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Study on Sustainable Supply Chains' Business Impact: A Framework and Model Proposition

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Abstract

This paper is an attempt to study the best practices in the supply chain and operations arena of firms across sectors, and propose a framework and a model to arrive at profitable options and alternatives towards achieving sustainability. A test of a small-scale manufacturing apparel unit is taken to check the model; it is found that sub-functions of each supply chain component by itself can be used to reduce costs and achieve sustainability. Vendor sourcing, logistics, and manufacturer's make-or-buy decision (buy) is used to emphasise the model's sub-functions utility. Some sub-functions are not applicable for the case in question; however, the same is aimed towards manufacturing automobile firms to deploy in future researches.

Keywords: Sustainable Supply Chain, Case, Framework, Model, Manufacturing

Introduction and Literature Review

The cost of not acting on climate change across the globe amounts to USD15,438,848,703,515, and is still increasing every second United Nations (2019). Climate change has drawn immense attention from world leaders, academicians, and the corporate alike in the recent past, with the United Nations setting ambitious sustainable development goals, as well as world leaders introducing and amending national and international policies to accommodate the same. However, major execution responsibilities and systemic change are under the purview of corporations and business houses; given the increasing rate of the population and the proportion of increase in employability and purchasing power Indian Census (2018), the majority of the onus lies on the business fraternity and domestic households. It is pertinent to note that while the population of the world is only set to increase, it is also directly related to the increase in the consumption of goods and services, and therefore, the consumption of energy. The United Nations Sustainable Development Goals (Grosse-Ophoff, Hausler & Heineke, 2017) aim at collective action towards sustainable consumption and production, with its Goal No. 13 (Grosse-Ophoff, Hausler & Heineke, 2017) that places a key emphasis on the supply chains inclusive of everyone, starting from the producer to the consumer. Citing the example of India, a growing developing economy with a population of approximately 130 crore in 2019 as per Indian Census (2018), energy consumption is set to increase. Within the subset of industries, petroleum, paper and pulp, and fertilisers and MSMEs are leading consumers. The Micro Small and Medium Enterprises (MSME) are crucial to the manufacturing industry in India and contribute approximately 8% to its GDP. Given this contribution to the economy, manufacturing firms function in a competitive environment; achieving and maintaining profitability as well as quality is paramount. With regulations and policies towards sustainable and environmentally conscious products, customers would not prefer to shell out a premium for sustainability, as per Munzel and Boon (2017). IGEL, Wharton (2012) and even business firms consider this an additional task not yet under the mainstream purview of business tasks and primarily under Corporate Social Responsibility (CSR) initiatives. This is heavily discussed in (Nair, 2017); how green-marketing can aid in cost savings is elaborated. It goes further to emphasise that if product processes are green altogether, then the marketing would automatically communicate the brand's positioning, which would attract the concerned environmentally conscious customers. Given the premise that cost reduction and optimisation of resources is imperative for manufacturing firms' profit margins and the sustenance of the business in the long run, it is also a well-known fact that businesses run for profit, and even though the legislations require sustenance, firms have taken steps to tackle low hanging fruits. Thus, the key excerpts from the reviewed literature are further discussed and a sample of the literature reviewed is tabulated under the discussions as well.

Munzel and Boon (2017) IGEL, Wharton (2012) quotes General Electric's (GE) project manager, who said that businesses need not consider sustainability as a separate entity from measures for the bottom-line as a different business scenario – both can be achieved cohesively. This is further tested and reported in the paper that studies Green Supply Chain Management in India (Mishra, Choudhary & Rao, 2019). While it is noted that the study is limited to the Small and Medium Enterprises (SMEs) in India within the manufacturing industry and in South India, it draws findings that can be tested across other regions as well as in other firms, not only in India but globally. The hypotheses accepted established a correlation between the cost benefits of following a GSCM in the purchasing eco-design of products. It is worth noting that the paper fails to touch on the storage, distribution, packing, and reverse logistics aspects of the supply chain design network.

