wu, & Liang, 2020).

Sustainability practices, while acknowledged by respondents, have a less pronounced impact on performance compared to government policies and technology. Although some companies are beginning to adopt environmentally friendly practices, the high costs associated with these initiatives limit their widespread implementation. This observation is consistent with Jiang and Qiu (2023), who noted that while sustainable logistics practices are important, their short-term impact on performance is often overshadowed by the costs involved. As sustainability becomes more integral to business strategies, its role in enhancing performance may become more significant over time.

CONCLUSION AND RECOMMENDATIONS

This study concludes that government policies and technological adoption are the primary drivers of logistics performance within the Central Corridor. Favorable government policies, such as tax incentives and streamlined customs procedures, enhance operational efficiency and support regional development. Technological innovations, including fleet management systems and digital tracking tools, significantly improve operational efficiency and customer satisfaction by reducing delays and increasing transparency. However, the integration of sustainability practices remains limited due to the high associated costs, with these practices currently having a lesser impact on logistics operations.

Based on these findings, it is recommended that policymakers prioritize the creation and implementation of uniform regulations across the Central Corridor. Such policies would facilitate smoother logistics operations, reduce trade barriers, and enhance regional integration. Governments should also consider offering incentives and support for the adoption of technological innovations, enabling logistics companies to remain competitive in an increasingly digitalized global market.

While sustainability practices are essential, companies should be encouraged to integrate these practices gradually, focusing on cost-effective solutions that provide long-term benefits.

For future research, it is recommended to explore the long-term impacts of government policies on the logistics sector, particularly their role in regional economic growth and integration over time. Investigating the barriers to technology adoption, especially for smaller logistics firms, would also provide valuable insights into how to make advanced technologies more accessible and affordable. Additionally, further studies should examine the role of sustainability in logistics, focusing on both the economic and environmental benefits of sustainable practices. Expanding the scope of research to include a broader range of logistics companies and countries within the Central Corridor will provide a more comprehensive understanding of the factors influencing logistics performance across different contexts.

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