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Green supply chain management related performance indicators in agro industry: A review

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ABSTRACT

Environmental protection and sustainability issues in food sector have attracted global concerns in the past two decades. Companies and government in many countries have started realizing the importance of greening their supply chains. Green supply chain management has gained special attention of public and many companies are now interested in adopting it as their strategy to advance their brand image, capturing more market share and to win the trust of the customer. The purpose of this paper is to explore the diverse performance indicators and sub-indicators responsible for green supply chain management implementation and to check its reliability and to rank them using analytic hierarchy process analysis. After extensive literature review and consulting Industrial experts, the study has suggested 13 performance indicators and 79 sub-indicators. The quantitative phase was conducted through a survey using standard questionnaire with various agro based companies followed by a qualitative phase, where the duly filled questionnaires were received, edited and further analyzed. It has been concluded that internal environmental management, environmental design and regulatory pressure are ranked as the top three performance indicators. The sensitivity analysis has also been performed to see the effect of weightage on the final ranking of performance indicators. This is one of the first studies that suggest the performance indicators for implementation of green supply chain management in agro industry. The study will certainly aid the related organizations to implement green supply chain management.

1. Introduction

It has been observed that the industries now embraced the green supply chain management (GSCM) approach to green their supply chains and are very keen to know about the critical factors/performance indicators responsible for its implementation. It has emerged as a contemporary approach in twenty first century to attain efficiency, corporate profit, brand image, market share and to reduce the biological footprints of products, as well as the environmental concerns are increasingly becoming significant in managing the trade today. Considering the environmental regulations and growing demands by the overseas buyers for a lot of eco-friendly merchandise, many corporations across the globe are adopting environment friendly merchandises as their trade strategy for future sustainability and to have a competitive edge over others. In many nations, the Government, industries and some non-Government organizations are operating along to purchase eco products which would eventually benefit the environment and thus the civilization. Limiting damage to the environment has been the major challenge society faces over the coming years. Companies are increasingly being urged to play their part in taking action to avert long term irreversible damage to our planet and they are setting up their environmental programs to incorporate green policy throughout their various stages of the supply chain. GSCM aims to limiting wastes within the production so as to save energy and prevents the debauchery of harmful material into the environment. Organizations are taking steps to develop into more eco-conscious and going green within the limitations of their trade objectives.

The present study focuses on the implementation of GSCM in agro companies and provides them essential performance indicators and sub-indicators in order of their dominance. The introduction of GSCM in agro industry will improve their product design, procurement procedure, internal processing, distribution and re-processing operations etc.

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1.1. Concepts of GSCM

"The green supply chain management is an integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumer as well as end-of-life management of the product after its useful life." (Srivastava, 2007) (Fig. 1).

1.1.1. Main activities in GSCM

The main activities involved in GSCM are green design, green purchasing, green manufacturing, green transportation and reverse logistics. **Green design** is an approach to design the product with enhanced biological quality by reducing its adverse impact on the environment throughout its life cycle. It involves taking account of the environment during a products design phase. **Green sourcing,** embraces everything sourced from suppliers, sub contractors, service providers etc. Which incorporate environmental criteria that can be applied to all the phases of a sourcing process. **Green manufacturing** aims at lessening environmental impact that can be achieved by better consumption i.e. reducing unsafe emissions and waste (reuse) and lower consumption by reducing utilization of energy and raw supplies. **Green Transportation:** Transport sector is a crucial part of any supply chain. It accounts for almost half the world's consumptions of oil products, Survey report of BearingPoint, (2008, Supply Chain Monitor "How mature is the Green Supply Chain?"). The other forms of energy used (Electrical, Bio Gas and Gas) are still marginal. Moreover the transport sector has one of the highest greenhouse gas emissions. To reduce the impact of the transportation, we can use less polluting modes of transportation as shipping, rail or combined transportation e.g. rail-road, sea-road etc. It can also be scale back by limiting warehouses on the provision chain and reducing the traffic volume. **Reverse logistics:** The purpose of reverse logistics process is to ensure that product/material are returned from the user to the producer in order to be recycled, reused or reconditioned. In reverse logistics, the chain is covered in opposite direction. It therefore denotes a collection of planning; implementation and flow management measures of raw material and final products with the aim of convalescent and reprocessing those merchandises or materials. Logistics involve an entire range of activities including gathering, categorization, processing and reconditioning etc.

2. Literature review

Green supply chain management is the step towards attaining environmental sustainability. It has motivated many firms and researchers to work on it to protect the environment for the future generations. The various organizations have started realizing its importance therefore literature of GSCM is also growing each year. In this section detailed literature on GSCM implementation is discussed. The literature on various facets of GSCM has been discussed in Table 1. It is revealed from the literature that research has been carried out on green product design, green transportation, collaborative green practices, decision making in supply chain management, barrier of GSCM implementation, Co-relation between GSCM and ISO 14001 and ISO 9000 but very little work has been done on performance indicators/framework of GSCM which one must comply with, to implement it successfully. It has also been found that no work has been reported on GSCM implementation in agro industry. The present paper identifies the performance indicators and sub-indicators responsible for effective implementation of GSCM in agro Industry. It also suggests the performance indicators (PIs) according to their dominance.

3. Methods

The research initiated with extensive literature review on GSCM, in-depth interviews with the industrial experts and ISO auditors for identification of performance indicators and its sub-performance indicators. The data collected from it is further used to formulate the questionnaire. The questionnaires were mailed to the top and middle level managers of production, quality control and testing laboratory in agro industries. The sequence of research methodology is given in Fig. 2.

3.1. Formulation of questionnaire

In this phase, literature on GSCM was reviewed and interaction with academic and industrial experts including lead assessors of ISO 9000 and ISO 14000 had been carried out. After extensive literature review and thorough discussion with the experts, thirteen PIs and seventy nine sub-PIs were identified (Table 2). These were further used to develop the questionnaire. The questionnaire was designed using five point likert scale.

3.2. Pre-testing of the questionnaire

Before launching the questionnaire, it was pre-tested by four experts; two from academic side dealing with supply chain management and two experts from the industry dealing with implementation of environmental management system (ISO 14000) and ISO 9000 etc. The changes suggested by these experts were taken care of and the questionnaire was amended accordingly.

3.3. Data collection

During this phase, the survey was conducted using questionnaire. The questionnaires were distributed through mail and personal visits amongst 350 agro based companies of northern India, like sugar mills, textile mills, food and beverages units, sauce and juice making companies etc. It is worth mentioning here that all the companies were either ISO 9000 or ISO 14001certified. The targeted group was top level/middle level managers from the field of production, quality control and testing laboratories. They were well acquainted with the production process, government regulations, corporate strategies and environmental management of these firms. Two months time was fixed to respond the questionnaires. Regular weekly follow up was done through phone calling the respondents. Out of 350 mailed questionnaires 82 questionnaires were received but 8 questionnaires out of these 82 were incomplete; so 74 completely answered questionnaires were considered for analysis.

3.4. Data analysis

The data after collection has been processed and analyzed as per research plan. Processing of data such as editing, coding, classification and tabulation was done for ensuring that we had the relevant data for performing contemplated comparisons and analysis. The following data analyses were conducted:

3.4.1. Reliability analysis

It has been conducted on the data collected from various agro industries using questionnaire to see the internal consistency associated with the scores corresponding to the performance indicators. The scores of all the sub-performance indicators underlying each performance indicator are tabulated and thereafter value of Cronbach alpha is calculated for each PI using Eq. (1).

Table 1
Literature review.