Therefore, manufacturing firms would have to focus on reducing production costs as well as operating costs while ensuring sustainable standards and practices.

Taking a cue from the paper United Nations (2019), while traditionally it is found that supply chains follow an upstream and downstream flow of operations, an interaction across all sub-functions for flow of information and material is paramount. Thus, a framework was devised, keeping in mind cross sub-functional flows, as well as keeping in mind that some supply chains do not require each sub-function. It is pointed out that for firms to have sustainable supply chains the manufacturing industry will need to transition towards sustenance. It is inferred that the core of manufacturing firms lies in its supply chain network and design. From the source to inbound transportation, the make stage, storage, packing, distribution, last mile delivery, to the reverse logistics, the streamlined flow of the product across the chain determines the robustness of the chain as well as the costs saved or additional costs rendered.

Another paper worth highlighting is the publication report by Masoumi and Kazemi (2019) that touches on the requisite literature present in journals. It not only deals with various aspects of a supply chain with reference to its sub-functions, but also highlights terminologies such as green supply chain management, sustainable supply chain management, environmental management systems, reverse logistics, and so on. The research highlights a comprehensive review of the sustainable supply chains in the automobile industry, while it has enlisted the categories and spelt the areas where maximum research is undertaken (processes and outputs); the least are in the areas of legislations and standards, as well as in the inputs. Post-use processes are further found to be the maximum published and studied. It also captures the entire supply chain, and while some papers cover all aspects of the value chain, many cover various categories (including inputs, legislations, processes, resources, and outputs).

This led to the development of a framework for an End of Line (EOL), as well as a 5-stage procedure to design a sustainable supply chain automotive model.

Absorbing and inferring the reviewed literature, the next logical step led to the devising of a framework that captures facets of a supply chain. It is representative and it is to be noted that the framework can be altered depending on the varying design networks in a supply chain, from industry to location.

The next section describes the framework and its basic aspects. These aspects are categorised under the heads of 'stakeholders' and that of its related 'process'.

The 'stakeholders' are the related owners (people) involved, while the 'processes' are the actions undertaken under each head. These actions are not leading tasks undertaken and are not limited to the process allocated under the head.

Framework

This framework takes a holistic approach at what sub-functions constitute a supply chain. While flows are observed linearly, forwards as well as backwards, the dotted line flows are an attempt to highlight an elimination of an entire sub-function in some supply chains, or even during attaining timeliness to ensure deliveries are met.

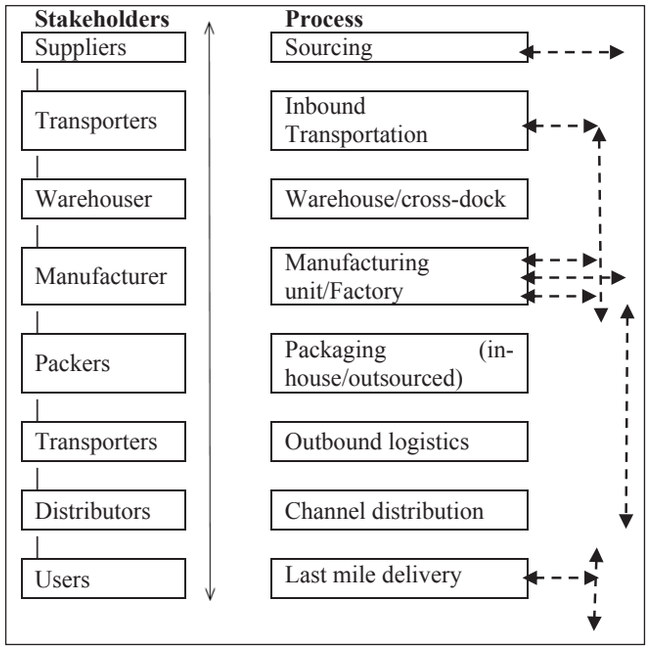

Fig. 1

Post the development of the model, each sub-function was tabulated to arrive at the best practices within the sustainable space taken up by firms across industries. However, as per Munzel and Boon (2017) corporates are yet to consider sustainability activities as CSR initiatives and would yield its results if taken seriously under the business purview. Vaz, Shoeninger Rauen and Rojas Lezana (2017) emphasises the impact of supply chain successes leading to business success. Thus, this finding ensures a link to these steps undertaken and best practices to a respective cost lever. The table extends the findings in (Mukhtar & Romli, 2019) to the nature of the business impact mentioned. Similar steps can be taken for firms to achieve business profitability while making changes in their supply chains, keeping in mind sustainability.

