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THE INFLUENCE OF ROAD TRANSPORT INFRASTRUCTURE ON SUPPLY CHAIN RESPONSIVENESS: THE MODERATING ROLE OF TRAFFIC MANAGEMENT

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ABSTRACT

This study investigates the influence of road transport infrastructure, encompassing equity and community elements, on supply chain (SC) responsiveness in the context of manufacturing firms in Ghana. Survey data from 359 senior managers validated our proposed model and analyzed using SPSS version 26 and Amos version 23. The findings emphasize the direct positive association between road transport equity, community involvement, and SC responsiveness. Additionally, traffic management was found to moderate the relationship between road transport infrastructure and SC responsiveness. These results underscore the critical need for investing in equitable road transport infrastructure and efficient traffic management systems to be well handled to realize the full potential of road infrastructure. The study's practical implications stress the importance of community engagement, safety measures, and knowledge-based decision-making in achieving optimal SC responsiveness. By embracing a comprehensive approach that incorporates these factors, organizations can enhance their adaptability and resilience in the complex landscape of SC management. However, it is important to acknowledge the study's limitations, such as its focus on beverage manufacturing firms in Ghana, and future research should explore these dynamics across various industries and consider evolving factors in SC management.

KEY WORDS

Road transport infrastructure, supply chain responsiveness, traffic management, equity, community participation.

In today's dynamic and interconnected global economy, the efficiency and responsiveness of supply chains have become paramount for businesses seeking to gain a competitive edge (Giannakis et al.,2019: Moh'd Anwer,2022: Shekarian et al.,2020: Garcia-Torres et al.,2019). According to Gu and Liu (2023) and Zhabin (2023), the ability to swiftly adapt to changing market demands, disruptions, and consumer expectations is contingent upon a multitude of factors, one of which is the quality and reliability of road transport infrastructure (Adu et al., 2023: Skorobogatova and Kuzmina-Merlino, 2017). Shladover (2022) indicated that roads serve as the arteries of commerce, facilitating the movement of goods from manufacturers to consumers, and everything in between. Consequently, the state of road transport infrastructure plays a pivotal role in shaping the responsiveness of supply chains, impacting industries, economies, and society at large (Adu et al., 2023: Novack et al., 2023). Therefore, the influence of road transport infrastructure on supply chain responsiveness is a multifaceted and complex relationship, intricately woven into the fabric of logistics and commerce. However, this relationship extends beyond the mere physical connectivity that roads provide, encompassing aspects such as reliability, resilience, technology integration, and sustainability (Große, 2023; Gu and Liu, 2023; Negri et al., 2021). Moreover, Sudan and Taggar (2021) reveal that Road transport infrastructure plays a pivotal role in the agility and responsiveness of supply chains by facilitating the movement of goods and materials across various nodes. However, the fundamental theme of road transport infrastructure from the different researchers unambiguously observed that for sustainable long-term organizational performance, organizations must pay attention to the influence of transport infrastructure (Cedillo-Campos et al. 2022; Bayoumi et al., 2021; Yeo et al., 2020; Ivankova et al., 2021; Munim and Schramm,2018; Tanco et al.,2018; Jiangteng 2021). To date, examining how road transport infrastructure (equity and community) could drive supply chain responsiveness in developing countries remains a grey area.

Again, despite the limited empirical evidence on how supply chain responsiveness could be leveraged through road transport infrastructure, the authors believe that superior supply chain responsiveness may not be achieved directly. This is because investment in road transport alone may not be enough to drive supply chain responsiveness (Fulzele and Shankar, 2021; Adu et al., 2023). This implies that examining just the link between road transport infrastructure (equity and community) and supply chain responsiveness may not be enough because certain essential elements that facilitate the success of road infrastructure may be missing (Delmas et al., 2011; Owusu Kwateng et. al., 2022). This study, therefore, introduces traffic management as a moderator in the road transport infrastructure (equity and community) and supply chain responsiveness link. To date, there is also no evidence of how traffic management moderates the influence or association between road transport infrastructure (equity and community) and supply chain responsiveness concurrently, and the need to investigate such a relationship is essential. The management of traffic plays a crucial role in regulating the connection between the infrastructure of road transport and the ability of supply chains to respond effectively. Efficient traffic management plays an integral part in mitigating congestion, enhancing predictability, reducing costs, facilitating emergency response, and informing infrastructure expenditures. These influence or contribute to the development of a more adaptable and responsive supply chain. The aforementioned statement highlights the value of a properly synchronized transportation system in facilitating the efficient movement of commodities and enhancing the responsiveness of supply chains.

This study, therefore, constitutes a contemporary attempt to provide answers to two key unattempted questions in extant literature: RQ1: Does road transport infrastructure (equity and community) influence supply chain responsiveness? Adding to the limited understanding of how supply chain responsiveness may be achieved via RTI, the underlying mechanisms surrounding the link are also less explored, thus, identifying the relationship between road transport infrastructure (equity and community), traffic management, and supply chain responsiveness is imperative, particularly in emerging economies in Sub Sahara Africa. Though Konkor, (2021) has shown that there is a strong relationship between road transport infrastructure and traffic management within the context of the Ghanaian economy, how they drive supply chain responsiveness is neglected. This leads to the second research question: RQ2: Is the relationship between road transportation infrastructure and supply chain responsiveness moderated by traffic management?

This paper employs system theory and knowledge-based view (KBV) theory as the theoretical lens to investigate the mechanism through which the effect of RTI on SCR occurs. The study therefore contributes to advancing supply chain literature by demonstrating how efficient traffic management remains crucial in the quest to enhance supply chain responsiveness through road transport infrastructure.

LITERATURE REVIEW

Comprehending the intricate relationship between road transport infrastructure and traffic management is crucial to optimize SC operations and effectively respond to the ever-changing demands of a dynamic marketplace. The survival of firms is contingent upon the strategic alignment of the appropriate product, location, and timing. Inadequate stock levels might result in decreased sales revenue, whilst excessive stock levels can have detrimental consequences (Adu et al., 2023). As a result, the assurance of appropriate materials and quantities is of paramount importance in manufacturing operations. Hugos (2018) stated that SCs play a crucial role in achieving competitive advantage and comprehending the functioning of these activities necessitates a certain level of knowledge. According to Soosay et al. (2016), the possession of advanced information facilitates the creation of distinctive commodities at the most efficient per-unit cost, hence enhancing competitiveness through the utilization of cost-effective strategies and improved product designs. However, the impact of road transport infrastructure on the responsiveness of SCs is vital, since it directly affects the efficiency, dependability, and adaptability of the transportation of commodities within the supply network. Moreover, McKinnon (2016) reveals that an extensively built road transportation infrastructure facilitates expedited transportation, reduces delivery times, and improves the overall efficiency of the SC. Nevertheless, the efficacy of road transportation infrastructure can be considerably influenced by the implementation of good traffic management systems (Chen et al., 2018). Hence, the comprehension of incorporating components results in enhanced efficiency and efficacy within companies. However, this study is grounded in systems theory and the knowledge-based view (KBV), which serve as the theoretical foundations.

