BALA302 - Business Analytics Industry Project

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Abstract:

This research examines the impact of sustainable construction materials, supply chain strategy, and logistics integration on supply chain performance in the automobile industry. Findings reveal that adopting sustainable materials can reduce costs, align with eco-efficiency goals, and meet consumer demand for eco-friendly products. Supply chain strategies are critical, aligning with business objectives, supplier relationships, information technology, and risk management. Integrated logistics systems improve visibility, coordination, and cost efficiency. The study employs PLS-SEM modeling and rigorous data analysis, explaining 45.6% of the variance in supply chain performance. Practical implications include cost reduction, regulatory compliance, risk mitigation, and consumer-driven sales growth. Future research should explore longitudinal trends, cross-industry comparisons, and strategies for enhancing supply chain resilience. In summary, embracing sustainable materials and optimizing supply chain strategy and logistics integration significantly enhance supply chain performance in the automobile sector. This research offers insights for decision-makers and encourages methodological rigor to ensure reliable findings, providing a foundation for understanding and improving supply chain performance in this dynamic industry. Please refer to *Fig.3* to view the various measurement constructs used in the model.

Introduction:

The efficiency and performance of supply chains play a pivotal role in the success and competitiveness of businesses across various industries, Specifically the automobile industry. As the world continues to evolve, the construction and logistics sectors are no exception to the growing demands for sustainable practices and improved performance. This research project delves into the complex interplay between three critical, independent variables—The Sustainable Use of Construction

Material, Supply Chain Strategy, and Logistics Integration—and their impact on the dependent variable at hand, Supply Chain Performance.

Efficient supply chain performance is essential for companies to meet customer demands, reduce costs, and enhance profitability. However, the automobile industry faces unique challenges due to its heavy reliance on resources and its substantial environmental footprint. Sustainable practices, including the use of eco-friendly construction materials, have gained prominence in addressing these challenges (Giampieri et al., 2020). We must ask the question of whether the adoption of sustainable construction materials contributes positively to supply chain performance in the automobile industry. Furthermore, the efficacy of supply chain strategies and the integration of logistics play vital roles in optimizing operations. Companies need to strategically align their supply chain practices and integrate logistics seamlessly to deliver products and services efficiently (Slam et al., 2023). But to what extent do these strategic decisions impact overall supply chain performance in the automobile sector?

The primary aim of this research report is to investigate and analyze the relationship between the Sustainable Use of Construction Material, Supply Chain Strategy, Logistics Integration, and their influence on Supply Chain Performance. To achieve this, the following research objectives have been established:

- To assess the impact of sustainable construction materials on supply chain performance in the automobile industry.
- To evaluate how different supply chain strategies impact the overall performance of automobile supply chains.
- To explore the relationship between logistics integration and supply chain performance within the automobile sector.

Through this research, we aim to shed light on the extent to which sustainable manufacturing practices, supply chain strategies, and logistics integration influence the performance of supply chains in the automobile industry. By exploring these questions further with secondary data and analysis, we aim to provide valuable insights to automobile businesses and industry stakeholders, helping them make informed decisions and enhance their competitiveness in an evolving industry.

Theoretical Underpinning and Research Model:

The use of sustainable materials in the automobile manufacturing industry has become a subject of considerable interest in recent years. The use of sustainable construction materials is "The extent of improving the efficient use of construction materials, minimizing waste generation, and creating channels to transform waste into the material resource" (Zeng et al., 2018). Sustainable materials are those that have a lower environmental impact in their production and use, which aligns with the broader societal goals of reducing carbon emissions, conserving resources, and minimizing environmental harm (Velenturf and Purnell, 2021). The use of such materials has the potential to positively influence supply chain performance in various aspects. Several studies have indicated that sustainable materials, such as lightweight and recyclable materials, can reduce production costs by lowering the weight of vehicles and increasing fuel efficiency. Lower production costs can positively impact supply chain performance as they can lead to higher profitability and cost savings (Sarkis, 2019). Increasingly, consumers are environmentally conscious and prefer products that are environmentally friendly. Sustainable materials can help automakers meet this demand, potentially leading to increased sales and improved supply chain performance (Luthra et al., 2018). Governments worldwide are enacting stricter regulations to reduce emissions and encourage the use of sustainable materials in the automotive industry. Firms that proactively adopt sustainable materials can remain compliant with these regulations, avoiding penalties and disruptions in the supply chain (Brennan et al., 2017). Additionally, the use of sustainable materials can mitigate risks associated with volatile commodity prices, as these materials are often derived from renewable resources or have stable pricing structures. Reduced supply chain disruptions due to price fluctuations can positively affect performance (Seuring & Gold, 2013). Such foundations that support the idea that sustainable materials positively influence supply chain performance in the automobile industry are grounded in environmental and economic theories. These theories emphasize the alignment of sustainable practices with long-term business success, the value of eco-efficiency, and the importance of meeting societal expectations.

