

# ANALYZING THE DETERMINANTS OF SUSTAINABILITY AND FIRM PERFORMANCE IN AUTOMOTIVE SUPPLY CHAINS: A DELPHI APPROACH

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## ABSTRACT

*Managing sustainability implementation in automotive environment and firm performance (FP) has always been an area of Interest for professionals & researchers. Accomplishing Sustainability Implementation in automotive context is very difficult and seeks to consider attention of suppliers, top management, dealers, government, regulators, and stakeholders. It is prudent that the Sustainability Implementation & FP is regularly assessed, supervised, and improved for gaining competitiveness & status for creating a point of differentiation. This paper tries to identify such Sustainability Implementation & FP criteria for Indian automotive industry. This study implemented Delphi approach through interview with 32 subject specialists. In this a list of 35 environmental, 48 social, 33 economical sub-measures and 45 performance sub-measures identified from the literature was given to these experts from which initial measures and their sub-measures were to be identified and grouped for automotive sector. These Sustainability Implementation factors can additionally be utilized to design a model to apply Sustainability practices in auto industry. This study employs the Delphi approach to analyze and examine Sustainability Implementation ideas and Firm Performance factors for Indian automotive sector.*

**Keywords:** Sustainability Implementation; Automotive Environment; Delphi Method; Firm Performance Measurement.

## INTRODUCTION

India is the fourth largest auto market in 2019 superseding Germany, with about 3.99 million units sold in the commercial and passenger vehicles segment. It is expected that India would surpass Japan as the third biggest auto market by 2021. FDI inflow in auto industry remained at US dollar 24.21 billion between April 2000-March 2020. Indian automobile sector (including parts / subsystem manufacturing organisation) is expected to reach at Rs 16.16-18.18 trillion (US\$ 251.4–282.8 billion) by 2026. India could be a leader in shared mobility by 2030, providing the opportunities for electric vehicles. Focus is shifting to electric vehicles to reduce emissions (Indian Brand Equity Foundation [online], 2020). The automotive industry has been under considerable pressure from governments and society to pursue a more sustainable model of growth. Transportation accounted for a quarter of the world's global CO<sub>2</sub> emissions, with road transportation alone accounting for 18%. The manufacturing of vehicles takes significant water, energy and other resources, thereby multiplying the carbon footprint. However, because of growing sales of SUVs after 2015, carbon emissions started to rise.

Rising environmental concerns have meant increased pressure from a variety of stakeholder groups like public – interest groups, investors, regulators, etc. (Capgemini, 2019). Sustainability is considered “*an important conceptual framework*” for aligning economic, environmental and social dimensions (Dempsey et al., 2009) and these three “*pillars*” (TBL) are pervasive within sustainability literature ((Vachon & Mao, 2008); (Hutchins, & Sutherland, 2008).

1. To figure out sustainability implementation and firm performance in the Indian automotive environment.
2. To ascertain sustainability implementation criteria and firm performance measurement for automotive sector using the Delphi approach

## **LITERATURE REVIEW**

### **Sustainability Implementation in Automotive Sector**

Sustainability practices differ according to business processes complexities, organization structure, company size, level of business maturity, strategic planning, and stakeholder interests (mostly of the shareholders). “*Firms that execute and implement sustainability, control their inclusion by delivering sustainability reports. Sustainability reports have increasingly expanded, with the most recognized report being the Global Reporting Initiative (GRI), utilized and acknowledged across the globe. There are no legal commitments in sustainability, so every firm utilizes its own reporting model*” (Lucian-Ionel Cioca et al., 2019).

The brainstorming session with 32 subject experts were selected based on their expertise and having more than 15 years of experience in SCM, Marketing, EHS and academics, care was taken to invite only the concerned professionals to support us in identifying the elements and their sub-elements that will probably be vital for the sustainability and performance measurement for automotive environment in India. A list of 35 environmental, 48 social, 33 economical sub-measures and 45 performance sub-measures identified from the literature was given to these experts from which initial measures and their sub – measures were to be identified and grouped for automotive sector.