Year	Title of Paper	Author	Conclusion	Methodology used	Scope for future work
2000	Multimodal Transportation, logistics and the environment	Rondnelli D. et al.	This article provides a framework for understanding instructions among transportation activities and the environment. It explores the forces driving the growth of intermodal transportation services & multimodal transportation infrastructure, identifies the major environmental influence of transportation activities and facilities, examines alternative means of controlling and preventing environmental hazards and descriptions the categories of data needed for the developing proactive environmental management system.	Detailed study for driving forces for multimodal transportation and then focus on transportation system components and its impact on environment has been carried out. Data is being collected through careful analysis of environmental monitoring, auditing and reporting through EMS which drives effective external and internal environmental issues with employees, regulators and stakeholder etc.	Study on information system, impact of other means of transportation on environment can be the direction for future work.
2004	Relationships between operational practices and performances among early adopters of Green Supply Chain Management practices in Chinese manufacturing enterprises	Zhu, Q., Sarkis, J.	The study is based on Chinese enterprises in respect of their adoption of GSCM practices. With the requirement of sustainable development and the economy globalization, Chinese have begun to change their focus from single plant improvement to the whole supply chain. GSCM tended to have win-win relationships in terms of environmental and economic performances. Quality management was a positive moderator in these quality programs along with GSCM practice perform better. Overall, the studies provided additional in- sight into the growing field of the relationship between environmental and operational practices and performance.	The methodology for operationalizing the variables and factors, acquiring the data, determining the reliability of factor grouping. The "modified hierarchical regression methodology" is used to test the various hypotheses.	The study has considered only environmental and economy performance influenced by GSCM and other aspects such as general Operational performance and possible strategic financial and organizational could be investigated. The investigation has been on enterprises who have recently adopted GSCM. Now future investigation can be on mature adopters & to see whether they have similar results.
2004	Environmental and reverse logistic policies in European Bottling and packaging firms.	Torre, P.L.G. et al.	A comparative study was conducted on Spanish and Belgian bottling/packaging industries in accordance with sub-sector of activity within the food and drinks industry, focusing especially on the joint implementation of environmental performance untidily with suppliers and customers.	Postal survey method was conducted among the companies in the food and drink sector in order to gather necessary information. The SPSS (V.10.0) computer package was utilized to hold out applied math analysis. One-issue Annova was meted out to understand the difference in implementation, environmental and reverse provision between Spanish and Belgian cases.	Work could further be stretched on integrated transportation and sourcing
2005	Environmental and sustainability ethics is supply chain management	Beamon, B.M.	Environmentally conscious supply chain management (ECSCM) refers to the management exerted over all immediate and eventual environmental effects of product and processes related with changing raw materials into final products. This paper describes ECSCM as a component highlights the measure issues associated with ethical decision-making in supply chain management.	Literature review, study of LCA (Life cycle assessment) and the grouping of corporate social responsibility to suggest a framework after thorough analysis.	Future work can be on the reverse logistics, study of ethical issues involving the development and management of scientific systems, techniques to attenuate barriers to ethical decision-making.
2007	Developing a frame work for sustainability management in engg. SMEs	Burke, S., Gaughran, W.F.	The study focuses on sustainability issues in manufacturing and production. The focus is to develop appropriate tools and strategies to satisfy the ISO 14001 standard. The frame work incorporates two levels, with the first focusing on ISO 14001 and second aiming towards managing all social, environmental associate and economical aspects within an engg. SME. Key results from the regional study of ISO 14001 certified engg. SMEs highlight the importance of environmental and sustainability awareness program for top management, eliciting and obtaining their full support and commitment.	The use of interviews and pre designed questionnaire methods has been used. Data analysis has been done by using co-relation methods.	Future work can be on testing the obtain frame work in engg. SMEs within country and can be sector specific.

Table 1 (*continued*)

Year	Title of Paper	Author	Conclusion	Methodology used	Scope for future work
2007	Evolutionary game model between govt. and core enterprises in greening supply chain	Qing, H.Z., Yi, J.D.	This paper analyses the price and edges so as to analyze the games between govt.and core enterprises in greening supply chain and further studies the evolutionary game model. Game analysis shows that core enterprises prices and edges to implement green supply chain management as well as funding and penalties from govt. directly affect the game results. To gain long term benefits, govt. should enforce strict environmental regulations and increase relevant subsidies and penalties.	Game modeling has been used as a tool to implement GSCM. "Equilibrium analysis" and "Replicator dynamics analysis" techniques has been used to develop this model.	For effective implementation of GSCM studies can further be carried out to know the co-operation level among enterprises along the supply chain.
2008	Environmental management systems and green supply chain management: complements for sustainability.	Darnall, N. et al.	This research reveals that organizations that adopt EMSs more frequently implement GSCM practices, no matter however long the EMS has been in situ. These results suggest that EMS and GSCM may complement each other and that EMS adopters have a stronger chance of perk up the environment not just within their boundaries but throughout their network of consumers and suppliers. The net effect may be an overall increase in environmental sustainability, since mechanisms are in place to boost net work wide environmental performance.	The data collected from survey on facility that had fifteen employees or more was collected to know the degree of implementation of environmental initiatives. To check variance "Port hoc Harman single factor test" has been used.	Future work may be on the relationship between EMS and GSM practices. It would be important to know whether to achieve greater internal efficiencies if they adopt EMS and GSCM in a particular sequence and what capabilities are needed to be in place prior to endeavoring either management practice. It would also be important to know whether organization that adopts both EMS and GSCM practices improve their environmental and business performance more than the organization that simply focus on one practice alone.
2008a	Firm – level correlates of emergent green supply chain management practices in Chinese context.	Zhu Q. et al.	This paper investigates the correlation of major factors i.e. organizational learning and management support for adopting GSCM. It also tells that GSCM can easily be implemented in the organization who have already adopted ISO 9000 and ISO 14001	"Chi-Square test" has been conducted to compare organization characteristics of the two groups of respondent manufacturer.	Future research can involve other factors which influence the implementation of GSCM e.g. regulations, marketing, supplier cost pressures, organizational size etc.
2008b	Confirmation of a measurement model for a green supply chain management practices implementation.	Zhu Q. et al.	This study presents practitioners with a twenty one item measurement scale for evaluating the different facets of their GSCM operations implementation. The empirical results suggest that twenty one items are critical attributes of the underlying factor to GSCM practices implementation.	First selection of measurement items for evaluating GSCM practices is done with the help of survey, questionnaire designed for measuring items. Interviews of academicians and practitioners are conducted. Pilot test, convenience sampling is also conducted on collected data. The models so constructed are further tested by CFA test.	It can be on performance implication of GSCM practices implication. Factors such as cooperation with number of reverse logistic channels. Measurement model for GSCM performance. Comparison of GSCM operations implementation between different countries can be another research direction.
2008	Embedding corporate responsibility into supply: A snapshot of progress.	Harwood, I., Humby, S.	This paper outlines the findings of a pilot study of corporate study responsibility within the procurement processes of nine large organizations with a predominant focus on utilities and service provider. There are however many problems and challenges facing those responsible for implementing CR in the supply domain.	Researcher adopts a case study methodology with a specific focus on an exploratory cross case analysis. Along with literature review, methods employed for collecting data include nine semi-structured interviews and follow up conversation in a variety of public and private organizations.	Future work includes designing and testing risk and measuring models for CR and supply conditions.
2008	Green component life cycle values on designed and reverse manufacturing in semi-closed supply chain.	Chung, C.J., Wee, H. M.	The study mainly concentrates on green product design due to increased competitive pressure, environmental consciousness and ecology protection. Green product design has received abundant attention recently as a result of product design significantly influences the cost of assembly, component examination and repair, remanufacturing and utilization. The author developed an integrated inventory model with green component life cycle value design and remanufacturing.	The product life cycle has been studied thoroughly to suggest integrated model considering the relevant price once implementing JIT delivery. Then sensitivity analysis has been done on the proposed Time-Weighted inventory deteriorating model.	Future work can be extended to consider to issues of controlling defects in production process. Multi objective optimization and reverse revenue sharing mechanism for the integrated model under green supply chain.