Hypothesis 1 aims to explore the true effects of Sustainable Use of Construction Material and that it does indeed have an effect on Supply Chain Performance in the automobile industry.

H0: The Sustainable Use of Construction Materials does not have an effect on the Supply Chain Performance.
H1: The Sustainable Use of Construction Materials has an effect on the Supply Chain Performance.

Supply chain strategy remains a critical driver of supply chain performance in the modern automobile industry. Recent research has explored the impact of various supply chain strategies on performance. The following underpinnings look further into supply chain strategy and are the foundation of Hypothesis 2. A study by Jena and Sudhir (2020) highlighted the importance of aligning supply chain strategies with the broader business goals of automobile manufacturers. Supply chain strategies that are closely aligned with cost efficiency, responsiveness, or sustainability objectives directly contribute to improved supply chain performance. Research by Li et al. (2022) delved into the concept of supply chain configuration in the automobile industry. The study emphasized that the need for supply chain strategies to match the specific product characteristics, market dynamics, and competitive landscape to enhance supply chain performance relies on continuous improvement of configuration and new strategies. Recent research by Kannan et al. (2021) has reaffirmed the importance of strong and collaborative relationships with suppliers in the automotive supply chain. These relationships are instrumental in improving supply chain performance through enhanced coordination, quality management, and information sharing. Information technology plays a critical role in supply chain strategy. A recent work by Shahzad et al. (2021) highlights firms that effectively leverage modern IT solutions for communication, visibility, and decision-making within the supply chain. It was found that this can significantly enhance the overall supply chain performance. Another pivotal aspect of supply chain strategy is risk management. The role of risk management in supply chain strategy is emphasized in a study by (2023). The research underscores the significance of risk-aware supply chain strategies in ensuring supply chain resilience, particularly in the face of disruptions such as the COVID-19 pandemic. This is necessary to keep in mind as we are in an everchanging world with new EVs and IT coming into play within the global automobile industry.

In light of these recent studies, Hypothesis 2 posits that the Supply Chain Strategy indeed has a direct effect on Supply Chain Performance in today's automobile industry. The choice and execution of supply chain strategies continue to be critical determinants of performance outcomes, underscoring the need for further Investigation.

H0: The Supply Chain Strategy does not directly affect the Supply Chain Performance.

H2: The Supply Chain Strategy has a direct effect on the Supply Chain Performance.

Logistics integration is a critical element of supply chain management, and its impact on supply chain performance has been studied extensively (Alam, 2022). Below, we will explore studies that support the idea of how seamless logistics integration can enhance supply chain performance in today's automobile industry. Logistics integration has been found to improve visibility across the supply chain. Research by Simatupang and Sridharan (2021) demonstrates that enhanced visibility and real-time information sharing help in better demand forecasting and order fulfillment. This transparency aids in reducing lead times and optimizing inventory levels within business operations. Logistics integration also fosters effective coordination among various stakeholders in the supply chain. An article by Mollenkopf et al. (2022) suggests that coordination through integrated logistics enhances responsiveness to customer demands and helps in meeting tight production schedules, ultimately improving supply chain performance. Similarly, in hypothesis 2, risk management plays a role in applying Logistics integration. Logistics integration allows for better risk management and mitigation strategies. Li et al. (2020) found that integrated logistics systems enable faster response to disruptions and crises, which is crucial for maintaining supply chain continuity and performance, particularly in the automobile industry, where disruptions can have significant consequences on supply chain output. With superior risk management, Integrated logistics systems have been shown to reduce operational costs. A study by Zhang et al. (2019) highlights that by streamlining processes, reducing redundancy, and optimizing transportation routes, logistics integration can lead to cost savings, which directly positively impact supply chain performance.