The utilization of systems theory in this study offers a relevant theoretical framework since it enables a more comprehensive understanding of organizational activities beyond the scope of supply chain responsiveness alone (Richey et al., 2022). This enables an insight into an organization's capacity to promptly adjust and respond to fluctuations in demand, supply, or market situations with efficiency and flexibility (Negri et al., 2021). The concept encompasses the ability to rapidly adapt production, distribution, and other supply chain operations in response to changing client demands, market dynamics, or unforeseen disruptions (Maleki, 2023). To comprehend how supply chain responsiveness impacts competitive advantage, Asamoah et al. (2021) suggest looking at a more comprehensive organizational structure. According to systems theory, the supply chain is a multifaceted system with interconnected parts and feedback loops (Mitra and Shaw, 2023). This viewpoint enables a thorough assessment of the traffic control and road transportation infrastructure of this intricate system. This demonstrates how SC responsiveness and efficiency can be impacted by traffic control techniques. As a result, the Systems-oriented approach exposes complex dynamics, highlighting the importance of gaining a complete understanding to improve supply chain responsiveness through road transportation infrastructure and traffic management.

The use of the Knowledge-Based View (KBV) paradigm is of great relevance when examining the impact of road transport infrastructure and traffic management on the responsiveness of supply chains. According to Chen et al. (2021), firms view knowledge as a valuable strategic asset that can be utilized to attain a competitive edge. Adu et al.(2023), stated that a well-established road transportation infrastructure plays a crucial role in minimizing transit durations, improving dependability, and facilitating just-in-time delivery approaches, which are essential elements of an adaptable SC (McKinnon, 2021). Abdallah et al. (2021) reveal that the presence of strong road infrastructure enables enterprises to achieve shorter lead times, which in turn facilitates agile inventory management. This capability enables companies to quickly respond and adjust to changes in demand patterns. In the realm of road transport infrastructure and traffic management, possessing knowledge regarding effective route planning, up-to-date traffic information, and skillful exploitation of existing infrastructure is of utmost importance. According to Muhalia et al. (2021), companies that properly utilize this knowledge can optimize their transportation networks, streamline their logistics operations, and improve the responsiveness of their SCs. Furthermore, the implementation of traffic management, supported by strategies based on knowledge-driven approaches, plays a crucial role in proactively addressing disturbances, hence promoting more efficient operations and ensuring timely delivery. The Knowledge-Based View theory emphasizes the need for informed decision-making, learning, and knowledge application in utilizing road transport infrastructure and traffic management to enhance the responsiveness and efficiency of the supply chain.

2.2 Conceptual Framework and Hypotheses

The framework presents a research model showing the link among the study variables. The framework in this research hypothesizes traffic management moderates the link between road transport infrastructure and supply chain responsiveness. The subsequent section provides a discussion of the various hypotheses in the study.

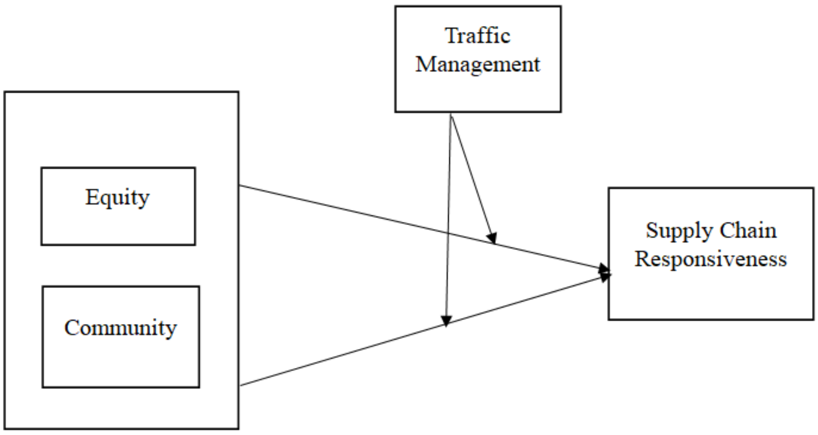

Figure 1 – Research Model

Supply chain responsiveness pertains to the capacity of an organization to promptly and efficiently adjust and react to alterations in client demand, market circumstances, technical progress, or other pertinent elements within the supply chain (Richey et al., 2022). According to Adu et al. (2023), the presence of road transport infrastructure significantly affects the ability of supply chains to adapt and perform effectively, hence influencing operational efficiency and flexibility. Rasol et al. (2022) stated that Road transport infrastructure encompasses the tangible and logistical elements that facilitate the transportation of commodities, individuals, and automobiles over road systems. According to Lv and Shang (2022), an extensively developed system of roads, known for its strong interconnectivity, minimal delays, and effective functioning, plays a crucial role in enabling efficient supply chain operations. This is achieved through timely deliveries, shorter lead times, and enhanced adaptability to market swings (Dong et al., 2022). Schachenhofer et al. (2023) underscored the significance of allocating resources towards road infrastructure upgrades, as they play a pivotal role in enhancing the efficiency of logistical operations, achieving cost-effectiveness, and elevating the quality of customer service. In addition, Ivanov et al. (2019) discovered that the use of technical developments such as route optimization, real-time tracking, and predictive analytics in road transport enhances the visibility and responsiveness of supply chains. On the other hand, Afrin and Yodo (2020) reveal that insufficient infrastructure leads to bottlenecks in transportation, causing delays and higher expenses. This emphasizes the significance of significant investment and ongoing maintenance in road transport infrastructure to improve the responsiveness of supply chains and overall operational efficiency.

The presence of road transport infrastructure is crucial in facilitating fairness and enhancing the efficiency of supply chain operations. Raza et al. (2023) claimed that an equitable road infrastructure ensures that all stakeholders, regardless of their geographical location or organizational size, have equal and efficient access to transportation. This promotes fairness and equal opportunities in the supply chain. Millonig et al. (2022) indicated that achieving a fair allocation and advancement of road infrastructure is crucial in mitigating inequalities in the accessibility of markets, resources, and economic prospects. Zhang and Zhao (2021) claimed that equitable allocation of road infrastructure facilitates enhanced business engagement, particularly for enterprises situated in rural or socioeconomically challenged regions, thereby fostering a more comprehensive and equitable expansion of the economy. Furthermore, Fulzele and Shankar (2021) posit that the establishment of a fair and just road network plays a crucial role in enhancing the accessibility of vital services and markets, thereby generating advantages for marginalized populations and promoting social and economic equality. Lee et al. (2020) indicate that the establishment of a fair and just road infrastructure plays a crucial role in guaranteeing equal access and opportunity for diverse stakeholders involved in the supply chain. On the other hand, Trojanowski (2020) revealed that discrepancies in the accessibility of road infrastructure have the potential to worsen pre-existing inequalities, thereby impeding equitable involvement and responsiveness throughout the supply chain. Therefore, the establishment of a well-rounded and easily accessible road transportation system is crucial for promoting fairness and improving the efficiency of supply chain operations. This, in turn, leads to economic growth and overall community welfare. The study, therefore, hypothesizes that:

H1a: Road Infrastructure (Equity) positively affects supply chain responsiveness.

The impact of road transport infrastructure on the community's ability to enhance supply chain responsiveness is substantial (Konkor, 2021). According to Lee et al., (2020), an extensively constructed and easily navigable road infrastructure promotes community engagement by supporting the efficient transportation of commodities, hence enabling local firms to effortlessly integrate into supply chains. Alternately, Millonig et al., (2022) claimed that enhanced accessibility to basic goods and services contributes to the advancement of communities, resulting in greater economic prospects and overall development. Moh’d Anwer (2022) emphasizes that a meticulously designed and all-encompassing system of roads not only enables the smooth transportation of products but also fosters economic development within localities. Improved accessibility to markets and critical services leads to enhanced standards of life and increased economic activity. Moreover, Fulzele and Shankar (2021) underscored the significance of including local communities in the process of designing and constructing road infrastructure, as it cultivates a sense of ownership and cooperation, thereby matching supply chain tactics with the specific requirements of the community. Furthermore, Ivankova et al. (2021) emphasized that the presence of strategically positioned road infrastructure facilitates successful engagement between businesses and the local community, fostering a mutually beneficial relationship. On the contrary, Bayoumi et al. (2021) stated that insufficient infrastructure has the potential to segregate communities, obstructing their involvement in supply chains and limiting the progress of economic development. Hence, it is imperative to make investments in road transport infrastructure that take into account the requirements and interconnectivity of the community. This will establish a symbiotic association that enhances the responsiveness of the supply chain and fosters local socio-economic progress. The study, therefore, hypothesizes that:

H1b: Road Infrastructure (Community) positively affects supply chain responsiveness.