(*continued on next page*)

Table 1 (*continued*)

Year	Title of Paper	Author	Conclusion	Methodology used	Scope for future work
2009	Opportunities in green supply chain management	Johnny C. H. et al.	This paper compares and contrasts the traditional and green supply chains. Because of recently changed environmental requirement that affect on producing operations and transportation systems, Growing attention is given to the development of environmental management ways for supply chain. A GSCM aims at limiting the waste within the industrial system so as to conserve energy and present the dissipation of harmful material in to the environment.	Literature review and study of various journals has been used to gather data.	Research opportunities in GSCM in bio based, packaging can be the promising area of research.
2011	Using multi objective genetic algorithm for partner selection in green supply chain problem.	Yeh, W.C., Chuang, M.C.	This paper introduced green criteria into the frame work of supplier selection criteria. The aim of this study was to develop an optimal arithmetical designing model for green partner selection which involved objectives like value, time, merchandise quality and green appraisal score.	It involved following steps. Develop the evolution process for green supply chain partner as per literature survey. Collect the relevant information from the supply chain partner. Use two algorithms proposed by Murata et al. (1996) and Altiparmak (2006)	Modified weight sum approaching to obtain more Pareto optimal solution than previous studies. Additionally uncertainty of cost and demand can be considered in a new model.
2011	A multi objective optimization for green supply chain network design	Wang F. et al.	This paper introduced a multi objective green supply chain model based on the classical facility location problem for the firm's strategic planning. The distinguished feature of this model is its consideration of environment element which includes environmental level of facility in the handling and transportation process. This model aims to minimize total cost and environmental influence.	"Normalized common constraint method" to resolve the model by general MIP solver CPLEX 9.0 to get the Pareto optimal test has been used. After that this model is tested by a six node example a case study.	Future research direction is to consider more factors in supply chain as transportation modes, demand uncertainty and so on. It can also extend our research through designing new solution method to solve multi objective model.
2011	Systems of sustainability and transparency of food supply chains – current status and challenges.	Wognum, P.M. et al.	This paper is about transparency with the aim to show current efforts towards transparent and sustainable food supply chains. Technical approaches e.g. LCA (Life cycle assessment) to improve the environmental and social dimensions of sustainability has been discussed.	"Product life cycle assessment" (LCA) has been used to see the brunt of environmental foot prints.	Role of government agencies for stimulating innovation. Integrated information systems.
2011	An organizational theoretic review of GSCM literature	Sarkis J. et al.	GSCM has gained increasing attention inside each domain and trade. As the literature grow, finding new directions by critically evaluating the research and identifying future direction becomes important in advancing knowledge for the field. Using organizational theory to help categorized the literature provides opportunities to address and for future direction.	Evolution of various theories on GSCM based on literature review has been formulated.	How to reduce uncertainty arises from implementing the GSCM. Innovation diffusion mechanism and relationships between large and smaller suppliers and customers for GSCM need further investigation. How external and internal factors interactively promote GSCM practices.
2011	Drivers of green supply management performance: "Evidence from Germany"	O. Large R., Gimenez C.T.	The study suggests that a degree of green provider assessment and the level of green partnership exert direct influence on environmental performance. These two practices are driven by the strategic level of the purchasing department and the environmental commitment of the firm.	Data collection has been done using questionnaire and data analysis e.g., Reliability analysis and factor analysis is done using SPSS and smart PLS.	The studies can be further extended on buyer-supplier relationship. In the present study performance has been measured only from the perspective of the buying firm; supplier's environmental performance has not been considered. So future study can be extended on it.
2011	The influence of greening the suppliers and green innovation on environmental performance competitive advantage in Taiwan.	Chiou, Y.T. et al.	The distinguished result of this work is that greening the supplier through green innovation contributes significant benefit to the environmental performance and competitive advantage of the firm.	Data collection is through survey based on questionnaire followed by Reliability analysis and T-test etc.	Future study could extend this to other GSCM practices as well as exploring in more detail the moderate effect of green modernism on green product and process innovation.
2011	Study of green supply chain management in the Indian Manufacturing industry: A literature review cum an analytical approach for the measurement of performance.	Bhateja, A.K. et al.	This paper discusses various environmental factors affecting in the manufacturing sectors. GSCM index having 17 indicators and 33 sub-indicators is designed with the help of which performance of various manufacturing sector towards green future can be assessed.	Survey based on questionnaire has been used for data collection.	Future work can be on calculation of carbon emissions of any particular process.

Table 1 (*continued*)

Year	Title of Paper	Author	Conclusion	Methodology used	Scope for future work
2012	An empirical study of green supply chain management in Indian perspective	Toke L.K. et al.	The study aims to examine the measurement model of GSCM practices implementations focusing on nineteen performance measure factors with 113 underlying dimensions	Based on associate extended literature review, numerous approaches were known to see their reliability on validity and were extracted into studied dimensions. AHP was applied for determining relative importance and selecting appropriate approach in GSCM practice.	The study is limited to Indian manufacturing industry only; nevertheless it can be extended to meet the need of the special category of industry after identification of key critical success factor.
2013	An ISM approach for the barrier analysis in implementing green supply chain management	Mathiyazhagan, K. et al.	This study seeks to spot that which barrier is performing as the most dominant one for the adoption of Green Supply Chain Management and this result is useful for industries to form easier the adoption of green concept in the supply chain.	The interpretive structure modeling (ISM) qualitative analysis has been used.	The study can be extended to different type of industry.
2014	Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process	Govindan, K. et al.	The study has known the barriers of GSCM implementation and has tried to suggest a framework and to minify barriers to create manager's efforts towards surroundings improvement slightly easier.	Questionnaire is used for data collection and the most common barriers widely accepted by various organizations scrutinized. Thereafter, key barriers identified using AHP approach.	Future work can be on additional barrier classes and barriers. Various sectors in business might even be thought-about for thorough investigation resulting in additional improved ways for GSCM implementation.
2014	Close-loop or open hierarchical structures in green supply chain management under uncertainty	Tseng, M.L. et al.	This study aims to explore the variations between close loop and open hierarchical structure which are used in the analytical network process (ANP) analysis of Green supply chain management under uncertainty. The results indicate that the close-loop hierarchical structure more closely resembles existing applications.	Hybrid fuzzy set theory and ANP methods are used.	The study can further be extended on the corporate social responsibility

Fig. 1. Concept of GSCM.

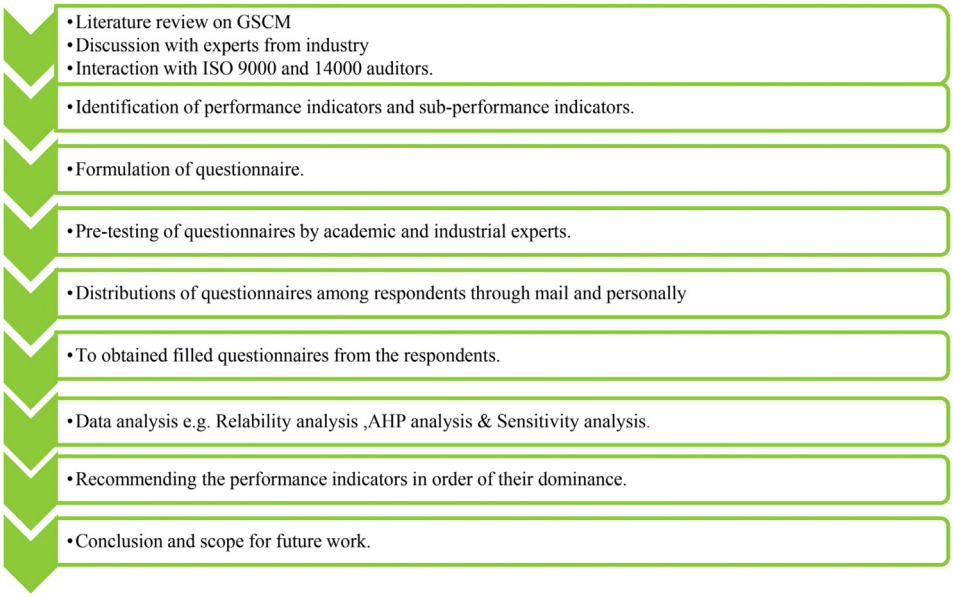

Fig. 2. Sequence of research methodology.