The process and practices in the automotive sector are very complex and highly technology oriented. All over the automotive sector, cost reduction activities and methods are emphasized. The automotive sector is an intricate system of indirect and direct products to create economic benefit. Automotive sector has a significant impact on the environment, social and economic elements of sustainable development. “*Automobile system and subsystem manufacturing organisations are assessed by regulatory authorities to ensure they meet environmental standards and reduce the impact on both products and their manufacturing processes. This situation drives them to introduce innovative business strategies to achieve environmental and economic performance goals. Implementing sustainable development helps them reduce their organizational impact on the planet, profit, and people*” (Lucian-Ionel Cioca et al., 2019).

### **Need and Rationale for Delphi**

The sustainability deployment criteria are different according to the country and circumstances. Various authors have suggested that the model is customized accordingly. Delphi has been utilized by a few authors to explain the randomness.

“The Delphi approach permits us to get quantitative estimates from qualitative variables, building up the level of understanding among the experts on standard and established procedures” (Soria-García & Martínez-Lorente, 2014).

“Academicicians have utilized Delphi approach in various domains, for example, education (Vakani & Sheerani 2012); (Sitlington & Coetzer, 2015) and healthcare (Mullen, 2003) services (Birdir and Pearson, 2000). Results from the Delphi technique are useful, since the opinions are from subject matter experts” (Ali, 2005). However, this methodology has not been used to study sustainability and firm performance in Indian context for the automobile industry. Thus, this study within the automobile industry is worthwhile.

### Initial Identification of Sustainability and Firm Performance Measures

After the literature review, brainstorming session with the experts was carried out to identify the sustainability practices measures and sub-measures and performance measures for automotive environment. With emphasis on the various sustainability models and firm performance measures, conducted a brainstorming session with 32 subject experts (experts are selected based on their experience and having more than 15 years of experience in sourcing, care was taken to invite only the sourcing experts) to help us to identify the measures and their sub-measures that might be important for the sustainability and performance measurement for automotive environment in India. In this a list of 35 environmental, 48 social, 33 economical sub-measures and 45 performance sub-measures identified from the literature was given to these experts from which initial measures and their sub-measures were to be identified and grouped for automotive sector. In this session, each measure and sub-measure was checked and rechecked for similar meaning and repetition which resulted in a basic Sustainability practices framework consisting of 3 measures and 35 environmental, 48 social, 33 economical sub-measures (Table 1), and 45 firm performance sub-measures (Table 2).

<b>Environmental Practices</b>	<b>Social Practices</b>	<b>Economical Practices</b>
Materials	Commitment to safety	Economic Performance
Energy	Community	Market Presence
Water and Effluents	Diversity	Indirect Economic Impacts
Biodiversity	Employee	Procurement Practices
Emissions	Human rights	Trade-offs and Spin-off
Waste	Employment	Anti-competitive Behavior
Environmental Compliance	Safety	Tax
Supplier Environmental Assessment	Work conditions	Investment
Environmental accidents	Support for community projects	Fine for environmental accidents

Hazardous/harmful/toxic materials	Health and safety policy and procedures	Fee for waste treatment and discharge
Environmental collaboration with suppliers	Workmanship insurance	Competitive advantage
Product environmental impact	Labor rights	Risk reduction
ISO 14001 certification	Qualified employment	Operating efficiency
Environmentally friendly packaging	Resource investment in social programs	Sales/Investment recovery
Climate change	Education Infrastructure	Operational and maintenance costs
Ozone depleting chemicals	Occupational Health and Safety	Market-based performance
Reuse	Social new product and process development	Operational-based Performance
Recycling	Social supply chain redefinition	Accounting-based Performance
Green product	Workers' health	Cost, differentiation, and niche
Environmental audit	Safety Systems and Compliance	Plant performance (manufacturing costs, work-in process inventory)
Cleaner technologies	Social Audits	Anti-corruption
Life-cycle analysis	Social stakeholder development practice	Firm competitiveness
Greenhouse gas emission	Supplier social performance	Cost of equity and debt capital
Environmental logistics practices	Social welfare	Shareholder wealth
Environmental proactivity	Socially responsible investments	Stock market
Land use reduction	Philanthropy	Firm value
Pollution prevention	Motor carrier safety	Financial performance
Green purchasing	Labor/Management Relations	Transaction cost attributes
Chemical consumption	Fair treatment of customers	Lean performance
Environmental management systems	Harmonious relationship between company and employees	Strategic collaboration and Information sharing
Green logistics	Accident rate	Number of new patents
Green supply chain management	Working environment stress	Brand value
Alternative energy	Training and Education	
Depletion of natural resources	Diversity and Equal Opportunity	
Fuel consumption	Non-discrimination	