Traffic management encompasses the deliberate coordination, control, and harmonization of traffic flow and transportation infrastructure to facilitate secure, streamlined, and effective mobility of automobiles, pedestrians, and various transportation modes throughout road systems, streets, highways, and interconnected transportation networks (Deveci et al., 2020). The significance of traffic management in modulating the relationship between road transport infrastructure and supply chain responsiveness cannot be overstated. Safiullin et al. (2020) stated that traffic management plays a crucial role as an intermediary, exerting influence on the extent to which infrastructure affects the dynamics of the supply chain. Again, Kerimov et al. (2020) argue that efficient traffic management solutions, such as real-time monitoring, congestion alleviation, and route optimization, aim to maximize the utilization of current road infrastructure. In addition, Deveci et al. (2020) claimed that Traffic management plays a crucial role in improving supply chain responsiveness through the reduction of traffic bottlenecks and the optimization of transit times. This results in the facilitation of timely and dependable deliveries. On the other hand, Zhang and Lu (2020) emphasized that insufficient traffic management has the potential to compromise the advantages of a well-developed road network, resulting in delays, disturbances, and diminished efficiency in the movement of goods and services. Hence, the implementation of efficient traffic management plays a crucial role in enhancing the favorable influence of road transportation infrastructure on the responsiveness of supply chains, thereby facilitating a more agile and efficient supply network.

The crucial role of traffic management is essential in influencing the relationship between equity and supply chain responsiveness. Alternately, Afrin and Yodo (2020) contend that equitable distribution of benefits among stakeholders is a key outcome of effective traffic management, which plays a crucial role in facilitating a well-functioning supply chain. This includes ensuring timely deliveries and providing accessibility to markets. Khatri et al. (2021) claimed that efficient traffic management strategies enhance the utilization of road infrastructure, hence enhancing accessibility for enterprises situated in various locations and of different scales. Furthermore, Kumar et al. (2020) assumed that traffic management plays a crucial role in promoting fair access to transportation resources, particularly advantageous for smaller enterprises and geographically secluded regions, by effectively addressing congestion and facilitating efficient route design. This phenomenon results in increased engagement and rivalry among the various entities involved in the supply chain, hence promoting economic fairness. Numerous studies continually demonstrate that the implementation of efficient traffic management systems has the potential to alleviate transportation disparities and promote fairness within the supply chain (Kerimov et al., 2020; Deveci et al., 2021; Zhang and Lu, 2020). However, Zhang and Lu (2020) reveal that traffic management plays a crucial role in promoting equitable access to supply chain resources and opportunities by optimizing traffic flow, mitigating congestion, and prioritizing routes for underserved or marginalized areas. Moreso, Yu et al. (2020) stated that the fair allocation of resources leads to enhanced supply chain agility, facilitating the active involvement of firms of varying scales and geographical locations. On the other hand, Zhu et al. (2019) discovered that insufficient traffic management amplifies inequalities in terms of accessibility and has a disproportionate impact on marginalized populations or areas, hindering their integration into the supply chain. Therefore, traffic management plays a crucial role in regulating the fair distribution of road transport infrastructure's impact on the responsiveness of supply chains, eventually fostering an economically equitable and inclusive environment. therefore, based on these observations the study hypothesized:

H2a: Traffic management moderates equity and supply chain responsiveness.

The influence of traffic management in shaping the relationship between the community and supply chain responsiveness is essential. Gurzhiy et al.(2021) stated that efficient traffic management systems play a crucial role in promoting the smooth integration of communities into the supply chain since they ensure that road infrastructure effectively meets their requirements. According to Paiva et al.(2021), traffic management plays a crucial role in improving the accessibility of vital commodities and services by optimizing traffic flow and reducing congestion. This not only benefits the community but also provides advantages to stakeholders involved in the supply chain (Pournader et al.,2020). According to Gurzhiy et al.(2021) and Liu and Ke (2023), the implementation of effective traffic management techniques, such as congestion reduction and route optimization, has a direct influence on the integration of communities into the supply chain network. Evtiukov et al. (2020) stated when the alignment of traffic management with community demands occurs, it results in an improvement in the accessibility of critical services and markets. This, in turn, promotes active community engagement in the supply chain. The aforementioned alignment not only confers advantages to the community but also exerts a favorable impact on supply chain responsiveness through the guarantee of punctual delivery and enhanced operational efficiency. Moreover, Kerimov et al. (2020) observe that the inclusion of the community in the decision-making process for traffic management cultivates a feeling of ownership and cooperation, thereby ensuring that infrastructure development is in line with the specific needs and preferences of the local population. On the other hand, Ning et al. (2020) disclose that insufficient traffic management has the potential to create a state of isolation among communities in terms of efficient mobility, thus restricting their involvement in the supply chain and hindering socio-economic development. Therefore, the implementation of efficient traffic management is of utmost importance as it serves as a vital intermediary between road transport infrastructure, community involvement, and supply chain adaptability. Ultimately, this contributes to the enhancement of an all-encompassing and streamlined supply chain system. therefore, based on these observations the study hypothesized:

H2b: Traffic management moderates community and supply chain responsiveness.

METHODS OF RESEARCH

Sampling and data collection. The study's model was tested by employing survey data gathered from beverage manufacturing firms in Ghana. The unit of analysis included senior managers of manufacturing firms in Ghana. To curb the problem of common method bias, multiple responses were gathered from each firm and subsequently, the average response for each firm was computed. Data was gathered using both personal visits and e-mail invitations to managers. 69.9% of the participants were males and 30.1% were females. Also, the majority of the sample (38.2%) fell within 21-30 years, while the participants with 51+ years were the lower representation of the sample (5.6%). The majority (35.7%) of the participants had a first degree, while those with others (10.0%) and PhD (10.3%) had a lower representation of the sample. The majority (36.2%) of the sample had been in their position for 2-5 years while only 3.6% had been in their position for 16+ years. Also, 39.8% indicated a larger proportion of the sample had worked in their firm for 6-10 years, and 6.1% indicated a lower proportion of the sample had worked for 16+ years. Again, firms with more than 16 years (54.0) represent the majority of the sample while those with less than 2 years (2.5%) represent a lower proportion of the sample.

Measurement Development. The model has three (3) constructs (road transport infrastructure, supply chain responsiveness, and traffic management). All these constructs were measured using items adapted and modified from previously validated instruments. To ensure the authenticity and validity of the data, the items were altered to suit the manufacturing context in Ghana. To enhance the validity of the survey instrument, the questionnaire was reviewed by two (2) academic professors and two (industry experts from the manufacturing industry). The revised questionnaire was further piloted. Issues identified during the pilot were then corrected. A five (5) point Likert scale was used to evaluate all items in the study (1 = strongly disagree, 5 = strongly agree). This study is inspired by the works of Dissanayake and Cross (2018), Ganji et al. (2015), Lai et al. (2002), APICS (2017), Sutopo et al. (2015), all of whom examined supply chain performance from the standpoint of SCOR performance variables. Based on the SCOR Model, this study assesses three performance criteria: reliability, responsiveness, and agility. The elements of reliability, responsiveness, and agility are categorized as consumer-oriented attributes (Sutopo et al. 2015). The study on road transport infrastructure used road sector performance metrics for African nations that demonstrate the level of service provided to road users (Silva 2000, Haas et al. 2009, Jurgens and Chan 2005). The study adopted Botha's (2005) road safety performance indicators to measure road safety.