Table 2
Performance indicators and sub-indicators.

S. No		GSCM performance Indicators
1	**ED**	**Environmental design**
	1.1	Design of product for reduce consumption of material/energy
	1.2	Design of product for reuse, recycle etc.
	1.3.	Design to reduce use of harmful/toxic material.
	1.4	Product design to store at room temperature/cold storage.
	1.5	Design of product for storage area during transportation.
2	**IEM**	**Internal environmental management**
	2.1	Written environmental policy statement.
	2.2	Written environmental objective.
	2.3	Assignment of management representative.
	2.4	System to track environmental laws and regulations.
	2.5	Regulatory compliance audits.
	2.6	Documented procedure to implement corrective action plan.
	2.7	Supplier environmental plan.
	2.8	Top management commitment for GSCM.
	2.9	Middle level management commitment for GSCM.
	2.10	ISO 9000 certification.
	2.11	ISO 14001 certification.
3	**GP**	**Green purchasing**
	3.1	Supplier's environmental targets/objective.
	3.2	Supplier's environmental management system.
	3.3	Status of environmental audits on supplier's internal Mgmt.
	3.4	Eco-labeling of products.
	3.5	Suppliers are green partner/not
	3.6	Is Eco-labeling informative enough for consumers.
	3.7	Co-operation with suppliers for environmental objectives.
	3.8	Training of suppliers to reduce non recyclable packaging.
	3.9	Survey of customer to see their liking for green packaging.
4	**GM**	**Green manufacturing**
	4.1	Manufacturing system/process control hazardous substances.
	4.2	Use of energy efficient technology.
	4.3	System for waste minimization.
	4.4	Green manufacturing lead to lower raw material consumption.
	4.5	Green manufacturing's impact on brand image.
	4.6	Reduction in material cost after implementing green practices.
	4.7	Company follow 3Rs (Recycle, Re-manufacture, Reuse)
	4.8	Use of emission control system to control green house gases & CO_2
5	**CGT&CS**	**Collaborative green transportation and cold storages.**
	5.1	Use of collaborative transportation and ware houses.
	5.2	Effect of size, shape and material of packaging in transportation.
	5.3	Reduced packaging material reduces material handling and transportation cost.
	5.4	Cooperation with vendors to standardize packaging.
	5.5	Use of combination mode of transportation e.g. Rail to Road, Road to Ship, Road to Air etc.
	5.6	Use of Eco friendly refrigerants in transportation vehicle and in cold storage.
	5.7	Customer feedback regarding use of green transportation.
6	**RL**	**Reverse logistic**
	6.1	System to retrieve products from and consumer for recycling/reuse.
	6.2	Are there any waste collectors to collect waste from company?
	6.3	Re processing of used product by company.
	6.4	Steps taken by company to reduce waste.
	6.5	Sale of excessive capital equipments.
7	**CSC**	**Cooperation with suppliers and customers for joint action.**
	7.1	Involvement of supplier in planning/design with
	7.2	Sharing of GSCM targets with suppliers and vendors
	7.3	Customer feedback Sys. for eco-design.
	7.4	Cooperation from customer for cleaner production.
	7.5	Cooperation from customer for green purchasing.
	7.6	Does company have information sharing structure with suppliers and consumers?
8	**EP**	**Environmental performance**
	8.1	Ability of GSCM to reduce emission
	8.2	Effectiveness of the system to reduce water and solid pollutants.
	8.3	Extent to which GSCM reduces harmful/toxic material
	8.4	Extent to which GSCM encourages use of preservative as per std.
9	**EP**	**Economic performance**
	9.1	Extent to which GSCM decreases material cost.
	9.2	Reduction in cost of energy consumption by GSCM.
	9.3	Does GSCM create quest for innovation.
	9.4	Has green practices decreased cost of waste discharge.
	9.5	Up to what extent GSCM reduces penalty/compensation for ecological accidents.
	9.6	Has GSCM increased revenue for the company?
	9.7	Reduction in service related cost and increase in market share.
10	**OP**	**Operational performance**
	10.1	Accurate delivery time as outcome of GSCM.
	10.2	Improvement in capacity utilization after GSCM implementation.

Table 2 (*continued*)

S. No		GSCM performance Indicators
	10.3	Does GSCM promote quality and brand image.
	10.4	Up to what extent GSCM can enhance public relations.
	10.5	Increased brand loyalty by consumers.
11	**MS**	**Market share**
	11.1	Expansion of new market for product.
	11.2	Increase in company's market share.
	11.3	Improvement in export orders.
	11.4	Subsidy in export orders.
12	**RP**	**Regulatory Pressure**
	12.1	Pressure from state/central govt. regarding promoting GSCM
	12.2	Does regional environmental regulation force to implement GSCM
	12.3	Does GPNI force to adopt GSCM
13	**CP**	**Competitive pressure**
	13.1	Extent to which brand image is a major factor/driver for implementing GSCM
	13.2	Pressure as of non-government organization (N.G.O.) to put into practice GSCM.
	13.3	Effect of competitor's green strategies to implement GSCM
	13.4	Up to what extent urge to have competitive edge is main driver for implementation of green practices.
	13.5	Increase in interest of CEO/Board of directors by competitive green practices.

Table 3
Result of reliability analysis.

S. No.	Performance indicators	Total no of sub factors	Cronbach's alpha(α)
1	Environmental design	5	0.729
2	Internal environmental management	11	0.943
3	Green purchasing	9	0.989
4	Green manufacturing	8	0.995
5	Collaborative green transportation and cold storages.	7	0.994
6	Reverse logistic	5	0.996
7	Cooperation with suppliers and customers for joint action.	6	0.998
8	Environmental performance	4	0.999
9	Economic performance	7	0.999
10	Operational performance	5	1.000
11	Market share	4	0.997
12	Regulatory Pressure	3	0.999
13	Competitive pressure	5	0.999

Table 4
Result of AHP analysis.

	Performance indicators	Identified weightage scale: 0–100	Rank
IEM	Internal Environmental Management	18.55932308	1
ED	Environmental Design	16.08001923	2
RP	Regulatory Pressure	9.153163769	3
GP	Green Purchasing	8.116817	4
CGT&CS	Collaborative Green Transportation and cold storage	8.109793615	5
CSC	Cooperation with suppliers and customer	7.993230462	6
GM	Green Manufacturing	7.847403538	7
CP	Competitive Pressure	6.353709923	8
RL	Reverse Logistic	4.506762308	9
ENV.P	Environmental Performance	4.014138077	10
OP	Operational Performance	3.835001923	11
MS	Market Share	2.838126769	12
ECO.P	Economic Performance	2.592838231	13

Reliability analysis helps out to measure precision, recurrence and uniformity of the scores of PIs. The reliability analysis procedure works out a number of usually used measures of scale dependability and also provides information about the correlation between individual items in the scale. Interclass correlation coefficients are often used to compute inter-rater reliability estimates. To measure the internal consistency based on the average inter item correlation is called Alpha (Cronbach) i.e. how closely associated a set of items are as a group. It is recommended that the value of alpha should be more than 0.6 (Saaty, 2008). The value of alpha is calculated as per Eq. (1). The values of alpha for all the PIs are shown in Table 3.

$$\alpha = \frac{N \cdot \overline{C}}{\overline{v} + (N-1) \cdot \overline{C}} \tag{1}$$

here, N = no of items, C-bar is the average inter item covariance and V-bar equals the average variance.

Table 5
Comparison matrix.