In conclusion, many case studies have proven to support Hypothesis 3, indicating that Logistics Integration has a direct effect on Supply Chain Performance in the context of the global automobile industry. The seamless integration of logistics processes and systems is theorized to lead to enhanced coordination, visibility, risk mitigation, and cost-efficiency, ultimately improving supply chain performance (Raj et al., 2022).

H0: Logistics integration does not affect the Supply Chain Performance.

H3: Logistics integration has an effect on the Supply Chain Performance.

Fig. 1

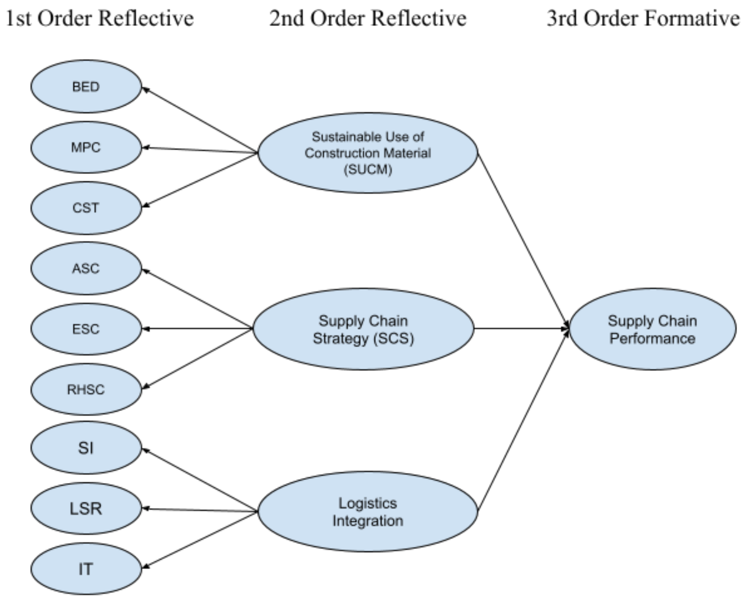


Fig 2.

Table 1

Measurement items of the constructs.

Constructs	*Sub-constructs*	*Definitions*	*Code*	*Measurement Items*	*Sources*
Sustainable Use of Construction Material (SUCM)	BMCC environmental design (BED)	The extent of source control and materials optimization through design, to set up environmental targets and find alternatives to non-renewable resources.	BED1 BED2	There are alternatives of non-renewable sources. There is early setting of environmental targets.	(Zeng et al., 2018)
	Material procurement and consumption (MPC)	The extent of process control and material using regulation, including accurate material quantity estimation, green procurement, and appropriate material use strategies.	MPC1 MPC1 MPC1 MPC1	There is accurate quantity estimation. There is adoption of sustainable/green material. There is green procurement of material. There are green material consumption strategies.	
	C&D waste sustainable treatment (CST)	The extent of re-using and recycling construction and demolition waste with corresponding regulations, standards, and technologies.	CST1 CST2 CST3 CST4	Recycling Technology. Re-use of site recycled BMCC. Approval of qualified recycled BMCC. Raw-material extraction from demolition.	
Logistics Integration (LI)	Supplier Involvement (SI)	Where the manufacturer involves the supplier at any given stage of the product development process.	SI1 SI2 SI3	The organisation has profited from closer involvement with its supplier. Long-term commitment from the supplier and appropriate technological preparedness. There is proactive initiative and involvement or "give and take" from both the supplier and the organization.	(Salam, Ali and Seny Kan, 2017)
	Length of Supplier Relationship (LSR)	Length of connection between the supplier and its supplier.	LSR1 LSR2 LSR3	There is trust between the supplier and the organization. There is a sense of strong collaborative relationship between the supplier and organization.	