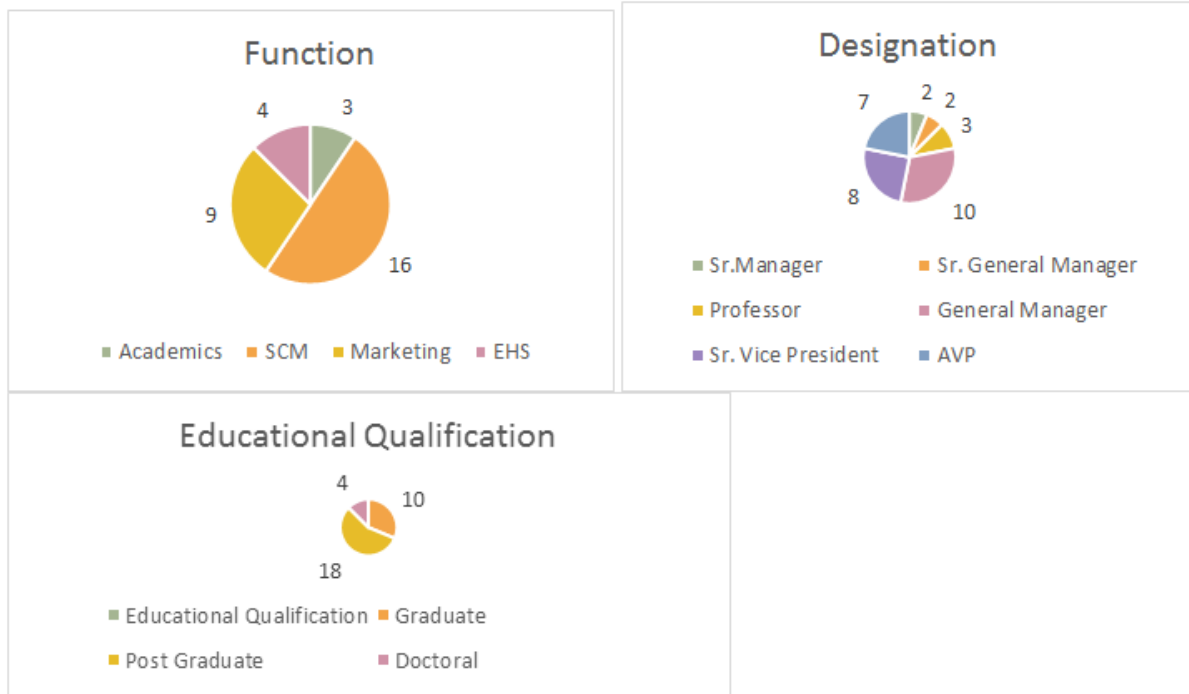
	Freedom of Association and Collective Bargaining	
	Child Labor	
	Forced or Compulsory Labor	
	Security Practices	
	Rights of Indigenous Peoples	
	Human Rights Assessment	
	Local Communities	
	Supplier Social Assessment	
	Public Policy	
	Customer Health and Safety	
	Marketing and Labeling	
	Customer Privacy	
	Socioeconomic Compliance	

<b>Table 2</b>
<b>INITIAL FIRM PERFORMANCE MEASURES FOR AUTOMOTIVE ENVIRONMENT</b>
Firm Performance Variables
Continuous Improvement
Marketing Planning
Branding
Advertising
Promotions
Channel marketing
Customer relationship management systems
Overall competitive position
Overall customer service levels
internal operational performance
customer satisfaction
customers enhancement
customer loyalty
new customers
products and services