Control variables: We controlled for the age, size, and ownership type of the organization. The years of the firm's existence were used as a proxy for firm age while the number of employees was also used as a proxy for firm size (see, Srinivasan and Swink, 2017).

RESULTS OF STUDY

The study employed both exploratory factor analysis and confirmatory factor analysis to enhance the reliability and validity of the constructs used in the model. The paper further employed PROCESS MACRO to validate the proposed hypotheses.

The study engaged two subject matter experts to evaluate the content validity of the instruments, with the results confirming their adequacy. Additionally, a pilot test involving 15 respondents from manufacturing organizations was conducted to refine and validate the questionnaire's structure and content. The feedback from the pilot test indicated no significant issues with the wording of the questionnaire. Also, to ensure the items within each scale accurately measure their intended concepts and to validate that the findings accurately represent the dimensions of road transport infrastructure and SC performance, we conducted exploratory and confirmatory factor analyses (Shou et al., 2018). We also conducted EFA using SPSS 26, employing maximum likelihood extraction. We chose oblique rotation with the varimax method, assuming some level of correlation among the constructs (Lee et al., 2019). Additionally, we verified the suitability of the data for analysis using the KMO measure of sampling adequacy which yielded a value of 0.839 indicating data sufficiency and suitability (Nimon, 2012; Yong and Pearce, 2013). Also, Bartlett's Test of Sphericity, examining the null hypothesis that the correlation matrix is an identity matrix, demonstrated high significance (p<.000). We retained items with loadings exceeding 0.5, aligning the highly significant level of loading criterion (Hair et al., 2014). Consequently, the EFA revealed 6 factors, each with eigenvalues exceeding one, collectively accounting for 73.808% of the variance in the analyzed items surpassing the 60% threshold (Fan et al., 2003; Matsunaga, 2010), indicating a satisfactory outcome. We also assessed reliability by calculating Cronbach's alpha for the primary constructs. Items that did not significantly contribute to reliability were removed for simplicity. The Cronbach's alpha values for all constructs exceeded the commonly accepted threshold of 0.7 (see Table 1), confirming good internal consistency and supporting the measure's reliability (Hair et al., 2010). Additionally, as presented in Table 3, the composite reliability (CR) values for all constructs exceeded 0.8, the threshold recommended by Hair et al. (2017), providing further evidence of robust reliability.

We used Amos 23 for CFA to refine the scales developed in the EFA and evaluate the measures' unidimensionality and validity (Matsunaga, 2010). Our CFA criteria included item loading paths, AVE, CR, and various model fit indices. We compared our results to established benchmarks from prior empirical studies. The overall measurement model fit results support the unidimensionality of latent variables, as evidenced by the goodness-of-fit indices ($\chi2 = 357.535$; df = 157; CFI = 0.950; TLI = 0.947; PCFI = 0.750; RMSEA = 0.067; RMR = 0.075; P-close = 0.117). The normed $\chi2$ value of 1.560 was below the recommended maximum value of 3.0 (Hair et al., 2010). Additionally, all other model fit indices were within acceptable ranges, suggesting a good fit between the model and the data. To meet these criteria, we removed six items (RTIC4, RTIC5, RSTM2, RSTM3, RSTM4, RSTM5). In addition, the AVE and CR values for each scale exceeded the specified thresholds, as illustrated in Table 3. Table 1 also shows the revised scale containing measurement items, standardized loading, and Cronbach's alpha statistics for each construct (see Table 1). The standardized regression coefficients for all items exceeded 0.60 and were more than twice their standard errors, affirming convergent validity (Hosany et al., 2015). Further validation of convergent validity is found in the AVE statistics for all constructs, which exceeded the 0.5 thresholds, indicating that each construct explains over half of the variance in its corresponding indicators (Hair et al., 2017). To establish discriminant validity, we verified that the square root of each AVE exceeded the absolute correlation between the measurement scale and other scales (Fornell and Larcker, 1981; Hair et al., 2010). All constructs met this requirement, confirming discriminant validity (see Table 3).

Table 1 – Constructs Validity and Reliability

Constructs	Items	Loadings
Supply Chain Responsiveness	SCPR8	0.716
	SCPR7	0.721
	SCPR6	0.804
	SCPR5	0.897
	SCPR4	0.890
	SCPR3	0.871
Equity	RTIEQ5	0.811
	RTIEQ4	0.786
	RTIEQ3	0.883
	RTIEQ2	0.881
	RTIEQ1	0.834
Communication	RTIC3	0.801
	RTIC2	0.918
	RTIC1	0.889
Traffic management	RSTM7	0.856
	RSTM6	0.871
	RSTM1	0.724

Source: Authors' processing from PLS-SEM.

Table 2 – Goodness of Fit Statistics

Goodness of Fit Statistics	Measurement Model	Recommended Values for Satisfactory Data
CMIN/DF	2.277	<3.0
CFI	0.950	>0.9
TLI	0.947	>0.9
PCFI	0.750	>0.5
Close	0.117	>0.05
RMSEA	0.067	<0.08

Source: Authors' processing from PLS-SEM.

Table 3 – Convergent and Discriminant Validity

Constructs	CR	AVE	1	2	3	4
SC Responsiveness	0.924	0.672	0.820			
Equity	0.923	0.705	0.785	0.840		
Communication	0.904	0.758	0.418	0.292	0.871	
Traffic management	0.859	0.672	0.567	0.49	0.572	0.820

Source: Authors' processing from PLS-SEM.

Following the establishment of the measurement via CFA, we tested our research hypotheses using Process Macro (Hayes, 2018). The results are shown in table 4 below. In the analysis, the two factors representing road traffic infrastructure dimensions were treated as exogenous variables, while SC responsiveness was considered an endogenous variable. Firm size and ownership type were significant in the model. The test results indicated that the path about road transport infrastructure (equity and community) and SC performance (responsiveness) are supported (H1a- β=.8.1490, p-value<0.01: H1b- β=1.5018, p-value<0.01), suggesting that road transport infrastructure (equity and community) significantly affect SC responsiveness. Also, traffic management positively affects SC responsiveness (β=5.7773, p-value<0.05). We also found traffic management significantly moderates the road transport infrastructure and SC responsiveness link (β=.5704, p-value<0.05: β=.2.1959, p-value<0.01), confirming H2a and H2b. Since the direct and indirect effects are both significant, it can be concluded that the type of moderation is complementary partial or positive confounding or a consistent model (Zhao et al., 2010).

Table 4 – Structural Model

	Dependent Variable	
	Model 1	Model 2
	Coeffic. (p)	*Coeffic. (p)*
Controls		
Firm Size	2.243***(.0079)	2.4535***(.0003)
Firm Age	.2555(.5361)	.0951(.8139)
Ownership Type	1.7501***(.000)	1.7553***(.0000)
Main Effect		
Equity	8.1490***(.0001)	5.9740***(.0000)
Community	1.5018***(.0079)	9.9290***(.0004)
Traffic management	5.7773**(.0152)	12.1953***(.0000)
Interaction Effect		
Equity*TM	.5704***(.0000)	
Community*TM		2.1959***(.0020)
Model Summary		
R^2	0.7189	0.7309
F-test	71.2377	75.6523
P-Value	0.000	0.000

*Note: *** p<.01, ** p<.05, * p<.1.*
Source: Authors' processing from PLS-SEM.