		ED	OP	RL	RP	IEM	GP	GM	ENV.P	ECO.P	MS	CSC	CP	CGT&CS
Environmental Design	ED	1.00	4.00	3.00	3.00	0.50	3.00	3.00	3.00	6.00	5.00	3.00	3.00	2.00
Operational Performance	OP	0.25	1.00	0.50	0.33	0.25	0.50	0.50	0.50	2.00	3.00	0.50	0.50	0.50
Reverse Logistic	RL	0.33	2.00	1.00	0.33	0.25	0.33	0.50	2.00	2.00	2.00	0.50	0.50	0.50
Regulatory Pressure	RP	0.33	3.00	3.00	1.00	0.50	3.00	2.00	2.00	2.00	3.00	0.50	2.00	0.50
Internal Environmental Management	IEM	2.00	4.00	4.00	2.00	1.00	3.00	3.00	6.00	6.00	4.00	3.00	2.00	3.00
Green Purchasing	GP	0.33	2.00	3.00	0.33	0.33	1.00	0.50	2.00	2.00	3.00	2.00	2.00	2.00
Green Manufacturing	GM	0.33	2.00	2.00	0.50	0.33	2.00	1.00	3.00	3.00	4.00	2.00	0.50	0.50
Environmental Performance	ENV.P	0.33	2.00	0.50	0.50	0.16	0.50	0.33	1.00	2.00	2.00	0.50	0.50	0.50
Economic Performance	ECO.P	0.16	0.50	0.50	0.50	0.16	0.50	0.33	0.50	1.00	0.50	0.33	0.50	0.50
Market Share	MS	0.20	0.33	0.50	0.33	0.25	0.33	0.25	0.50	2.00	1.00	0.50	0.50	0.33
Cooperation with suppliers and customer	CSC	0.33	2.00	2.00	2.00	0.33	0.50	0.50	2.00	3.00	2.00	1.00	2.00	2.00
Competitive Pressure	CP	0.33	2.00	2.00	0.50	0.50	0.50	2.00	2.00	2.00	2.00	0.50	1.00	0.50
Collaborative Green Transportation and cold storage	CGT&CS	0.50	2.00	2.00	2.00	0.33	0.50	2.00	2.00	2.00	3.00	0.50	2.00	1.00
	SUM	6.42	26.83	24.00	13.32	4.89	15.66	15.91	26.50	35.00	34.50	14.83	17.00	13.83

3.4.2. AHP analysis

In this stage, the data collection and analysis was made through the AHP methodology. In AHP analysis, comparing the criteria and defining their significance over each other was done by discussing it with the experts from industry and environmental management system which can be seen in comparison matrix Table 5. The AHP method employs different ways to determine the final weights; one of the techniques is geometric mean. The weights in pair-wise comparison matrix of attributes are calculated by following formula shown as Eq. (2), as:

$$r_i = \prod_{j=1}^{n} (a_{ij}) 1/n \tag{2}$$

where, r_i = represents the geometric mean of ith criterion at which $a_{i\ j}$ (i, j = 1 … … … …..n) are the comparison ratios and n = is number of alternatives or factors.

The relative priority of each decisive factor or weightage is then calculated by normalizing this column by dividing each value by the sum of the column (or the sum of the geometric mean values) as in Eq. (3). The values are depicted in Normalized matrix Table 6.

$$w_i = \frac{r_i}{\sum_j r_j} \tag{3}$$

where, w_i = represents the relative priority of ith criterion.

A measure of how far-off a matrix is from consistency is described that having the value of _max (maximum eigenvector or relative weights necessary in calculating the consistency ratio (CR). Then, the consistency index (CI) for each matrix order n is computed by using Eq. (4), as:

$$CI = \frac{\lambda \max^{-n}}{n-1} \tag{4}$$

Where, _max = is the biggest Eigen value at which *n* is the number of criteria RI is the consistency index for a pair-wise comparison matrix which is generated randomly. The final CR is calculated by comparing the CI with the RI as per Eq. (5).

$$CR = \frac{C_1}{R_1} \tag{5}$$

The CR is designed such a way that shows a practical level of consistency in the pair-wise comparisons. If CR value is more than 0.1 or 10%, the inconsistency of judgments inside that matrix has occurred and the evaluation process should therefore be reviewed, reconsidered and enhanced.

3.4.3. Sensitivity and statistical analysis

The sensitivity analysis has been used to find out the sensitivity in assigning weights to formulate comparison matrix. In this work, it has been used to determine the effect of weights on the final ranking of performance indicators responsible for GSCM implementation. The weights in the comparison matrix were assigned by taking average of weights assigned by three experts. The opinion was sought from a team of experts comprising one Professor in the field of supply chain management and two industry experts, (i) General Manager, Bharat heavy electrical company, New Delhi, India (ii) Manager (Quality control), Verka Milk Plant, Jalandhar, India, since they are among leading experts in this region. In this analysis, we have constructed three separate comparison matrix by taking weights of three experts individually. It can be seen from Tables 7–9 that little bit changes have occurred in the ranking of PIs e.g., internal environmental management, environmental design, green purchasing, cooperation with suppliers and customers etc. If we take the opinion of first expert, then environmental design gets first rank and internal environmental management comes at second place, collaborative green transportation and cold storage changes its rank from fifth to fourth, cooperation with suppliers and customer comes at fifth place instead of sixth place earlier and green purchasing comes down to sixth rank. We can notice similar changes in expert opinion two and three. The statistical analysis like mean, mode, median and variance has also been performed on the data to have an estimate about where the middle value of data lies. The results of statistical analysis are shown in Table 10. MS-EXCEL was used to calculate statistical values.

3.4.4. Recommendation of performance indicators

Finally, the ranking of performance indicators is obtained from the results of AHP analysis based on opinion from the three experts as shown in Table 4. Thereafter, these performance indicators were recommended as per their dominance to the agro companies from where the data was collected. Although, the results have been derived based on the data collected from these companies however the research can be further extended to test the effectiveness of these recommended performance indicators.

4. Results and discussion

The following results are derived from the study:

- After extensive literature review and interacting with academic and industrial experts 13 PIs and 79 sub PIs were identified in agro industry.

Table 6
Normalized matrix (cell divided by column sum).