Table 1

Company Name	Industry Category	Process Stage	Sustainable Measure	Impact on Profitability
GE	Electricals	Sourcing	LCA of products and vendors to arrive at those vendors yielding the maximum environmental impact Collaboration with vendors to arrive at guidelines	
Xerox	Printing	Business Model	Servicising – it does not sell but rather outsources its products to its clients while maintaining it	Re-manufacturing; re-use of valuable parts manufactured and/or re-manufacture parts that are valuable to the user and far less to produce
Interface	Carpets, Textile	Sourcing	RFP stage used to vet vendors as well as vendors expected to innovate and add value A vendor invented a process to re-use nylon in its products and/or in products of another industry	
Walmart	Hypermarket		Vendor continuance on the basis of a dictum; 50% continue business, rest do not. Handouts on how to continue business as per environmental norms shared in a meeting, where 20% of vendors were invited, contributing to 80% of the business; energy efficiency companies were invited to consult when vendors needed aid	

While measures such as supplier enhancements, rationalisation, material changes, and load re-consolidations in transit and storage, as well as re-use of energy transmissions, have yielded positive but limited results, high hanging fruits are yet to be achieved. Firm's transportation costs are approx. 4%; however, the potential is manifold.

Jasinski, Meredith and Kirwan (2016). categorises environmental practices of gas emissions to 37%, eco-innovation in 27% of the cases, life-cycle assessment in 18% cases, cleaner production in 9%, and reverse logistics in 9%. While gas emissions fall under regulatory purview and eco-innovation was focused primarily on product design changes, eco-innovation in a process is little explored. Processes that ensure sustainable practices as well as metrics measuring the result of the process are areas that are less researched and developed for firms' direct usage.

Munzel and Boon (2017), the report highlights best practices across industries and highlights the lack of data linking it to profitability as a major hindrance towards reaping benefits. Thus, this author would like to propose developing a database and a real-time user interface that is a ready reckoner for business, supply chain, and operations decision makers to know the best practices that would lead to cost benefits, keeping the environment in mind.

Research Questions and Aims

To develop a database that maps best practices under each sub-function of the supply chain that are sustainable, as well as categorise them on the basis of the timeframe and cost benefits.

The key questions to address would be as follows:

- What are the sustainable supply chain best practices?
- How would successful sustainable alternatives in a particular function, industry, or region yield the same desired result elsewhere? Would a test/metric

be required to arrive at a predictive result to classify as a viable sustainable option?

- What are the leading supply chain constraints across each sub-function? (mapped as per cost)
- How would the sustainable practices be categorised? (mapped according to time for execution, cost saved, and breakeven time)
- What metrics/KPIs would be required to test the sustenance of the best practices, post implementation?
- What model scenario would yield an ideal state of a sustainable supply chain?
- How would the practices be introduced in the design of the business process and strategy?

While this paper caters to the research questions 1 and 4, the rest are nominally dealt with in literature review. The remaining questions and scope are left for further research purposes. In particular, the paper progresses by exploring question 6 by means of developing a database-cum-GUI that throws upon the user various sustainable alternatives.

Research Methodology

Secondary Research: Literature review of papers, articles, industry reports, and government reports.

Primary Research

- Insights of experts in the industry.
- Case of a small-scale manufacturing firm to test the model.

Limitations: The scope of this model is limited to sustaining a supply chain; a small-scale apparel manufacturing firm has been considered for the study. The same can be extended to other firms of larger scales and the optimum equation can be arrived at.