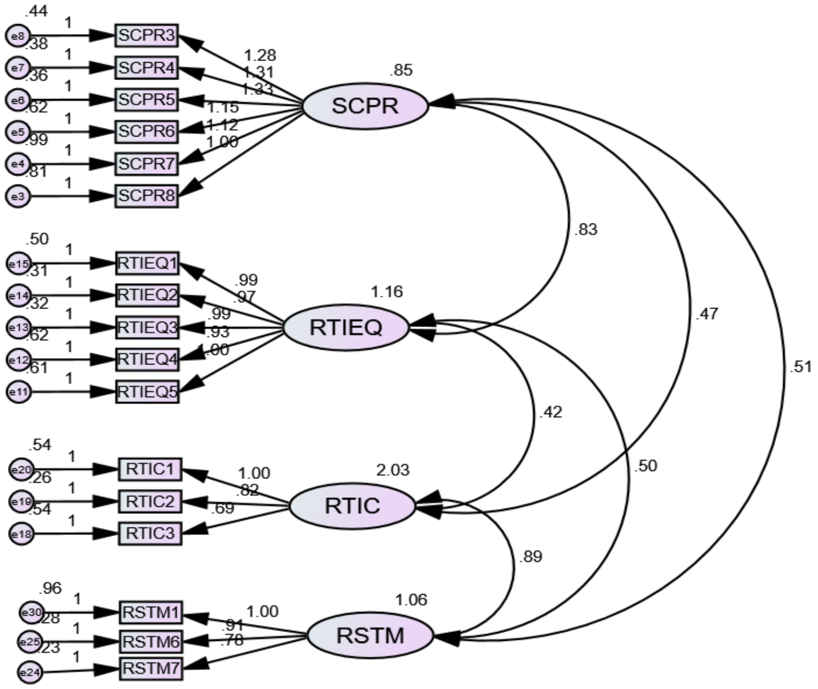

Figure 2 – Measurement Model Assessment

DISCUSSION OF RESULTS

Our results showed that road transport infrastructure which is comprised of equity and community positively drives SC responsiveness, indicating that higher levels of road transport equity and community significantly improve SC responsiveness in manufacturing firms (Kaufman et al., 2021; Ma et al., 2023; Duncan-Andrade, 2022; Lin and Cui, 2021). According to Yakavenka et al. (2020), the efficiency of SC performance is significantly impacted by the quality of road transportation infrastructure. According to Al-Rashid et al. (2021), equitable road transport networks have a critical role in enhancing SC responsiveness. When transportation infrastructure is planned with equity in mind, it eliminates bottlenecks, minimizes disturbances, and improves accessibility, allowing SC to quickly adjust to changing market dynamics and disruptions (Musah 2020). Furthermore, community participation has emerged as an important aspect since it promotes information sharing, trust, and collaboration, resulting in more agile and responsive SC (Yadav and Samuel, 2022; Nayal et al., 2022). The combined effect of road transport equality and community support is especially notable since they support one another. When SCs are connected with equitable road transport networks and embedded within supportive communities, they display a better level of responsiveness to market swings and disruptions, hence improving overall performance (Segovia-HernándeZ et al., 2022). These results highlight the need to take social and ethical elements into account in SC management, highlighting their direct effect on SC responsiveness and resilience.

Our study also found that road safety (traffic management) moderates the link between road transport infrastructure equity and community and SC responsiveness. The availability of adequate traffic management systems can enhance the overall responsiveness and participation of communities and SCs. This is in line with (Sundarakani et al., 2021; Bethoux, 2020; Yadav et al., 2022). Sundarakani et al. (2021) highlighted that businesses and regulators must evaluate how road safety moderates road transport infrastructure in SC. Road safety measures and effective traffic management, according to Boranbayev et al. (2020), have a substantial impact on SC responsiveness by minimizing disruptions and delays in transportation. Although equitable road infrastructure and community support are essential, the effectiveness of these elements may be enhanced by well-implemented traffic management systems. SC may operate with higher agility and reliability when traffic is adequately controlled to guarantee safety and minimize congestion (Lamssaggad et al., 2021). The moderating role of Road safety emphasizes the interconnectivity of multiple factors in affecting SC performance and resilience. Organizations should consider not only fair road infrastructure and community participation to achieve optimum SC responsiveness but also invest in strong traffic management practices that support the seamless movement of products and information (Van Wee et al., 2019).

The findings add to both Systems Theory and Knowledge-Based Theory, providing useful insights into the complex dynamics of SC management. The interconnectedness and interdependence of diverse constituents within a system are emphasized in systems theory. The findings support the viewpoint by emphasizing the systemic character of supply chains. Equitable road infrastructure and active community involvement may be seen as vital components that impact the overall performance of a well-functioning SC system. According to Systems Theory, changes in one area of the system may have a ripple effect on the whole system, and the beneficial impact of road transport equality and community participation on SC responsiveness supports this theory. Knowledge-based theory emphasizes the importance of information and knowledge in creating organizational performance. The moderating role of traffic management highlights the relevance of knowledge-based decision-making in SC management. To guarantee the safe and efficient movement of products, effective traffic management depends on the use of knowledge and information. This finding highlights the importance of information availability (in terms of road safety measures), as well as its strategic application in moderating the interactions between various characteristics (road transport equality, community participation, and SC responsiveness). According to Knowledge-Based Theory, organizations that effectively harness knowledge are more likely to achieve better performance, and this study demonstrates how knowledge (in the form of traffic management) plays a critical role in optimizing SC responsiveness.

CONCLUSION

In conclusion, this study underscores the pivotal role of road transport infrastructure, encompassing equity and community aspects, in enhancing supply chain (SC) responsiveness within the manufacturing sector. These findings emphasize that higher levels of road transport equity and community support significantly contribute to improved SC responsiveness, ultimately benefiting manufacturing firms. Furthermore, community participation fosters information sharing, trust, and collaboration, fostering a more agile and responsive SC. Importantly, the combined effect of road transport equity and community support complements one another, leading to better SC performance. Additionally, the study reveals that road safety, particularly traffic management, moderates the relationship between road transport infrastructure and SC responsiveness. Adequate traffic management systems play a crucial role in enhancing overall responsiveness and community participation in the SC. Effective traffic management minimizes disruptions, and delays, and ensures the safety of transportation. This moderating effect emphasizes the interconnectivity of various factors in shaping SC performance and resilience, highlighting the need for investing in robust traffic management practices. The study contributes to both Systems Theory and Knowledge-Based Theory, shedding light on the intricate dynamics of SC management. It underscores the systemic nature of supply chains, where changes in one aspect can ripple through the entire system. Knowledge-based decision-making is crucial, with traffic management exemplifying the significance of knowledge and information in optimizing SC responsiveness. These results highlight the varied nature of SC responsiveness, advising organizations to take a comprehensive strategy that incorporates these elements into their SC plans. Organizations may not only improve their response to market swings and disruptions by doing so, but they can also develop sustainability, resilience, and competitiveness in the volatile terrain of SC management.