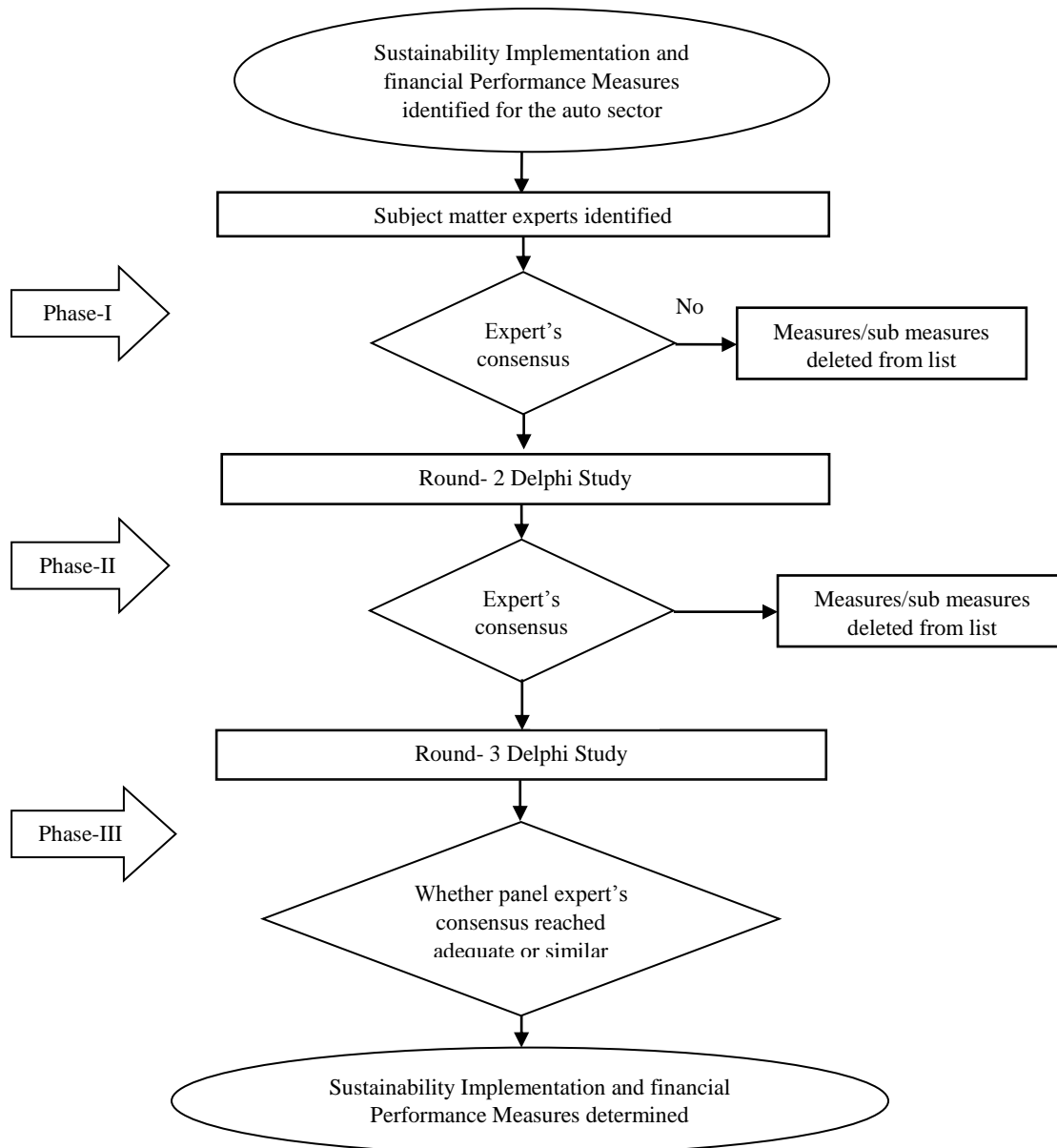
Overall product quality
Recruitment
Training and retention
Appraisals
Incentives
Performance based reward
Corporate culture and external factors
Marketing
Operational
New product development
New market development
Level of Innovation
Labour productivity
product differentiation and technological transfer
Advanced manufacturing technologies
Information readiness
Brand awareness
Intra-regional geographic diversification
Research and development capability
Supply chain process integration
Supply Chain Capabilities
Operational Performance
Market Performance
Goods delivered on time
Inventory levels
Scrap rate
Capacity utilization
Employment opportunities
Human Resource performance
Production flexibility

## METHODOLOGY

The Delphi is a quantitative approach based on a judgment from the subject matter experts. It is a methodical and iterative method for seeking viewpoints and common thoughts of the experts (Landeta, 1999). An idea-generation session was undertaken with 32 experts and their credentials are as portrayed in Figure 1. These experts were asked to categorise the elements into various groups of elements and sub-elements. Subsequently, 3 rounds of Delphi were executed to reach to a unanimous decision for the Indian automobile sector. The process flow of Delphi approach is portrayed in Figure 2.