	ED	OP	RL	RP	IEM	GP	GM	ENV.P	ECO.P	MS	CSC	CP	CGT&CS	GM		Identified weightage scale: 0-100	Rank
ED	0.155763	0.149087	0.125	0.225225	0.102249	0.191571	0.188561	0.113208	0.171429	0.144928	0.202293	0.176471	0.144613	3.50625E-11	0.156948	0.168686	16.86859117	2
OP	0.038941	0.037272	0.020833	0.024775	0.051125	0.031928	0.031427	0.018868	0.057143	0.086957	0.033715	0.029412	0.036153	1.29166E-19	0.035238	0.037873	3.78732923	11
RL	0.051402	0.074543	0.041667	0.024775	0.051125	0.021073	0.031427	0.075472	0.057143	0.057971	0.033715	0.029412	0.036153	1.20031E-18	0.04183	0.044958	4.495788523	9
RP	0.051402	0.111815	0.125	0.075075	0.102249	0.191571	0.125707	0.075472	0.057143	0.086957	0.033715	0.117647	0.036153	7.14236E-15	0.081627	0.087732	8.773151988	3
IEM	0.311526	0.149087	0.166667	0.15015	0.204499	0.191571	0.188561	0.226415	0.171429	0.115942	0.202293	0.117647	0.21692	1.99467E-10	0.179406	0.192823	19.28225614	1
GP	0.051402	0.074543	0.125	0.024775	0.067485	0.063857	0.031427	0.075472	0.057143	0.086957	0.134862	0.117647	0.144613	1.38276E-15	0.071942	0.077322	7.732184687	6
GM	0.051402	0.074543	0.083333	0.037538	0.067485	0.127714	0.062854	0.113208	0.085714	0.115942	0.134862	0.029412	0.036153	1.04755E-15	0.070422	0.075688	7.568804733	7
ENV.P	0.051402	0.074543	0.020833	0.037538	0.03272	0.031928	0.020742	0.037736	0.057143	0.057971	0.033715	0.029412	0.036153	2.90985E-19	0.03751	0.040315	4.031489845	10
ECO.P	0.024922	0.018636	0.020833	0.037538	0.03272	0.031928	0.020742	0.018868	0.028571	0.014493	0.022252	0.029412	0.036153	1.45493E-21	0.024954	0.02682	2.682027724	13
MS	0.031153	0.0123	0.020833	0.024775	0.051125	0.021073	0.015713	0.018868	0.057143	0.028986	0.033715	0.029412	0.023861	2.47565E-21	0.025996	0.02794	2.793963923	12
CSC	0.051402	0.074543	0.083333	0.15015	0.067485	0.031928	0.031427	0.075472	0.085714	0.057971	0.067431	0.117647	0.144613	1.39673E-15	0.071997	0.077382	7.738164772	5
CP	0.051402	0.074543	0.083333	0.037538	0.102249	0.031928	0.125707	0.075472	0.057143	0.057971	0.033715	0.058824	0.036153	8.81773E-17	0.058214	0.062568	6.256754481	8
CGT&CS	0.077882	0.074543	0.083333	0.15015	0.067485	0.031928	0.125707	0.075472	0.057143	0.086957	0.033715	0.117647	0.072307	2.11625E-15	0.074336	0.079895	7.989492784	4
															0.930418	1		
0.156948	0.140952	0.125489	0.244881	0.089703	0.215825	0.211265	0.112529	0.149724	0.129978	0.215992	0.174642	0.148671	2.116599916	13.48595				
0.039237	0.035238	0.020915	0.026937	0.044851	0.035971	0.035211	0.018755	0.049908	0.077987	0.035999	0.029107	0.037168	0.487283121	13.82834				
0.051793	0.070476	0.04183	0.026937	0.044851	0.023741	0.035211	0.075019	0.049908	0.051991	0.035999	0.029107	0.037168	0.574030783	13.72306				
0.051793	0.105714	0.125489	0.081627	0.089703	0.215825	0.140843	0.075019	0.049908	0.077987	0.035999	0.116428	0.037168	1.203502779	14.74393				
0.313897	0.140952	0.167319	0.163254	0.179406	0.215825	0.211265	0.225058	0.149724	0.103982	0.215992	0.116428	0.223007	2.426109201	13.52303				
0.051793	0.070476	0.125489	0.026937	0.059204	0.071942	0.035211	0.075019	0.049908	0.077987	0.143995	0.116428	0.148671	1.053059557	14.63768				
0.051793	0.070476	0.083659	0.040814	0.059204	0.143883	0.070422	0.112529	0.074862	0.103982	0.143995	0.029107	0.037168	1.021893748	14.51109				
0.051793	0.070476	0.020915	0.040814	0.028705	0.035971	0.023239	0.03751	0.049908	0.051991	0.035999	0.029107	0.037168	0.513594737	13.69231				
0.025112	0.017619	0.020915	0.040814	0.028705	0.035971	0.023239	0.018755	0.024954	0.012998	0.023759	0.029107	0.037168	0.339114655	13.58955				
0.03139	0.011629	0.020915	0.026937	0.044851	0.023741	0.017605	0.018755	0.049908	0.025996	0.035999	0.029107	0.024531	0.361362571	13.90094				
0.051793	0.070476	0.083659	0.163254	0.059204	0.035971	0.035211	0.075019	0.074862	0.051991	0.071997	0.116428	0.148671	1.038537418	14.42467				
0.051793	0.070476	0.083659	0.040814	0.089703	0.035971	0.140843	0.075019	0.049908	0.051991	0.035999	0.058214	0.037168	0.821557864	14.11272				
0.078474	0.070476	0.083659	0.163254	0.059204	0.035971	0.140843	0.075019	0.049908	0.077987	0.035999	0.116428	0.074336	1.061558098	14.28059				
														14.03491				
														CI		0.086243		
														RI		1.5		
														CR		0.057495		

Table 7
Expert opinion −1.

	ED	OP	RL	RP	IEM	GP	GM	ENV.P	ECO.P	MS	CSC	CP	CGT&CS
ED	1.00	4.00	3.00	4.00	1.00	3.00	3.00	3.00	7.00	5.00	4.00	3.00	2.00
OP	0.25	1.00	0.50	0.33	0.25	0.50	0.50	0.50	2.00	3.00	0.50	0.50	0.50
RL	0.33	2.00	1.00	0.33	0.25	0.33	0.50	2.00	2.00	2.00	0.50	0.50	0.50
RP	0.25	3.03	3.03	1.00	0.50	3.00	2.00	2.00	2.00	2.00	0.50	2.00	0.50
IEM	1.00	4.00	4.00	2.00	1.00	3.00	3.00	6.00	6.00	4.00	3.00	2.00	3.00
GP	0.33	2.00	3.03	0.33	0.33	1.00	0.50	2.00	2.00	3.00	2.00	2.00	2.00
GM	0.33	2.00	2.00	0.50	0.33	2.00	1.00	3.00	3.00	4.00	2.00	0.50	0.25
ENV.P	0.33	2.00	0.50	0.50	0.17	0.50	0.33	1.00	2.00	2.00	0.50	0.50	0.50
ECO.P	0.14	0.50	0.50	0.50	0.17	0.50	0.33	0.50	1.00	0.50	0.33	0.50	0.50
MS	0.20	0.33	0.50	0.50	0.25	0.33	0.25	0.50	2.00	1.00	0.50	0.50	0.33
CSC	0.25	2.00	2.00	2.00	0.33	0.50	0.50	2.00	3.03	2.00	1.00	2.00	3.00
CP	0.33	2.00	2.00	0.50	0.50	0.50	2.00	2.00	2.00	2.00	0.50	1.00	0.5
CGT&CS	0.50	2.00	2.00	2.00	0.33	0.50	4.00	2.00	2.00	3.03	0.33	2.00	1.00

Performance indicators	Identified weightage scale: 0-100	Rank
Environmental Design	18.71738974	1
Internal Environmental Management	18.18196904	2
Regulatory Pressure	8.291745856	3
Collaborative Green Transportation and cold storage.	8.13655584	4
Cooperation with suppliers and customer	7.784294628	5
Green Purchasing	7.714085636	6
Green Manufacturing	7.14795609	7
Competitive Pressure	6.227648432	8
Reverse Logistic	4.474874383	9
Environmental Performance	4.028469222	10
Operational Performance	3.766797552	11
Market Share	2.8735103	12
Economic Performance	2.654703281	13

Table 8
Expert opinion-2.

	ED	OP	RL	RP	IEM	GP	GM	ENV.P	ECO.P	MS	CSC	CP	CGT&CS
ED	1.00	4.00	3.00	3.00	0.25	3.00	3.00	3.00	6.00	4.00	2.00	3.00	2.00
OP	0.25	1.00	0.50	0.33	0.25	0.50	0.50	0.50	2.00	3.00	0.50	0.50	0.50
RL	0.33	2.00	1.00	0.33	0.25	0.33	0.50	2.00	2.00	2.00	0.50	0.50	0.50
RP	0.33	3.03	3.03	1.00	0.50	3.00	2.00	2.00	2.00	3.00	0.50	2.00	0.50
IEM	4.00	4.00	4.00	2.00	1.00	3.00	3.00	6.00	6.00	4.00	3.00	2.00	3.00
GP	0.33	2.00	3.03	0.33	0.33	1.00	0.50	2.00	2.00	2.00	2.00	2.00	2.00
GM	0.33	2.00	2.00	0.50	0.33	2.00	1.00	3.00	3.00	5.00	2.00	0.50	0.75
ENV.P	0.33	2.00	0.50	0.50	0.17	0.50	0.33	1.00	2.00	2.00	0.50	0.50	0.50
ECO.P	0.17	0.50	0.50	0.50	0.17	0.50	0.33	0.50	1.00	0.50	0.33	0.50	0.50
MS	0.25	0.33	0.50	0.33	0.25	0.50	0.20	0.50	2.00	1.00	0.50	0.50	0.33
CSC	0.50	2.00	2.00	2.00	0.33	0.50	0.50	2.00	3.03	2.00	1.00	2.00	1.00
CP	0.33	2.00	2.00	0.50	0.50	0.50	2.00	2.00	2.00	2.00	0.50	1.00	0.5
CGT&CS	0.50	2.00	2.00	2.00	0.33	0.50	1.33	2.00	2.00	3.03	1.00	2.00	1.00