STUDY IMPLICATIONS

The study has significant practical implications since it gives actionable insights for organizations seeking to improve their SC responsiveness via the optimization of road transport equality, community involvement, and road safety practices. The results highlight the critical need to invest in equitable road transport infrastructure. This entails organizing and supporting road development projects that prioritize equity, safety, and accessibility for all stakeholders. Collaboration with local governments and advocacy organizations is one practical step toward ensuring that road infrastructure is developed and maintained equitably. This might include addressing discrepancies in road conditions, access to transit hubs, and safety measures to reduce interruptions. Organizations may construct a more reliable and effective transport network by prioritizing road transport equity, decreasing lead times and costs while boosting overall SC responsiveness. The importance of community involvement in SC responsiveness cannot be stated. Practical consequences include creating strong bonds with local communities via outreach, collaboration, and open communication. Involving communities in SC operations may give organizations significant insights into local circumstances, possible hazards, and possibilities, allowing them to adjust their plans appropriately. Collaboration with communities may also help to create a supportive climate, reducing disturbances like demonstrations or strikes. In their SC planning, organizations should address community expectations and demands, since this practical approach may lead to easier operations and improved SC response. The moderating influence of road safety practices especially traffic management, highlights the practical need to invest in safety measures across the SC. Safety practices, such as well-planned traffic management systems, frequent safety audits, and employee education, should be prioritized by organizations. Effective traffic management not only promotes safer mobility but also reduces delays and interruptions caused by accidents or congestion, hence enhancing SC responsiveness. In practice, organizations may work with transportation authorities to adopt technology-based solutions like real-time traffic monitoring and predictive analytics to improve traffic flow and reduce safety hazards. The results emphasize that combining these aspects might result in a more responsive supply chain. Adopting a comprehensive approach to SC management that includes concerns for road transport fairness, community participation, and road safety are examples of practical initiatives. Companies might form cross-functional teams or departments tasked with aligning these elements with SC objectives. To successfully apply best practices, organizations should participate in knowledge-sharing and collaboration with industry peers and experts.

LIMITATIONS AND FUTURE RESEARCH

While the results of this research give important insights into the factors determining SC responsiveness, it is important to recognize possible limitations. First, the concentration on data obtained primarily from beverage manufacturing enterprises may restrict the results' generalizability to other sectors. Similar studies across a larger variety of businesses could help future studies by assessing the applicability of these results in other circumstances. Furthermore, this research focuses on the impact of road transport infrastructure equity, community engagement, and traffic management on SC responsiveness. Future studies should look at the possible linkages and interdependence of SC response dynamics with other variables such as technology improvements, regulatory changes, or global SC disruptions. Furthermore, given the ever-changing nature of SC management, continuing research efforts should strive to investigate the dynamic nature of these interactions across time to capture changes and adjustments in response to new trends and issues.

REFERENCES

1. Abdallah, A.B., Alfar, N.A. and Alhyari, S., 2021. The effect of supply chain quality management on supply chain performance: the indirect roles of supply chain agility and

innovation. International Journal of Physical Distribution & Logistics Management, 51(7), pp.785-812.

2. Adu, J.P., Dorasamy, N. and Keelson, S.A., 2023. Road Transport Infrastructure and Supply Chain Performance in the Beverage Manufacturing Setting: Does Road Safety Compliance Matter? Journal of Law and Sustainable Development, 11(3), pp.e581-e581.
3. Afrin, T. and Yodo, N., 2020. A survey of road traffic congestion measures towards a sustainable and resilient transportation system. Sustainability, 12(11), p.4660.
4. Al-Majidi, S.A., 2022. Sustainable Supply Chain Management through the Integration of IoT: Road Transportation.
5. Al-Rashid, M.A., Shamsul Harumain, Y.A., Goh, H.C. and Ahmad, Z., 2021. Psychosocial factors of public transport users and social inclusion implications among older women in Pakistan. Journal of Urban Planning and Development, 147(4), p.04021046.
6. Asamoah, D., Agyei-Owusu, B., Andoh-Baidoo, F.K. and Ayaburi, E., 2021. Inter-organizational systems use and supply chain performance: Mediating role of supply chain management capabilities. International journal of information management, 58, p.102195.
7. Bayoumi, E., Elgazzar, S., Abdelbary, A. and Ricci, S., 2021. The Role of Road Transport Infrastructure Investments on Logistics Performance: A Research Agenda. International Business, 1(2).
8. Bethoux, O., 2020. Hydrogen fuel cell road vehicles and their infrastructure: An option towards an environmentally friendly energy transition. Energies, 13(22), p.6132.
9. Botha, G. J. 2005. Measuring Road Traffic Safety Performance Proceedings of the 24th Southern African Transport Conference (SATC 2005) ISBN Number: 1-920-01712-7 Pretoria, South Africa Conference Planners
10. Cedillo-Campos, M.G., Piña-Barcenas, J., Pérez-González, C.M. and Mora-Vargas, J., 2022. How to measure and monitor the transportation infrastructure contribution to the logistics value of supply chains? Transport Policy, 120, pp.120-129.
11. Chen, J., Wang, L. and Qu, G., 2021. Explicating the business model from a knowledge-based view: nature, structure, imitability, and competitive advantage erosion. Journal of Knowledge Management, 25(1), pp.23-47.
12. Chen, Q.A., Yin, Y., Feng, Y., Mao, Z.M. and Liu, H.X., 2018, February. Exposing congestion attack on emerging connected vehicle-based traffic signal control. In NDSS.
13. Deveci, M., Pamucar, D. and Gokasar, I., 2021. Fuzzy Power Heronian function-based CoCoSo method for the advantage prioritization of autonomous vehicles in real-time traffic management. Sustainable Cities and Society, 69, p.102846.
14. Dissanayake, C.K. and Cross, J.A., 2018. Systematic mechanism for identifying the relative impact of supply chain performance areas on the overall supply chain performance using SCOR model and SEM. International Journal of Production Economics, 201, pp.102-115.
15. Dong, P., Zhao, J., Liu, X., Wu, J., Xu, X., Liu, Y., Wang, S. and Guo, W., 2022. Practical application of energy management strategy for hybrid electric vehicles based on intelligent and connected technologies: Development stages, challenges, and future trends. Renewable and Sustainable Energy Reviews, 170, p.112947.
16. Duncan-Andrade, J.M., 2022. Equality or equity: Toward a model of community-responsive education. Harvard Education Press.
17. Evtiukov, S.A., Kurakina, E.V. and Evtiukov, S.S., 2020, April. Smart Transport in road transport infrastructure. In IOP Conference Series: Materials Science and Engineering (Vol. 832, No. 1, p. 012094). IOP Publishing.
18. Fan, J., Ye, B., Zhang, Z. and Liu, B., 2003. Exploratory factor analysis: a literature review between 1991 and 2000. Advances in Psychological Science, 11(05), p.579.
19. Fornell, C. and Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. Journal of marketing research, 18(1), pp.39-50.
20. Fulzele, V. and Shankar, R., 2021. Performance measurement of sustainable freight transportation: a consensus model and FERA approach. Annals of Operations Research, pp.1-42.