Data Analysis

The case of a small-scale, growth-stage apparel manufacturing start-up was taken to map, study, and test the supply chain network's sustainability.

On conducting an initial analysis of a year-long trend of its collections, it was found that the average rate of costs incurred were under the following heads:

Table 2

Particulars	Costs (in INR lakhs)	Contribution
Raw materials	₹620.96	67%
Production	₹165.12	18%
Packaging	₹60.20	6%
Logistics	₹36.96	4%
Sampling and grading	₹23.87	3%
Photography	₹15.72	2%
Brand illustrations	₹7.11	1%
Total	₹929.94	100%

It was observed that while raw material costs (primarily the fabric costs) were the highest, the rate per metre of each fabric differed. Since 75% of the apparel wear were produced for children and 25% for adults, the complexity of design and usage of fabric had an implication on the cost incurred. Thus, alternate vendors for fabrics were to be sought to reduce the cost of goods sold.

An exercise of assessing the vendors, which the firm would want to alter, was undertaken. The findings were as follows:

Table 3

Fabric Type (Handwoven/ Organic)	Type of Supplier (Weaver/Vendor/ Middleman)	Location (City)	Rate (Per Metre)	No. of Repeat Purchases (within the Past One Year)	Classification of Supplier (Excellent/Good/ To Be Changed)
Handwoven	Vendor	Gujarat	200-250	1	To Be Changed
Organic Cotton	Vendor	Gujarat	165-225	1	To Be Changed
Organic Cotton	Vendor	Rajasthan	175-250	2	To Be Changed
Handwoven	Middleman	Mumbai	200-500	3	To Be Changed

It is found that while the materials used are sustainable, the process of vendor sourcing with respect to geographic proximity, number of trips, and a middleman are not sustained. The assessment showed that each vendor had to be changed.

The next particular, production costs, contributed to 18% of the entire costs. Given that the firm is asset light with respect to its manufacturing set-up and is outsourced, it was found that the manufacturing operations was not functioning at its optimum level, inclusive of idle time and unutilised machines in the case of a ramp-up of production. Thus, a scenario was built to test a complex design to be produced in an hour's shift with an increase of 50%. The output of the model is rendered in Table 4.

Table 4

Parameters	UOM		Dependent Parameter	UOM (Where Applicable)	
Capacity	Units produced/shift/machine	4	Design complexity		Mixed
No. of machines	Count	3			
No. of shifts	Count	1			
Shift duration	Hours/shift	8			
Working days/month	Days	26			
Total produce/tailor	Units produced/month/tailor	312			
Actual labourers – tailors	Count	3			
Total capacity/month	Units produced/month	936			
Actual labourers – master	Count	1			
Wage rate – tailor	Rs./labour/shift	₹962	Wage rate – tailor	Rs./labour/month	25000
Wage rate – master	Rs./labour/shift	₹1,154	Wage rate – master	Rs./labour/month	30000
Labour cost	Rs.	₹105,000			
Workstation space – tailors	Sq. ft.	48			
Workstation space – master	Sq. ft.	16			
Utilities space (cupboard)	Sq. ft.	32			
Utilities space (ironing board)	Sq. ft./unit	6			
Washrooms space	Sq. ft.	60			
Inventory storage space (HBR)	Sq. ft.	0			
Total production unit space	Sq. ft.	750			
Rent rate	Rs./sq. ft.	₹100			
Rent	Rs.	₹75,000			
Utilities rate	Rs./sq. ft.	₹347			
Utilities	Rs.	₹260,131.72			
Total cost	Rs.	₹440,132			

Apart from these costs, capital expenditures were also taken into account; however, they were eliminated from this research.

Findings

- The packaging and labelling do not utilise sustained products and are not recycled, even though they are made of paper and cardboards.
- While the firm does not use distributors, it does have retail shelf-space. Trip optimisation for replenishment when demands are high is an un-explored area.
- Major sales of the products occur during fairs and exhibitions. While this curtails the costs of distribution due to an instant sale, the costs of unsustainable brand advertising and marketing material add to the operating costs of the firm.
- Costs of inventory add on when sales are not as per anticipation in these exhibitions and are at geographically far flung regions from the manufacturing unit.