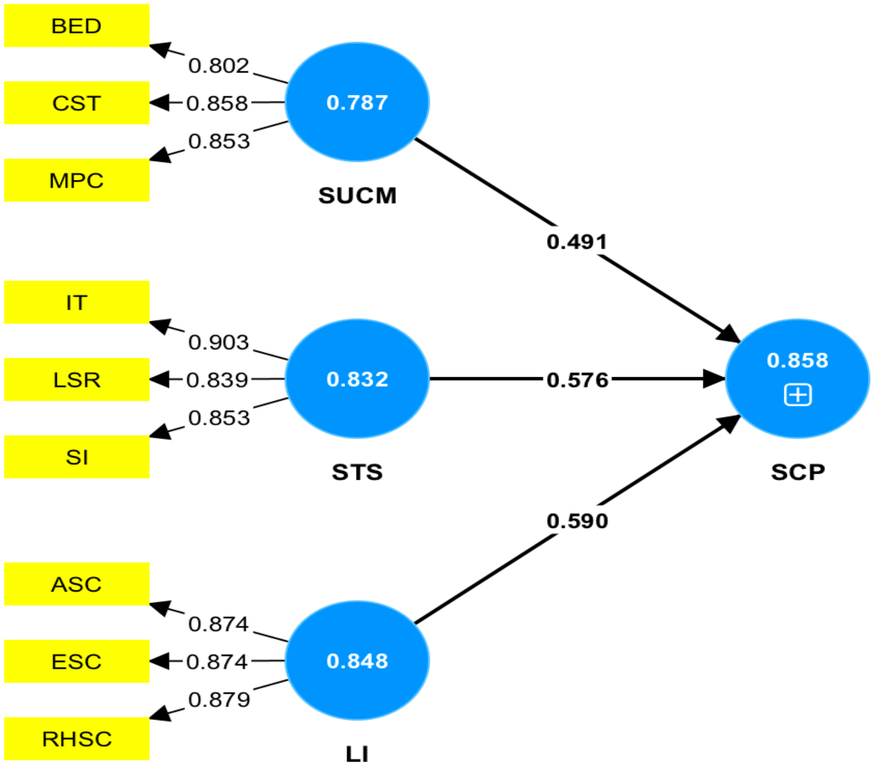
				There is a sense of opportunistic behaviour and intense collaboration between supplier and organization.	
	Information Technology (IT)	The use or study of systems for storing, retrieving, and sending information.	IT1 IT2 IT3	The organization shares information among its supply chain partners. Integration of IT has enhanced flexibility and responsiveness and has helped overall competitiveness. Incorrect or delayed information between supply chain partners has led to volatile orders and other related inefficiencies.	
Supply Chain Strategy (SCS)	Agile Supply Chain (ASC)	Responsive and flexible to customer needs.	ASC1 ASC2 ASC3 ASC4	Our supply chain always faces the volatile customer demand. Our supply chain needs to maintain a higher capacity buffer in response to the volatile market. Our supply chain provides then customer with personalized products. Our supply chain structure often changes to cope with a volatile market.	(Alam, 2022)
	Efficient Supply Chain (ESC)	Creating the highest cost efficiencies in the supply chain.	ESC1 ESC2 ESC3	Our supply chain supplies predictable products. Our supply chain reduces any waste as much as possible. Our supply chain reduces costs through mass production.	
	Risk-Hedging Supply Chain (RHSC)	Pooling and sharing resources in a supply chain so the risks of supply disruption can also be shared.	RHSC1 RHSC2 RHSC3	Our supply chain partners are ready to share resources whenever necessary. Our supply chain reduces costs through sharing capacities/resources. Our supply chain partners are always ready to support and cooperate.	

Methods and Analysis:

The following model will be assessed using PLS-SEM modeling to assess the strength of the latent variables against the dependent variable Supply Chain Performance. First, we will collect secondary data from various sources, including industry reports, government publications, and manager perception interviews. Variables will be collected from 20 companies from diverse countries, with country-specific and domestic data from the country where the business operates. Variables of interest will include the sustainable use of construction materials, supply chain strategy, and logistics integration of different companies. We will ensure data integrity by cleansing the data upon collection and getting rid of any invalid responses. Invalid responses can be any responses with missing data and invalid categorical variables. After the cleansing of the data, descriptive statistics will be employed to better understand our variables at hand. We will collect the averages, coefficient of variation, and VIF of each variable and exile outliers while assessing the validity of each variable. Cronbach's alpha (α) will be employed to assess the internal consistency of latent constructs. This study will use a threshold of 0.7 for established constructs with values of 0.6 accepted in our early-stage research (Taber 2017). Using the PLS-SEM checklist, the examination of outer loadings will evaluate indicator reliability. Indicators of our reflective measurement models should have outer loadings greater than or equal to 0.708, indicating that they are robust and should be retained as they contribute significantly to measuring the latent construct. For our formative model, we will be looking for a convergent validity score of more than or equal to .70 correlation. Convergent validity will be assessed by calculating each latent variable's Average Variance Extracted (AVE). AVE represents the variance captured by indicators relevant to the total variance in the latent variable. We will consider relationships to be significant If the p-value is less than 0.05 when tested with a 95% confidence interval. Loadings of ≥ 0.50 that are statistically significant are considered relevant. R squared values of 0.75, 0.50, and 0.25 are considered substantial, moderate, and weak. R squared values of 0.9 and higher are typically indicative of overfit, so we will not consider any values of this to be significant. The report will next assess discriminant validity. Discriminant validity ensures that each construct is not highly correlated with other constructs in the model. The report will use the Heterotrait-Monotrait (HTMT) Ratio to measure this. HTMT is calculated between pairs of latent constructs by comparing the average shared variance (ASV) between the constructs and the product of their AVEs. The predetermined threshold used for this analysis will be an HTMT ratio of 0.85. If the ratio is less than 0.85 for latent variables in the model, it suggests they are less correlated with each other relative to the variance explained by their indicators. This supports discriminant validity.