**FIGURE 1**  
**DEMOGRAPHIC DISTRIBUTION OF EXPERTS- FUNCTION, DESIGNATION,**  
**EDUCATIONAL QUALIFICATION**



**FIGURE 2**  
**APPLICATION OF DELPHI APPROACH IN PRESENT STUDY**

In the current study, a group of 32 members was formed which included senior professionals (SCM, Marketing and EHS) from the industry and academicians. Sample size (no. of experts) varied from one survey session to the next due to absence of experts in subsequent rounds.

### Round 1 Delphi study

For the first round of the study, a survey instrument consisting of 3 sustainability practice measures, with 35 environmental, 48 social, 33 economical sub- measures and 45 firm performances sub- measures were developed. A total of 161 sub-measures were identified across



the 4 measures. In this round, each expert received a statement of the problem and a questionnaire with which his or her independent views regarding the problem were elicited.

### Round 1 Result

Varied responses were obtained from the experts, in which 57 of the 161 sub-measures were excluded and merged by more than 50% of the experts and many gave their valuable comments/suggestions for 4 measures and 161 sub-measures for sustainability practices and firm performances. A summary of the comments given by more than 50% experts about the measures is given below.

1. Most of the experts were of the view that the sub-measures should be specific to automotive environment and not generic.
2. Sub-measures should be given specific names and similar sub - measures should be combined together.
3. Some of the sub-measures having no relevance to automotive environment may be eliminated.
4. The most notable and repeated suggestion was that 'automotive environment' should be sub-characterized in greater depth, beyond the other measures currently present.
5. Some sub-measures need not be included as independent sub-measures under a particular measure as similar sub – measure is already existing elsewhere under some other measure.
6. Sub-measures may be moved /shuffled under appropriate measure.
7. Some sub-measures could be further broken into more sub-measures to convey specific meaning.

Wherever, more than 50% experts agreed on elimination of any particular measure / sub-measure, the same were eliminated. In the cases where, there were suggestions on renaming, shifting, more elaboration on measures / sub-measures, the list was again prepared with the suggestions from the experts.

Based on the Round 1 survey data we added, removed and renamed measures and sub-measures and reorganized the sustainability practices into 3 measures and 73 sub-measures (Table 3) and 31 sub-measures for firm Performance (Table 4).

<b>Table 3 AFTER ROUND 1 – SUSTAINABILITY PRACTICES FOR AUTOMOTIVE ENVIRONMENT</b>		
<b>Environmental Practices</b>	<b>Social Practices</b>	<b>Economical Practices</b>
Materials	Commitment to safety	Economic Performance
Energy	Employment	Market Presence
Water and Effluents	Workmanship insurance	Indirect Economic Impacts
Biodiversity	Occupational Health and Safety	Procurement Practices
Emissions	Safety Systems and Compliance	Trade-offs and Spin-off
Waste	Social Audits	Anti-competitive Behavior
Environmental Compliance	Social stakeholder development practice	Tax
Supplier Environmental Assessment	Supplier social performance	Operational and maintenance costs

Environmental collaboration with suppliers	Social welfare	Cost, differentiation and niche
Product environmental impact	Philanthropy	Plant performance (manufacturing costs, work-in process inventory)
Green product	Motor carrier safety	Anti-corruption
Environmental audit	Labor/Management Relations	Firm competitiveness
Cleaner technologies	Fair treatment of customers	Cost of equity and debt capital
Life-cycle analysis	Training and Education	Shareholder wealth
Greenhouse gas emission	Diversity and Equal Opportunity	Stock market
Pollution prevention	Non-discrimination	Firm value
Green purchasing	Freedom of Association and Collective Bargaining	Financial performance
Green logistics	Child Labor	Transaction cost attributes
Green supply chain management	Forced or Compulsory Labor	Lean performance
Alternative energy	Security Practices	Strategic collaboration and Information sharing
Depletion of natural resources	Rights of Indigenous Peoples	Number of new patents
	Human Rights Assessment	Brand value
	Local Communities	
	Supplier Social Assessment	
	Public Policy	
	Customer Health and Safety	
	Marketing and Labeling	
	Customer Privacy	
	Socioeconomic Compliance	