21. Ganji Jamehshooran, B., Shaharoun, M. and Norehan Haron, H., 2015. Assessing supply chain performance through applying the SCOR model. International Journal of Supply Chain Management, 4(1).
22. Garcia-Torres, S., Albareda, L., Rey-Garcia, M. and Seuring, S., 2019. Traceability for sustainability–literature review and conceptual framework. Supply Chain Management: An International Journal, 24(1), pp.85-106.
23. Giannakis, M., Spanaki, K. and Dubey, R., 2019. A cloud-based supply chain management system: effects on supply chain responsiveness. Journal of Enterprise Information Management, 32(4), pp.585-607.
24. Große, C., 2023. A review of the foundations of systems, infrastructure, and governance. Safety Science, 160, p.106060.
25. Gu, B. and Liu, J., 2023. Port resilience analysis based on the HHM-FCM approach under COVID-19. Ocean & Coastal Management, 243, p.106741.
26. Gurzhiy, A., Kalyazina, S., Maydanova, S. and Marchenko, R., 2021. Port and city integration: transportation aspect. Transportation Research Procedia, 54, pp.890-899.
27. Haas, R., Felio, G., Lounis, Z. and Falls, L.C., 2009. Measurable performance indicators for roads: Canadian and international practice. In Proceedings of the 2009 Annual Conference of the Transportation Association of Canada, Vancouver, British Columbia.
28. Hair Jr, J.F., Matthews, L.M., Matthews, R.L. and Sarstedt, M., 2017. PLS-SEM or CB-SEM: updated guidelines on which method to use. International Journal of Multivariate Data Analysis, 1(2), pp.107-123.
29. Hair, J.F., Gabriel, M. and Patel, V., 2014. AMOS covariance-based structural equation modeling (CB-SEM): Guidelines on its application as a marketing research tool. Brazilian Journal of Marketing, 13(2).
30. Hayes, A.F., 2018. Partial, conditional, and moderated moderated mediation: Quantification, inference, and interpretation. Communication monographs, 85(1), pp.4-40.
31. Hosany, S., Prayag, G., Deesilatham, S., Caušević, S. and Odeh, K., 2015. Measuring tourists' emotional experiences: Further validation of the destination emotion scale. Journal of Travel Research, 54(4), pp.482-495.
32. Hugos, M.H., 2018. Essentials of supply chain management. John Wiley & Sons.
33. Ivankova, V., Gavurova, B., Bačík, R. and Rigelský, M., 2021. Relationships between road transport infrastructure and tourism spending: A development approach in European OECD countries. Entrepreneurship and Sustainability Issues, 9(2), p.535.
34. Ivanov, D., Dolgui, A., Das, A. and Sokolov, B., 2019. Digital supply chain twins: Managing the ripple effect, resilience, and disruption risks by data-driven optimization, simulation, and visibility. Handbook of ripple effects in the supply chain, pp.309-332.
35. Jurgens, R. and Chan, J., 2005. Highway performance measures for business plans in Alberta. In Annual Conference of the Transportation Association of Canada (pp. 1-16).
36. Kaufman, B., Burke, M. and Leung, A., 2021. Evaluating demand-responsive transit services using a density-based trip rate metric. Journal of Transport and Land Use, 14(1), pp.499-519.
37. Kerimov, M., Evtiukov, S. and Marusin, A., 2020. Model of multi-level system managing automated traffic enforcement facilities recording traffic violations. Transportation Research Procedia, 50, pp.242-252.
38. Kerimov, M., Marusin, A., Marusin, A. and Danilov, I., 2020. Methodological aspects of building a mathematical model to evaluate the efficiency of automated vehicle traffic control systems. Transportation Research Procedia, 50, pp.253-261.
39. Khatri, S., Vachhani, H., Shah, S., Bhatia, J., Chaturvedi, M., Tanwar, S. and Kumar, N., 2021. Machine learning models and techniques for VANET based traffic management: Implementation issues and challenges. Peer-to-Peer Networking and Applications, 14, pp.1778-1805.
40. Konkor, I., 2021. Examining the relationship between transportation mode and the experience of road traffic accidents in the upper west region of Ghana. Case studies on transport policy, 9(2), pp.715-722.

41. Kumar, N., Rahman, S.S. and Dhakad, N., 2020. Fuzzy inference enabled deep reinforcement learning-based traffic light control for intelligent transportation systems. IEEE Transactions on Intelligent Transportation Systems, 22(8), pp.4919-4928.
42. Lai, K.H., Ngai, E.W. and Cheng, T.C.E., 2002. Measures for evaluating supply chain performance in transport logistics. Transportation Research Part E: Logistics and Transportation Review, 38(6), pp.439-456.
43. Lamssaggad, A., Benamar, N., Hafid, A.S. and Msahli, M., 2021. A survey on the current security landscape of intelligent transportation systems. IEEE Access, 9, pp.9180-9208.
44. Lee, J., Arts, J., Vanclay, F. and Ward, J., 2020. Examining the social outcomes from urban transport infrastructure: Long-term consequences of spatial changes and varied interests at multiple levels. Sustainability, 12(15), p.5907.
45. Lee, J., Lee, D., Park, Y., Lee, S. and Ha, T., 2019. Autonomous vehicles can be shared, but a feeling of ownership is important: Examination of the influential factors for intention to use autonomous vehicles. Transportation Research Part C: Emerging Technologies, 107, pp.411-422.
46. Lin, D. and Cui, J., 2021. Transport and mobility need for an aging society from a policy perspective: Review and implications. International Journal of Environmental Research and Public Health, 18(22), p.11802.
47. Liu, C. and Ke, L., 2023. Cloud-assisted Internet of Things intelligent transportation system and the traffic control system in the smart city. Journal of Control and Decision, 10(2), pp.174-187.
48. Lv, Z. and Shang, W., 2022. Impacts of intelligent transportation systems on energy conservation and emission reduction of transport systems: A comprehensive review. Green Technologies and Sustainability, p.100002.
49. Ma, J., Chen, X., Xing, Z., Zhang, Y. and Yu, L., 2023. Improving the performance of airport shuttle through demand-responsive service with a dynamic fare strategy considering mixed demand. Journal of Air Transport Management, 112, p.102459.
50. Magalhães, V.S.M., 2021. Framework development for the prevention of food loss and waste: an analysis along the fresh food supply chain (Doctoral dissertation, 00500:: Universidade de Coimbra).
51. Maleki, E., 2023. Resiliency in the supply chain. International journal of industrial engineering and operational research, 5(1), pp.8-18.
52. Matsunaga, M., 2010. How to Factor-Analyze Your Data Right: Do's, Don'ts, and How-To's. International journal of psychological research, 3(1), pp.97-110.
53. McKinnon, A.C., 2016. Freight transport deceleration: Its possible contribution to the decarbonization of logistics. Transport Reviews, 36(4), pp.418-436.
54. McKinnon, A.C., 2021. The influence of logistics management on freight transport research short history of a paradigm shift. Journal of Transport Economics and Policy (JTEP), 55(2), pp.104-123.
55. Millonig, A., Rudloff, C., Richter, G., Lorenz, F. and Peer, S., 2022. Fair mobility budgets: A concept for achieving climate neutrality and transport equity. Transportation Research Part D: Transport and Environment, 103, p.103165.
56. Mitra, A. and Shaw, R., 2023. Systemic risk from a disaster management perspective: A review of current research. Environmental Science & Policy, 140, pp.122-133.
57. Moh’d Anwer, A.S., 2022. An investigation of transportation logistics strategy on manufacturing supply chain responsiveness in developing countries: the mediating role of delivery reliability and delivery speed. Heliyon.
58. Muhalia, E., Ngugi, P. and Moronge, M., 2021. Effect Of Transportation Management Systems On Supply Chain Performance Of Fmcg In Kenya. American Journal Of Supply Chain Management, 6(1), pp.1-12.
59. Munim, Z.H. and Schramm, H.J., 2018. The impacts of port infrastructure and logistics performance on economic growth: the mediating role of seaborne trade. Journal of Shipping and Trade, 3(1), pp.1-19.
60. Musah, W.E., 2023. Building resilient supply chains in industry 4.0: The case of the medical equipment industry.