The results of the following tests are presented below in *Fig. 3*

Fig.3



Outer Loadings: All measurement items on the reflective models (Sustainable Use of Construction Material - SUCM, Supply Chain Strategy - STS, and Logistics Integration - LI) exhibit outer loadings exceeding 0.78. This suggests that these constructs are robust and significantly contribute to the measurement of the latent constructs. Please refer to Appendix A for outer loading findings.

Internal Consistency: The Cronbach's Alpha (α) values for the latent constructs are well above 0.7, with SUCM at 0.848, STS at 0.832, LI at 0.848, and Supply Chain Performance (SCP) at 0.858. These high alpha values indicate an acceptable level of reliability within the model. Please refer to Appendix B for the Cronbach's Alpha (α) values.

Convergent Validity: The Average Variance Extracted (AVE) scores for all latent variables are notably above 0.5, with SUCM at 0.702, STS at 0.749, LI at 0.767, and SCP at 0.778. These scores demonstrate strong convergent validity, affirming that the measurement items of all variables are valid in the research methodology and measurement procedures. Please refer to Appendix B for the AVE scores.

Discriminant Validity: The Heterotrait-Monotrait Ratio (HTMT) analysis reveals that all latent variables have HTMT ratios less than 0.85, signifying that they are not highly correlated with one another. This supports the discriminant validity of the model. Please refer to Appendix C for HTMT ratio scores.

Collinearity Assessment: The Variance Inflation Factor (VIF) for all variables falls between 1.462 and 2.382, all below the threshold of 5. This implies that there is no significant multicollinearity within the model. Please refer to Appendix D for VIF scores.

R-squared (R^2): The R-squared value for Supply Chain Performance (SCP) is calculated at 0.456, indicating that the model explains 45.6% of the variance in SCP. Based on the results and model assessments, the research has produced significant insights into the relationships between Sustainable Use of Construction Material (SUCM), Supply Chain Strategy (STS), Logistics Integration (LI), and Supply Chain Performance (SCP) in the automobile industry. These findings can be summarized as follows:

Discussions and implications:

In this section, we will discuss the theoretical contributions and practical implications of our research findings, shedding light on the significance of sustainable construction materials, supply chain strategies, and logistics integration in the automobile industry.

Theoretical Contributions:

Our research findings align with sustainability theories by highlighting how the adoption of sustainable construction materials positively influences supply chain performance. This alignment underscores the importance of considering long-term sustainability goals in business strategies. The use of eco-friendly materials, as supported by our research, demonstrates the value of eco-efficiency. This concept emphasizes the reduction of environmental impact while achieving economic success, reinforcing the idea that sustainability can lead to improved supply chain performance. Our findings reinforce the significance of meeting societal expectations regarding eco-friendliness and responsible resource management. As consumers increasingly demand environmentally friendly products, automobile manufacturers can leverage sustainable materials to meet these expectations and boost their supply chain performance.

Practical Implications:

All businesses in the automobile industry can benefit from incorporating sustainable construction materials into their supply chain manufacturing processes. Our research highlights that these materials can reduce production costs by lowering vehicle weight and improving fuel efficiency. This, in turn, can lead to higher profitability and cost savings for the business. As governments worldwide introduce stricter regulations to reduce emissions, companies proactively adopting sustainable materials can remain compliant, avoiding penalties and supply chain disruptions. Firms should prioritize sustainability to navigate the evolving regulatory landscape effectively. Sustainable materials can serve as a buffer against risks associated with volatile commodity prices. As these materials are often derived from renewable resources or have stable pricing structures, supply chain disruptions due to price fluctuations can be reduced. This risk mitigation contributes positively to supply chain performance. Additionally, recognizing that consumers are increasingly environmentally conscious, automobile manufacturers can leverage sustainable materials to meet this demand. This can lead to increased sales and improved supply chain performance as eco-friendliness becomes a selling point.