<b>Table 4</b>
<b>AFTER ROUND 1 – FIRM PERFORMANCE MEASURES FOR AUTOMOTIVE ENVIRONMENT</b>
<b>Firm Performance Variables</b>
customer satisfaction

customers enhancement
customer loyalty
new customers
products and services
Overall product quality
Recruitment
Corporate culture and external factors
Marketing
Operational
New product development
New market development
Level of Innovation
Labour productivity
product differentiation and technological transfer
Advanced manufacturing technologies
Information readiness
Brand awareness
Intra-regional geographic diversification
Research and development capability
Supply chain process integration
Supply chain performance
Operational Performance
Market Performance
Goods delivered on time
Inventory levels
Scrap rate
Capacity utilization
Employment opportunities
Human Resource performance
Production flexibility

## Round 2 – Delphi study

Some of the Delphi panel members who were selected to participate in the study did not respond in the Round 2, and hence the Delphi panel was reduced from 26 members to 22 members for second round.

For the second round of the study, experts were asked to rate importance of particular sustainability practices and firm Performance measure using a 7- point Likert scale (Appendix I (c) and I (d)). The following scale of importance was assigned to the responses provided on the questionnaire: 7 = Extremely important, 6 = Very important, 5 = Important, 4 = Moderately important 3 = Somewhat important 2 = Slightly important 1 = Not important

## Round 2 Results

A total of 22 completed surveys in Round 2 were received. Of the 4 measures and 104 sub-measures, 59 sub-measures received < 3.5 mean score (MS) so they were removed from the Sustainability practices and firm performance framework.

To obtain convergence of opinion, the mean of the standard deviation was calculated. A decrease in the mean standard deviation value indicated a greater convergence of opinion among the experts. A list of measures / sub-measures for sustainability practices and firm performance measures for automotive environment based on mean and standard deviation scores is given in (Table 5) and (Table 6) respectively. Measures which have higher mean score, lower standard deviation were considered to be important measures as there was relative agreement among experts on their importance. Measures which had higher mean score, higher standard deviation were also considered to be important measures but there was less relative agreement among experts on their importance (Shah et al., 2011).

<b>Environmental Practices</b>	<b>Mean</b>	<b>SD</b>	<b>Social Practices</b>	<b>Mean</b>	<b>SD</b>	<b>Economical Practices</b>	<b>Mean</b>	<b>SD</b>
Materials	5.29	0.967	organizational Work Culture and environment	6.71	0.381	Financial & Marketing practices	5.16	1.256
Green Operational Practices	6.13	0.654	Community and diversity	5.42	0.882	Indirect Economic Impacts	5.73	0.554
Water and Effluents	6.12	0.536	Training and Education	5	1.426	Operational efficiency	4.67	1.803
Biodiversity	6.39	0.582	Occupational Health and Safety	6.53	0.422	Collaboration & Information sharing	4.1	2.018
Green supply chain practices	6.09	0.607	Diversity and Equal Opportunity	5.03	1.112	Anti-competitive Behavior	3.64	2.585
Waste	4.23	1.982	Social stakeholder development practices	5.87	0.748	Tax	5.57	0.855

Environmental compliance	6.15	0.421	Freedom of Association and Collective Bargaining	5.23	0.922
Supplier Environmental Assessment	4.02	2.148	Child Labor	4.86	1.634
			Rights of Indigenous Peoples	5.85	0.757
			Human Rights Assessment	6.18	0.502
			Local Communities	5.37	0.512
			Supplier Social Assessment	6.08	0.76
			Public Policy	4.32	0.778
			Customer Health and Safety	4.29	1.868
			Marketing and Labeling	5.02	2.258
			Customer Privacy	4.03	2.389
			Socioeconomic Compliance	4.13	2.029

<b>Table 6</b>		
<b>MEAN AND STANDARD DEVIATION SCORES FOR FIRM PERFORMANCE MEASURES</b>		
<b>Firm Performance Variables</b>	<b>Mean</b>	<b>SD</b>
new customers	5.19	1.222
Overall product quality	4.32	0.558
Corporate culture and external factors	4.12	0.632