61. Nayal, K., Raut, R.D., Yadav, V.S., Priyadarshinee, P. and Narkhede, B.E., 2022. The impact of sustainable development strategy on sustainable supply chain firm performance in the digital transformation era. Business Strategy and the Environment, 31(3), pp.845-859.
62. Negri, M., Cagno, E., Colicchia, C. and Sarkis, J., 2021. Integrating sustainability and resilience in the supply chain: A systematic literature review and a research agenda. Business Strategy and the environment, 30(7), pp.2858-2886.
63. Nimon, K.F., 2012. Statistical assumptions of substantive analyses across the general linear model: a mini-review. Frontiers in Psychology, 3, p.322.
64. Ning, Z., Zhang, K., Wang, X., Obaidat, M.S., Guo, L., Hu, X., Hu, B., Guo, Y., Sadoun, B. and Kwok, R.Y., 2020. Joint computing and caching in 5G-envisioned Internet of Vehicles: A deep reinforcement learning-based traffic control system. IEEE Transactions on Intelligent Transportation Systems, 22(8), pp.5201-5212.
65. Novack, R.A., Gibson, B.J. and Suzuki, Y., 2023. Transportation: a global supply chain perspective. Cengage Learning.
66. Paiva, S., Ahad, M.A., Tripathi, G., Feroz, N. and Casalino, G., 2021. Enabling technologies for urban smart mobility: Recent trends, opportunities and challenges. Sensors, 21(6), p.2143.
67. Pournader, M., Shi, Y., Seuring, S. and Koh, S.L., 2020. Blockchain applications in supply chains, transport, and logistics: a systematic review of the literature. International Journal of Production Research, 58(7), pp.2063-2081.
68. Rasol, M., Pais, J.C., Pérez-Gracia, V., Solla, M., Fernandes, F.M., Fontul, S., Ayala-Cabrera, D., Schmidt, F. and Assadollahi, H., 2022. GPR monitoring for road transport infrastructure: A systematic review and machine learning insights. Construction and Building Materials, 324, p.126686.
69. Raza, A., Akuh, R., Safdar, M. and Zhong, M., 2023. Public transport equity with the concept of time-dependent accessibility using Geostatistics methods, Lorenz curves, and Gini coefficients. Case Studies on Transport Policy, 11, p.100956.
70. Richey, R.G., Roath, A.S., Adams, F.G. and Wieland, A., 2022. A responsiveness view of logistics and supply chain management. Journal of Business Logistics, 43(1), pp.62-91.
71. Safiullin, R., Fedotov, V. and Marusin, A., 2020. Method to evaluate the performance of measurement equipment in automated vehicle traffic control systems. Transportation Research Procedia, 50, pp.20-27.
72. Schachenhofer, L., Kummer, Y. and Hirsch, P., 2023. An analysis of underused urban infrastructures: usage opportunities and implementation barriers for sustainable logistics. Applied Sciences, 13(13), p.7557.
73. Segovia-Hernández, J.G., Sanchez-Ramirez, E., Alcocer-Garcia, H., Romero-Garcia, A.G. and Quiroz-Ramirez, J.J., 2022. Sustainable Production of Biofuels Using Intensified Processes. Springer Nature.
74. Shekarian, M., Nooraie, S.V.R. and Parast, M.M., 2020. An examination of the impact of flexibility and agility on mitigating supply chain disruptions. International Journal of Production Economics, 220, p.107438.
75. Shladover, S.E., 2022. Opportunities, challenges, and uncertainties in urban road transport automation. Sustainability, 14(3), p.1853.
76. Shou, Y., Li, Y., Park, Y. and Kang, M., 2018. Supply chain integration and operational performance: The contingency effects of production systems. Journal of Purchasing and Supply Management, 24(4), pp.352-360.
77. Silva, G.F., 2000. Toll roads: Recent trends in private participation
78. Skorobogatova, O. and Kuzmina-Merlino, I., 2017. Transport infrastructure development performance. Procedia Engineering, 178, pp.319-329.
79. Soosay, C., Nunes, B., Bennett, D.J., Sohal, A., Jabar, J., and Winroth, M., 2016. Strategies for sustaining manufacturing competitiveness: comparative case studies in Australia and Sweden. Journal of Manufacturing Technology Management, 27(1), pp.6-37.

80. Sudan, T. and Taggar, R., 2021. Recovering supply chain disruptions in post-COVID-19 pandemic through transport intelligence and logistics systems: India's experiences and policy options. Frontiers in Future Transportation, 2, p.660116.
81. Sundarakani, B., Ajaykumar, A. and Gunasekaran, A., 2021. Big data driven supply chain design and applications for blockchain: An action research using case study approach. Omega, 102, p.102452.
82. Sundarakani, B., Pereira, V. and Ishizaka, A., 2021. Robust facility location decisions for resilient sustainable supply chain performance in the face of disruptions. The International Journal of Logistics Management, 32(2), pp.357-385.
83. Sutopo, W., Maryanie, D.I. and Yuniaristanto, 2015. Evaluation of valuable chain in palm oil industry based on SCOR model: A case study. International Journal of Logistics Systems and Management, 21(2), pp.229-241.
84. Tanco, M., Escuder, M., Heckmann, G., Jurburg, D. and Velazquez, J., 2018. Supply chain management in Latin America: current research and future directions. Supply Chain Management: An International Journal, 23(5), pp.412-430.
85. Trojanowski, P., 2020. Comparative analysis of the impact of road infrastructure development on road safety–a case study. Zeszyty Naukowe Akademii Morskiej w Szczecinie.
86. Van Velzen, A., Annema, J.A., van de Kaa, G. and van Wee, B., 2019. Proposing a more comprehensive future total cost of ownership estimation framework for electric vehicles. Energy Policy, 129, pp.1034-1046.
87. Wagner, P., 2016. Traffic control and traffic management in a transportation system with autonomous vehicles. Autonomous Driving: Technical, Legal and Social Aspects, pp.301-316.
88. Yadav, A.K. and Samuel, C., 2022. Modeling resilient factors of the supply chain. Journal of Modelling in Management, 17(2), pp.456-485.
89. Yeo, A.D., Deng, A. and Nadiedjoa, T.Y., 2020. The effect of infrastructure and logistics performance on economic performance: The mediation role of international trade. Foreign Trade Review, 55(4), pp.450-465.
90. Yong, A.G. and Pearce, S., 2013. A beginner's guide to factor analysis: Focusing on exploratory factor analysis. Tutorials in quantitative methods for psychology, 9(2), pp.79-94.
91. Yu, K., Lin, L., Alazab, M., Tan, L. and Gu, B., 2020. Deep learning-based traffic safety solution for a mixture of autonomous and manual vehicles in a 5G-enabled intelligent transportation system. IEEE Transactions on Intelligent Transportation Systems, 22(7), pp.4337-4347.
92. Zhabin, A., 2023. Management strategies and enhancing enterprise efficiency in the context of contemporary geopolitical conditions. In E3S Web of Conferences (Vol. 420, p. 04003). EDP Sciences.
93. Zhang, H. and Lu, X., 2020. Vehicle communication network in intelligent transportation system based on the Internet of Things. Computer Communications, 160, pp.799-806.
94. Zhang, M. and Zhao, P., 2021. Literature review on urban transport equity in transitional China: From empirical studies to universal knowledge. Journal of Transport Geography, 96, p.103177.
95. Zhu, F., Lv, Y., Chen, Y., Wang, X., Xiong, G. and Wang, F.Y., 2019. Parallel transportation systems: Toward IoT-enabled smart urban traffic control and management. IEEE Transactions on Intelligent Transportation Systems, 21(10), pp.4063-4071.