Performance indicators	Identified weightage scale: 0–100	Rank
Internal Environmental Management	20.37908486	1
Environmental Design	15.26838977	2
Regulatory Pressure	8.811170247	3
Collaborative Green Transportation and cold storage.	8.197323341	4
Green Manufacturing	7.97204211	5
Cooperation with suppliers and customer	7.60160398	6
Green Purchasing	7.533042733	7
Competitive Pressure	6.274159344	8
Reverse Logistic	4.508294781	9
Environmental Performance	4.058555663	10
Operational Performance	3.79492971	11
Market Share	2.894970983	12
Economic Performance	2.706432477	13

- That internal environmental management is the most dominating performance indicator which depends on commitment of top management towards implementation of green practices to achieve GSCM and making it as their company policy since quality policy and Mission statement are decided by the top level management.
- Environmental design gets the next highest weightage which ensures the designing of recyclable/reusable product which consumes less material and less harmful.
- The government regulatory pressure is ranked 3rd which clearly shows that the regulatory bodies can also play an important role in implementing GSCM.

Table 9
Expert opinion-3.

	ED	OP	RL	RP	IEM	GP	GM	ENV.P	ECO.P	MS	CSC	CP	CGT&CS
ED	1.00	4.00	3.00	2.00	0.25	3.00	3.00	3.00	5.00	6.00	3.00	3.00	2.00
OP	0.25	1.00	0.50	0.33	0.25	0.50	0.50	0.50	2.00	3.00	0.50	0.50	0.50
RL	0.33	2.00	1.00	0.33	0.25	0.33	0.50	2.00	2.00	2.00	0.50	0.50	0.50
RP	0.50	3.03	3.03	1.00	0.50	3.00	2.00	2.00	2.00	4.00	0.50	2.00	0.50
IEM	4.00	4.00	4.00	2.00	1.00	3.00	3.00	6.00	6.00	4.00	3.00	2.00	3.00
GP	0.33	2.00	3.03	0.33	0.33	1.00	0.50	2.00	2.00	4.00	2.00	2.00	2.00
GM	0.33	2.00	2.00	0.50	0.33	2.00	1.00	3.00	3.00	3.00	2.00	0.50	0.50
ENV.P	0.33	2.00	0.50	0.50	0.17	0.50	0.33	1.00	2.00	2.00	0.50	0.50	0.50
ECO.P	0.20	0.50	0.50	0.50	0.17	0.50	0.33	0.50	1.00	0.50	0.33	0.50	0.50
MS	0.17	0.33	0.50	0.25	0.25	0.25	0.33	0.50	2.00	1.00	0.50	0.50	0.33
CSC	0.33	2.00	2.00	2.00	0.33	0.50	0.50	2.00	3.03	2.00	1.00	2.00	2.00
CP	0.33	2.00	2.00	0.50	0.50	0.50	2.00	2.00	2.00	2.00	0.50	1.00	0.50
CGT&CS	0.50	2.00	2.00	2.00	0.33	0.50	2.00	2.00	2.00	3.03	0.50	2.00	1.00

Performance indicators	Identified weightage scale: 0–100	Rank
Internal Environmental Management	20.28632239	1
Environmental Design	15.46202958	2
Regulatory Pressure	9.25141987	3
Collaborative Green Transportation and cold storage.	7.981417693	4
Green Purchasing	7.909430786	5
Cooperation with suppliers and customer	7.736322362	6
Green Manufacturing	7.395668896	7
Competitive Pressure	6.245600335	8
Reverse Logistic	4.487773715	9
Environmental Performance	4.040081741	10
Operational Performance	3.777655773	11
Economic Performance	2.732163637	12
Market Share	2.694113213	13

Table 10
Statistical analysis.

	Mean	Mode	Median	Variance
ED	4.506	5	5	0.943
IEM	4.316	5	5	1.346
GP	3.346	4	4	2.228
GM	4.235	5	5	1.292
COLL	3.622	5	4	2.678
RL	2.953	1	3	3.379
COOP	3.931	5	4	1.411
EP	4.574	5	5	0.786
OP	4.025	5	4	1.415
MS	4.176	4	4	0.885
REG.P	3.824	5	4	2.028
COM.P	3.804	5	4	2.081
Overall	**3.926**	**5**	**4**	**1.898**

It can easily be inferred from Table 3 that the collected data is initially tested for consistency using Reliability analysis in order to assess that how reliable these performance indicators are. The reliability test analysis results depict that the value of Cronbach's alpha (α) of all the 13 performance indicators is ranging from 0.729 to 1.00 is more then 0.6 (desirable value) that concludes that each one is arranged to its proper scale. The results of reliability analysis are also depicted in Bar Chart Fig. 4. The ranking of all the performance indicators is shown in Table 4. The ranking is actually based on AHP approach. It reveals that overall ranking is obtained by comparing the criterion and defining their importance over each other. The ranking of all the 13 performance indicators has been done using AHP analysis. The results of AHP analysis are shown in Pie Chart Fig. 3. Thereafter, Sensitivity analysis is performed to conclude the uncertainty in final ranking of PIs and the results reveal that by taking individual opinion of three experts, the assigned weights also changes to some extent in the comparison matrix thus final ranking of PIs also changes by negligible amount. It can be noticed from Table number 4, 7, 8 and 9 that there is no change in the ranking of PIs vis-à-vis regulatory pressure, competitive pressure, reverse logistics and operational performance etc. However in other PIs e.g. environmental design, internal environmental management, collaborative green transportation and cold storage, economic performance, cooperation with suppliers and customers, green purchasing, green manufacturing and market share ranking is altered by one or two steps. The range of change in weight percentage for each PI to study the effect was considered to be ±10%. The range was selected based upon the analysis of variation in subjective opinion of three experts considered in the study (Table 11). The subjectivity in the opinion of the experts can further be tackled by increasing the number of experts as well as by using fuzzy set theory. The calculated value of CR also shows consistency of judgment within the matrix. Furthermore, utilizing the result of previous study on measurement model for GSCM by Zhu et al. (2008a), wherein twenty one measurement items are identified as critical factors of the five underlying factors of GSCM, this study further extends in the same direction and extracted 79 sub-performance indicators and 13 performance indicators responsible for GSCM execution. The present study is also in accordance with the previous study conducted on green supply chain practices and performances in an automobile industry Diabat et al., 2013 which clearly states that 'internal environmental management' is the most significant GSCM performance and the present study also depicts the same result.