Thus, the supply chain model is tested mathematically as follows:

$$Ss = s - ti + m - p - to - d + u$$

Ss = sustainable supply chain

ti = inbound transportation

m = manufacturing

p = packing (in this case it is done at the firm once the materials are back from quality checks)

to = outbound transportation (only for retail shelf-space)

d = retailer in this case, as there are no distributors

However, the same is eliminated when the firm carries out an exhibition and sells.

u = users; in this case the purchasers are considered the users, as the actual users of the apparel are children.

Each component with a negative sign in front of it ensures that the same, in terms of costs, are reduced for an optimised model. Thus, while the manufacturing costs are the most in this case, since the materials used are of organic nature and sustainable, the same takes a positive sign. Consequently, while packaging and labelling are almost negligible costs, during ramp-ups or in cases where there are no exhibitions, these miniscule costs have a potential to increase, and thus must be reduced and negated by recycling the packaging, or even eliminating major packaging (three labels to only one) to enhance sustainability, at the same time reducing costs and unnecessary non-value add activities in the sub-function of the supply chain, thereby ensuring seamless and a lean eco-system for producers and consumers alike.

Conclusion: Advantages of the Proposed Framework and Model

Table 5

Stakeholders	Process	Levers and Metrics	Potential Decision
Suppliers	Sourcing	• Sustainability certification • Sustainable raw materials • Sustainable process of manufacturing raw materials/assembly • Measure of carbon footprint	• Vendor selection asks at the tie of RFP • Vendor rationalisation and cost reduction basis of agreements
Transporters	Inbound Transportation	• Emissions ratings • No. of owned fleet • Nature of fleet-fuel emitting or energy efficient (ratio) • No. of full load trips, i.e., space optimisation	• Make or buy decision of fleet • Transportation rationalisation and cost reduction on INCO terms, basis of agreements
Warehouser	Warehouse/cross-dock	• Sigma level/5S optimisation • Lean rating • ITR • ICC • Material type for storage • Utilities usage • Space utilisation and optimisation – probable rental	• Elimination of warehouse or costs and carbon reduction in the warehouse • Cost burns on the basis of metrics and optimisation
Manufacturer	Manufacturing Unit/Factory	• Sigma level • Sustainable process and standards adhered • Utilities usage, consumption pattern • Machinery emissions • Defects and returns reduction • Time • Human resource optimisation	• Capacity utilisation • Efficiency • Make or buy decision of key assemblies

Stakeholders	Process	Levers and Metrics	Potential Decision
Packers	Packaging (in-house/outsourced)	• Type of packaging material • Whether packaging material is required at all (e.g.: toothpaste, paste-tubes, readymade garments' cardboard, pins, and plastic wrapping)	• Elimination of packaging
Transporters	Outbound Logistics	• Emissions ratings • No. of owned fleet • Nature of fleet-fuel emitting or energy efficient (ratio) • No. of full load trips, i.e., space optimisation	• Make or buy decision of fleet • Transportation rationalisation and cost reduction on INCO terms, basis of agreements
Distributors	Channel Distribution	• Dealer branding material • Rent to yield ratio or ROI • Utilities usage and split/apportionment • Human resource deployment • Inventory tracking and cost tracking • Distributor's certification	• Rationalisation of distributors • Digitised brandings • Automation or manpower deployment decision
Users	Last mile delivery	• Emissions ratings • Timeliness	• Delivery rationalisation or pick-ups

It can be seen on testing the apparel firm's supply chain test that we have arrived upon fewer parameters than proposed. However, the potential decisions and metrics that would lead to cost reduction as well as optimisation towards a sustainable supply chain are tabulated as well as mathematically represented as follows:

$$Ss = s - ti - w + m - p - to - d + u$$

Discussions

The framework and the model proposed takes into account the requisite supply chain and its sub-functions' potential areas towards reduction of costs and underlying profitability. As shown in Table 6, the levers discussed in the previous section are representative and can be altered. In the case of manufacturing industries, it is found that the key metrics are majorly linked towards timeliness and towards costs. ITR (Inventory Turns Ratio) and ICC (Inventory Carrying Costs) are key indicators in a warehouse and even in the production unit where inventory may be moved.