Our research emphasizes the critical role of supply chain strategies. Businesses should carefully align their strategies with cost efficiency, responsiveness, and sustainability goals to directly contribute to improved supply chain performance. Supplier relationships and risk management should also be key components of these strategies. The benefits of logistics integration can be seen as enhanced visibility, coordination, responsiveness, risk management, and cost efficiency. Businesses should prioritize the seamless integration of logistics processes and systems to achieve these advantages.

The automobile industry is in a state of constant evolution, with emerging technologies such as electric vehicles (EVs) and information technology (IT) playing pivotal roles. Future research should explore how these developments impact supply chain performance and sustainability in the industry. In addition, the sector must remain vigilant in adapting to changing environmental regulations and sustainability standards, as these factors will continue to influence the use of sustainable materials in automobile manufacturing. The importance of supply chain resilience cannot be overstated, particularly in the face of global disruptions like the COVID-19 pandemic.

Further research should dive into strategies to enhance supply chain resilience and ensure business continuity during unforeseen crises.

The following research provides valuable insights for automobile businesses and industry stakeholders. It underscores the need to embrace sustainability, align supply chain strategies with business goals, and seamlessly integrate logistics to improve supply chain performance. These insights should guide decision-makers in navigating the complex and ever-evolving landscape of the automobile industry.

Conclusion and Recommendations:

In light of the findings and the comprehensive analysis conducted, there are several directions for future research. We recommend automobile companies to consider the following:

- Companies should conduct longitudinal studies to examine how the relationships between sustainable practices, supply chain strategies, logistics integration, and supply chain performance evolve over time.
- Cross-industry comparisons should also be made to compare the findings in the automobile industry with other industries to assess the generalizability of these relationships and if they hold any significance.
- The exploration of advanced statistical and machine learning techniques in order to gain deeper insights and predict the supply chain performance more accurately.
- Examination of how changes in environmental regulations and sustainability standards influence the adoption of sustainable materials and their effects on supply chain manufacturing.
- Lastly, companies must prioritize Investigation of strategies for enhancing supply chain resilience, particularly in the face of global disruptions like the COVID-19 pandemic.

The research has demonstrated that the use of sustainable construction materials, well-aligned supply chain strategies, and effective logistics integration can significantly enhance supply chain performance in the automobile industry. This information is invaluable for automobile businesses and industry stakeholders seeking to make informed decisions and maintain competitiveness in an evolving and environmentally conscious industry landscape. The research also underscores the importance of rigorous methodological approaches and model assessments to ensure the validity and reliability of research findings. Researchers and practitioners should apply similar methodologies in their studies to achieve more accurate and dependable results in the field of supply chain management. Overall, this research provides a solid foundation for understanding and optimizing supply chain performance in the automobile industry, and it encourages further exploration and innovation in this dynamic and crucial sector for generations to come.

Appendicies:

A

	Outer loadings
ASC <- LI	0.874
BED <- SUCM	0.802
CST <- SUCM	0.858
DV_2_A <- SCP	0.878
DV_2_B <- SCP	0.869
DV_2_C <- SCP	0.900
ESC <- LI	0.874
IT <- STS	0.903
LSR <- STS	0.839
MPC <- SUCM	0.853
RHSC <- LI	0.879
SI <- STS	0.853

B

	Cronbach's alpha	Average variance extracted (AVE)
LI	0.848	0.767
SCP	0.858	0.779
STS	0.832	0.749
SUCM	0.787	0.702

C

	Heterotrait-monotrait ratio (HTMT)
SCP <-> LI	0.689
STS <-> LI	0.697
STS <-> SCP	0.679
SUCM <-> LI	0.535
SUCM <-> SCP	0.595
SUCM <-> STS	0.669

D

	VIF
ASC	2.025
BED	1.462
CST	1.808
DV_2_A	2.060
DV_2_B	2.105
DV_2_C	2.382
ESC	2.124
IT	2.245
LSR	1.829
MPC	1.866
RHSC	2.026
SI	1.867

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