5. Conclusion

GSCM is a modern approach to improve ecological and economical performance along with improvement in operational parameters. It helps to produce the product with less material and

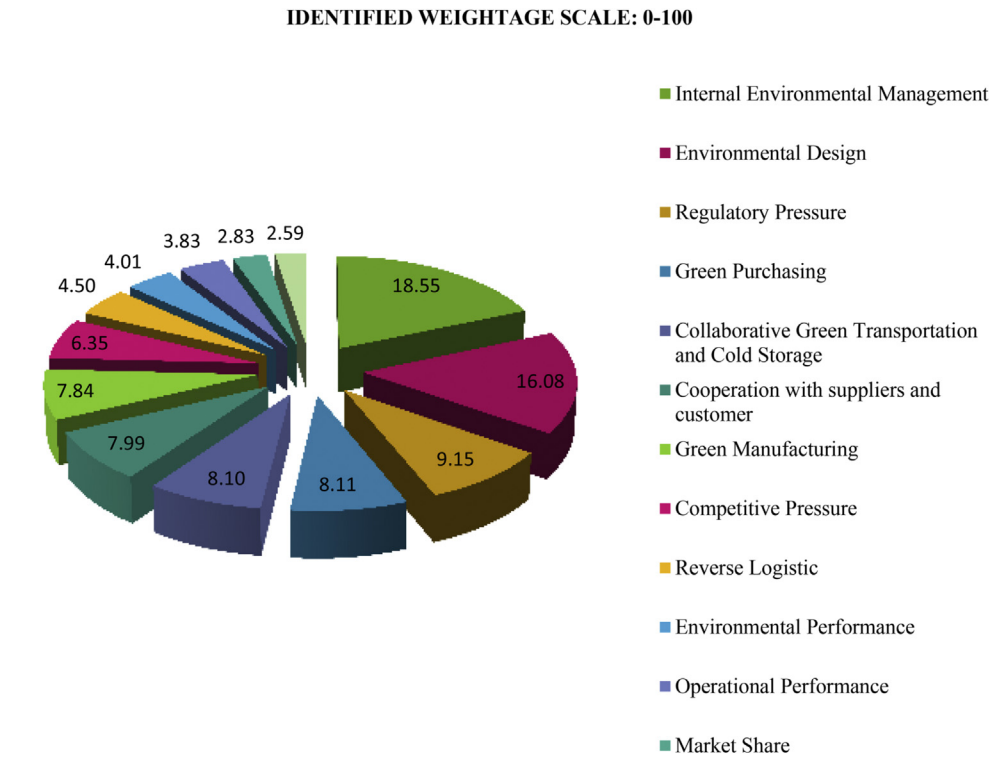

Fig. 3. Pie-Chart showing the results of AHP analysis.

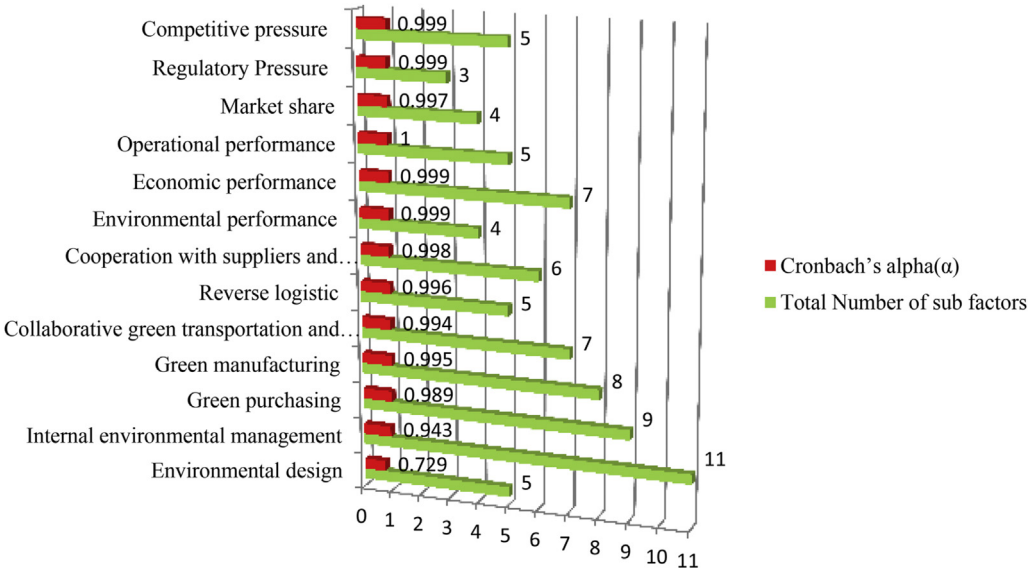

Fig. 4. Bar-Chart showing the results of Reliability analysis.

energy use. Green supply chain management certainly helps to achieve sustainability. In this paper crucial performance indicators are extracted through extensive literature review and personal in-depth interviews with industrial experts. These performance indicators will be further used to implement GSCM. After obtaining results of data analyses following inferences are drawn. GSCM implementation has become very crucial for any industry to have competitive edge in the market. It can only be successfully implemented if everyone in the company where it is to be implemented works like a link in the chain. The PIs are determined after literature review and during the research 79 sub PIs are identified under the main 13 PIs see Table 2. The reliability analysis is done using SPSS software and the ranking of PIs is done by AHP analysis. This work is limited to Agro industry and the future work can be extended to find out the effectiveness of the suggested performance indicators in agro industry.

Table 11
Range of change in weights for each PIs.

S. No	Performance Indicator P.I.	Mean identified weightage (A)	Identified weightage of expert Opinlon-1 (B)	Difference in identified weightage (C = (B-A))	%Age difference $\left(M1 = \frac{C*100}{A}\right)$	Identified weightage of expert Opinion-2 (D)	Difference in identified weightage (E = (D-A))	%Age difference $\left(M2 = \frac{E*100}{A}\right)$	Identified weightage of expert Opinion-3 (F)	Difference in identified weightage (G = (F-A))	%Age difference $\left(M3 = \frac{G*100}{A}\right)$	% Age range of difference in identified weightage (Minimum to maximum values of M1,M2 &M3)
1	Internal Environmental Management	18.55932308	18.18196904	−0.37735404	−2.033231699	20.37908486	1.81976178	9.805108582	20.28632239	1.72699931	9.305292561	−2.03 to 9.80
2	Environmental Design	16.08001923	18.71738974	2.63737051	16.40153828	15.26838977	−0.81162946	−5.047440854	15.46202958	−0.61798965	−3.84321462	−5.04 to 16.40
3	Regulatory Pressure	9.153163769	8.291745856	−0.861417913	−9.411149355	8.811170247	−0.341993522	−3.736342216	9.25141987	0.0982561	1.073466	−9.41 to 1.07
4	Green Purchasing	8.116817	7.714085636	−0.402731364	−4.96169082	7.533042733	−0.583774267	−7.192157554	7.909430786	−0.20738621	−2.555018969	−7.19 to-2.55
5	Collaborative green Transportation and Cold storage	8.109793615	8.13655584	0.026762225	0.329998842	8.197323341	0.087529726	1.079308921	7.981417693	−0.12837592	−1.582973971	−1.58 to 1.07
6	Cooperation with Supplier & Customers	7.993230462	7.784294628	−0.208935834	−2.613909795	7.60160398	−0.391626482	−4.899476924	7.736322362	−0.2569081	−3.214070972	−4.89 to-2.61
7	Green Manufacturing	7.847403538	7.14795609	−0.699447448	−8.913106668	7.97204211	0.124638572	1.588277848	7.395668896	−0.45173464	−5.756485439	−8.91 to 1.58
8	Competitive Pressure	6.353709923	6.227648432	−0.126061491	−1.984061163	6.274159344	−0.079550579	−1.252033536	6.245600335	−0.10810959	−1.701519102	−1.98 to-1.25
9	Reverse Logistic	4.506762308	4.474874383	−0.031887925	−0.707557284	4.508294781	0.001532473	0.034003857	4.487773715	−0.01898859	−0.421335578	−0.70 to 0.03
10	Envirmental Performance	4.014138077	4.028469222	0.014331145	0.357016742	4.058555663	0.044417586	1.106528603	4.040081741	0.02594366	0.646307215	0.35 to 1.10
11	Ope rational performance	3.835001923	3.766797552	−0.068204371	−1.778470321	3.79492971	−0.040072213	−1.044907247	3.777655773	−0.05734615	−1.495335626	−1.77 to-1.04
12	Market Share	2.838126769	2.8735103	0.035383531	1.246721302	2.894970983	0.056844214	2.002877906	2.694113213	−0.14401356	−5.074246773	−5.07 to 2.00
13	Economic Performance	2.592838231	2.654703281	0.06186505	2.385997293	2.706432477	0.113594246	4.381077255	2.732163637	0.13932541	5.37347083	2.38 to 5.37

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