The model thus ensures that those components are reduced, wherein the scope to reduce costs while moving to sustainable measures are undertaken, for example, the rationalisation of vendors, transporters, and even user pick-ups are considered to ensure fuel costs are reduced, while logistics are reduced. Agreements are proposed to ensure terms are kept in mind that are beneficial to the firm's profitability. Bashir, Yousaf and Wani (2016) discusses the various experiences of data usage and analytics. The conclusions tabulated would evidently require the levers arriving from various databases and eventually yielding in an e-factory, as well as additional stakeholders' mapping in a network design and re-design thereafter.

Table 6

Key Takeaway	Sustainable Assessment Criteria (Metrics and Framework)	Best practices across industries-financial link	Focal areas within the SC	Cost benefits while adopting GSCM	Effectiveness of EMS-focal area chemical components Difference between EMS & GSCM	Blockchain technology to reduce environmental risk	Levers in each supply chain function of inbound, operations, outbound and reverse logistics: Indian automobile	Business models-BV/PHEV/CV: Exhaustive study-to absorb all the different types of modelling types
Link	1750/1-s2.0-S0959652616X00248/1-s2.0-S0959652616309155/main.pdf?X-Amz-Security-Token=AgoJb3JpZ2luX2VjEOL%2F%2F%2	https://igel.wharton.upenn.edu/wp-content/uploads/2012/09/2012_0601_IGEL Supply-Chain-Sustainability_LR.pdf	file:///C:/Users/Seema/Downloads/sustainability-09-00880-v3.pdf	https://www.scirp.org/journal/paperinformation.aspx?paperid=94451		https://iopscience.iop.org/article/10.1088/1757-899X/551/1/012034/pdf	/profile/Manish_Choudhary8/publication/265147545_Integration_of_Green_Practices_in_S	/GKS/Sci%20Direct_Extracted/Consumer-preferences-for-business-models-in-electric-vehi_2019_Transport-Pol.pdf
Introduction	The paper elaborates on the assessment criteria, parameters and metrics covering the economic, social, environment and resource areas as levers. Since life cycle thinking is how the automobile sector functions upon, thus the focus areas of the metrics of the assessment are aligned with a car's lifecycle-from extraction of materials to ithe car's make and final end of life re-use	Report underlying the sustainable best practices across firms, encompassing sourcing, maintenance, transportation, material packaging and closed loop supply chains. The report emphasises the need for linking finacial databases with sustainability as well as developing data networks & build strategies that are beyond low-hanging fruits and robust for a long-term perspective	The paper is a secondary research on the sustainable practices in the automobile industry and highlights the measures limited to incremental process and product changes due to cost constraints.	Study on GSCM of 492 SMEs in South India with 4 hypotheses; 3 accepted 1 rejected. The research established the cost benefits of following a GSCM in the purchasing and eco-design of products.	The report is a case study on a leading chemical manufacturing company-BASF PETRONAS. It explores the similarities within a green supply chain and the EMS on the line sof continuous improvement, ISO 140001 standards and the researcher offers areas for improvement at mangement systemic levels and waste management for energy re-utilities	The research studies the implications and risks of the supply chain's operations on the environment. On reviewing valid and relevant papers, blockchain technology is considered to be the most beneficial towards product tracking and reducing the effects on the environment	The research studies the benefits of integrating a GSCM in the automobile sector, in India and enlists the issues it can address as well as the benfits-monetarily, timeliness & environmentally	The research conducted a consumer survey on the nature of vehicle preference of Battery Vehicles, Pure Hybrid Electric Vehicles etc. and their business models on purchase, battery lease or vehicle lease. It also includes results on the adoption of vehicles as per policies in 4 different scenarios. The research is exhaustive with its conceptual model and usage of discrete choice modelling to arrive at a mathematical equation and construct
Aims/Goals	To fill the gap of a holistic framework for a sustainable supply chain assessment	To cross-learn best practices in the supply chain arena and seek database linkages to profitability			To compare and measure the effect of EMS in GSCM	To study the environmental risk factors in supply chains and recommending research areas for the future	To identify the gap in integrating GSCM & evolve new opportunities for research in this area	Not mentioned