New product development	6.37	2.525
New market development	5.02	1.325
Advanced manufacturing technologies	5.08	1.255
Research and development capability	5.18	1.305
Operational Performance	4.18	1.259
Market Performance	4.02	0.548
Supply chain performance	4.01	0.506
Human Resource performance	5.72	0.933

**Round 3 Delphi study**

The third-round questionnaire was very similar to that of the first round. For this round, framework “after Round 2 - sustainability practices and firm performance and sub-measures for automotive environment” was given to the experts who were asked to rate them as “Yes” (the sustainability practices and firm performance measures must be included for automotive environment) or “No” (the sustainability practices and firm performance measures need not be included for automotive environment). Measures were selected when at least 80% of the experts agreed that they must be a part for automotive environment.

**Round 3 Results**

A total of 21 survey responses were received from experts in round 3. No measures and sub-measures received less than 80% of the expert’s opinion to be sustainability practices and firm Performance measures for automotive environment. Analysis of results from the third round should be the “consensus” opinion of all panel members. If the consensus reached was not adequate or similar, then there will be a possibility of fourth round.

After three rounds of Delphi study and analysis, 3 measures and 10 sub-measures were finalized as the Sustainability practices for automotive environment (Table 7) Similarly, after three rounds of Delphi study and analysis, 4 sub-measures were finalized as the firm Performance measures for automotive environment (Table 8).

<b>Table 7 FINAL SUSTAINABILITY PRACTICES FOR AUTOMOTIVE ENVIRONMENT</b>		
<b>Environmental Practices</b>	<b>Social Practices</b>	<b>Economical Practices</b>
Green Operational Practices	Occupational Health & Safety	Financial & Marketing practices
Green supply chain practices	Social Stakeholder development practices	Operational efficiency
Environmental compliance	organizational Work Culture and environment	Collaboration & Information sharing
	Community and diversity	

<b>Table 8 FINAL FIRM PERFORMANCE MEASURES FOR AUTOMOTIVE ENVIRONMENT</b>
<b>Firm Performance Variables</b>
Operational Performance

Market Performance
Human Resource performance
Supply chain performance

## Implications

This study helps the available literature in this field by expanding the knowledge of sustainability implementation automotive sector of India and enhancing the field of supply chain management incrementally from operational and firm performance. This encourages researchers to further work on sustainability implementation in the field of automotive Industry. This study can have a beneficial impact on the automotive industry and academicians in the below manner:

1. Suggested sustainability implementation elements and firm performance elements will be meaningful in developing the sustainability implementation in automotive industry.
1. 2 Deploying the suggested sustainability implementation elements and firm performance elements will lead to enhance the efficiency, productivity and meeting the expectations of stakeholders, additional analysis may be carried out in this context.
2. 3 Automotive industries can develop the cause-and-effect relationship of indicators to analyse the root cause. Will be able to analyse the cause and effect between variation and its indicator to ascertain the root cause.
3. 4 Emphasis on sustainability practices deployment and firm performance will lead to an increased competition. A healthy competition in the automotive market will result in improved service levels.

## CONCLUSION

The paper tried to evolve an inclusive list of 3 sustainability implementation elements (10 Sub elements) and 4 Performance elements for automobile sector in India. Subsequently all sustainability implementation elements have been further bifurcated into multiple sub-elements. The Delphi approach was effectively implemented in this analysis to establish sustainability implementation elements and firm performance elements for automotive sector in India. The useful inputs received from the group of experts assisted in formulating the framework. Organisations can use this outcome as a reference in crafting the strategy and sustainability mission.

This framework may be of some help to researchers and professional in other industry beyond automotive.

The paper is an investigation to determine sustainability implementation elements and firm performance elements for automobile sector in India. The present study is limited to the Indian context, however, when conducted in other parts of the world, it would prove to be a great avenue for a more holistic comparison and strengthening of the current model.

This study presented a holistic approach in supply chain for sustainability implementation with Indian automotive sector which is currently more leaning towards operational & financial efficiency.

To prioritize the action hierarchy and allocating the resources accordingly the importance of criteria will be a bearing in decision making.

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