Scope	Not mentioned	IGEL, Knowledge Wharton	31 papers from Scopus' database, 2004-2015	SMEs in South India	BASF PETRONAS Chemicals Gebeng Site, based in Kuantan, Pahang	Not mentioned	Not mentioned	Not mentioned
Methodology	Selection of criteria and metrics from literature review followed by discussions by means of interviews	Conference, interviews	Secondary research-Lit. review by clustering authors' works and citing similar findings by their keywords	Questionaire-survey	Subjective interview	Literature review-Search hits on supply chain and environmental risks in supply chain over Web of Science, Google Scholar, Science Direct & filteration on the basis of keywords	Literature review, secondary research	Secondary research of literature for model appropriateness, Primary research-consumer survey monitored by a Dutch panel carried out by a market research firm
Limitations	Views from developed nations	Inadequate data systems, single-minded approach aligning wrt subsidies	(i) the definition of the sample field, since this research used only one database; (ii) use of international studies only; (iii) use of articles published in journals, excluding theses, dissertations, monographies, conferences and books	i. 45% of respondents from the manufacturing sector, can be horizontally tested on other SMEs. Ii. Inclusion of more variables-org. cul, fin strength, demography, leadership etc.	Not mentioned	Reviewed literature's limitations summarised	Limitations of GSCM mentioned	i. Fixed price-limiting the test on price fluctuations and the popularity of the business model (battery/vehicle leasing) ii. For mobility guarantee-max. upper limit of 14 days tested (maybe insufficient for some consumers) iii. Powertrain versions of cars and choices available for all 3-limiting scenarios where business models are unavailable for some versions
Critical Summary	The paper exhibits a robust process towards selecting metrics and criteria for sustainable supply chains' assessments and sharpens it by means of insights from leaders' interviews. It is found that ingraining a sustainability thought process at the design as well as the inception of a car's lifecycle would yield a positive cost benefit and social impact. there is a key focus on the nature of metrics for each key lever apart from Carbon emissions and footprints	The report highlights the need for sustainable supply chains beyond a CSR initiative and is an attempt at eliminating the myth that CSR initatives are expensive and need a budget for it. Sustainability measures are best delivered with including various stakeholders & thus business partners viz. vendors and 3PL partners' buy-in is a must While, practical insights come to the forefront on coupling sustainable measures with cost cutting levers; the 'how' is left for the reader to proceed with	Environmental practices were related to issues of gas emissions in 37% of the cases, eco-innovation in 27%, life-cycle assessment in 18%, cleaner production in 9% and reverse logistics in 9% Key focus on product innovations & highlights the H-fuel, sugar (Ethanol) fuelled cars	While, the hypotheses are relvant and reiterate literature on the cost benefits of GSCM in the purchasing and eco-design of products; little is touched upon the allied services of storage, distribution, packing and the reverse logistics	The case study explores the similarities between an EMS and a GSCM in terms of a process; however little is touched base upon the respective ui2ui chemical manufacturing process & the gaps between the present scenario and the areas for improvement. It is noted that BASF is very diligient and focussed towards the environmental aspects and the performance measures as well as it's internal advocacy and communications are aligned with it.	The paper studies the various risk factors in the supply chain operations-including: respective manufacturer's strategies, emissions during the manufacturing phase, relevant vendor selections, reduction of materials used, reverse logistics solutions and distribution. These are tested in Risk Assessment Frameworks, Stoch. Prog. Model, mathematical programme, game theory etc. across relevant research papers	The paper mentions the various key automobile mnaufacturers in India and the increasing landscape; thereby highlighting the impact of the emissions on the environment; implying the need for a holistic and integrated view of GSC. Cites the definition of GSC, a framework as well as tabulates the areas addressed and gaps that can be explored for further research	The research conducted takes into consideration the subjective parameters of attitudes and consumer choices towards vehicle mobility-the physical changes in the car models, at a business model overview as well as including the price changes when partially leased as a vehicle. The data of the consumer survey allows room for investigating and addressing the loopholes in prior literature of business modelling and policy gaps by testing the key parameters and attributes' changes over vehicle type and business model type. It also mentions the nature of choice changes wrt socio demography, age and purchasing income
Gaps	Lack of testing the metrics' utility on the various car firms	Lack of an SOP on how to proceed with embedding sustainability in the supply chains Lack of metrics to measure sustainability in each function of the supply chain Impact of the measures on efficiencies	Lack of details on the measures undertaken in each environmental practice, its effectiveness and limitations	The paper doesn't elaborate on the methodology to evolve at the model and the model's fitment/application across the various categories of respondents as well as the parameters on sleection of the respondents.	Lack of details on what was the problem statement being tackled and how-at a case level	The paper doesn't explicitly mention the scope and no. of papers reviewed Its key recommendation of blockchain isn't derived at chronologically, eventhough appropriate	While the paper mentions the key manufacturers in India, it fails to highlight the initatives undertaken by them in the GSC space. The key area addressed is that of cost reduction across all the SC functions however, it fails to quantify the extent of optimisation & monetary benefits	Lack of clarity on the region/background of the respondents as there is a mention of models in the US' and its applicability for mobility guarantee Lack of business model dependency on commercial vehicles/two-wheelers etc Lack of literature on selection of model and its applicability for technology/R&D changes
Recommendation	The interviewees recommended the elimination of key resource parameters as some (eg: fuel,l ubricants) were already a part of the lifecycle; while recommendations were made to eliminate renewable materials as they are already a legal requirement.	Cross industrial learnings and platforms to share the same over an open forum allow room to explore high-hanging fruits towards sustaining a path towards sustainability. Recommended to have metrics and digital systems that link sustainability with profitability measures	Not mentioned	The researchers recommend to deploy the model to various other indsutries in different regions of India as well as the world by including alternative parameters, not limited to the study	The researcher suggests BASF to focus on the reusability of its wastes towards generating energy	Suggestion of blockchain technologies to reduce environmental risk by supply chains	Not mentioned	The research findings establish that BV & EV leasing are a favoured choice for those younger than 40 years Also, PHEV is preferred for its longer electric range Higher income earners have lower preference for buying BEV and PHEV and are also less interested in battery leasing, but they prefer leasing CV and PHEV Highly educated respondents prefer BV, PHEV & leasing BVs
Critical Review	Test the application of the framework in a live-case/environment specifically towards economic factors	VSM/Process flow map to identify the present scenario Assessment of the present SCM Areas to improve-devise an SOP & metrics for its sustenance	Gas emissions and cleaner production are limited to internal material and product standard usages-which a firm may not want to alter and share with a third party easily. Logistics per se, is a 4% load on the costs of a firm and thus may not yield the radical results as required in achieving profitability Eco-innovation in a life cycle assessment at a process level; is an area that can be explored furthermore	Enlist parameters across a specific SME that would yield in waste management(GSCM/or otherwise) leading to cost saving and time optimisation	Lack of specificty on the problem tackled leaves the inference open ended for the reader	Lack of details on blockchain technologies and respective review findings- while it is appropriate for tracking, whether tracking would garner data that could be used to green a supply chain, is questionable	A case approach of leading manufacturers' supply chain network and gap identification and detailing the value cycle would yield in specific parameters as levers/weights to modify the present SC to a GSC	While the research covers various gaps in the policy and business model at a consumer choice perspective, little is talked about on a business' preference keeping in mind consumer choices as well as profitability. Plug & play engine changes (BV leasing options) cost benefit analysis can be checked at a producer's level & compared with a a consumer's level The model can be replicated for a producer's perspective

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