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Environmental impact analysis of supply chain management of cement in construction site

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ABSTRACT

A significant segments of cement will be concrete, which has its own natural and social effects and contributes generally to those solid. .The cement industry is the one of the main producers of carbon dioxide ,a potent green house gases .Concrete causes damage to the most fertile layer of the earth. Building industry is one of the leaders in deterioration of environment by depleting resources and consuming energy. Emissions from Cement manufacturing are one of the major contributors in global warming and climate change. Concrete has a place with the frequently utilized structure materials and its creation is expanding over the world. But the cement industry is an energy enormous intensive and produce many emissions, odours and noise. The need to green the supply chain has therefore become critically important .Green supply chain management (GSCM) is considered as an environmental innovation. The concept of GSCM is to integrate environmental thinking into supply chain management. GSCM aims to minimize or eliminate wastages including hazardous chemical, emissions, energy and solid waste along supply chain such as product design, material resourcing and selection, manufacturing process, delivery of final product and end-of-life management of the product. In this project, green supply chain factors in cement industry are collected from literatures and green indices are prepared based on the collected data. Relative Importance Index is used to rank the environmental impacts

Index terms: Carbon emission, Cement, Environmental impact, Green supply chain management

INTRODUCTION

The use of cement has long been the basis for development of society and for the welfare of the people for generations. Concrete, which is made from cement, has been the ultimate material for construction. Cement manufacturing process is technology intensive. Building industry is one of the leaders in deterioration of environment by depleting resources and consuming energy. Environmental pollution and climate change have turned out to be one of the greatest challenges of the 21st century. The challenge is particularly acute for the construction sector due its outsized environmental footprint. The need to green the construction sector has therefore become critically important. Green Supply Chain Management (GSCM) incorporates environmental concerns into supply chain management, and has emerged as a holistic environmental management approach with environmental impacts of a product typically occurring at all its lifecycle stages. The cement industry faces many challenges due to environmental concerns and sustainability issues. To face challenges, these days companies are increasingly focusing on environmentally conscious supply chain, also called as green supply chain.

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AIMS AND OBJECTIVES

The main aim of the project is to analyse the environmental impact of cement consumption in construction site. The main objective behind this is to identify the green supply chain factors during consumption of cement in construction site using green indices obtained from literature.

- To evaluate the impact of the green supply chain factors based on the collected data.
- To propose a model for calculating the embodied carbon of the green supply chain factor having maximum impact on the environment.
- To validate the model through case studies.
- To propose remedies to reduce the environmental impact during the consumption of cement.

METHODOLODY

Through literature study, green supply chain factors affecting the environmental impact of consumption of cement are identified. Green indices are prepared to identify the most important factor. Green indices are analysed using Relative Importance Index (RII) method. Embodied carbon of cement during the transportation and construction stages of buildings is calculated using Life Cycle Assessment (LCA). Remedies are proposed to reduce the environmental impact of cement in construction site based on literature review.

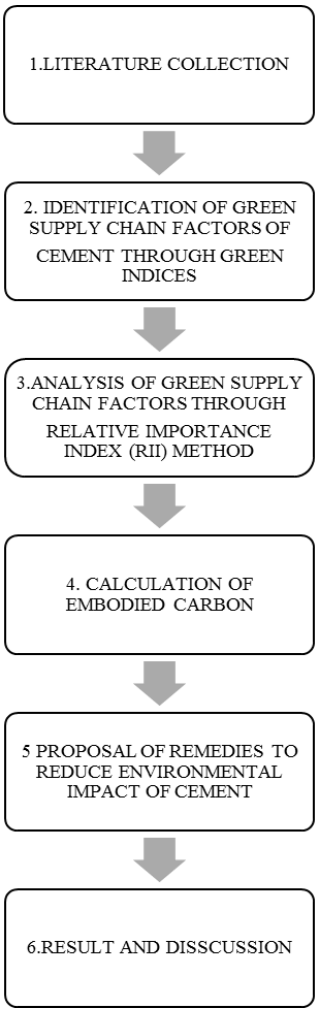

Figure 1 Step by step process of methodology

DATA COLLECTION

In order to find the environmental impact of supply chain management during the consumption of cement in construction site, green indices are prepared. Factors are identified through literature study and prioritised using relative importance index based on thegreen indices. Data were collected from ten sites in Ernakulum district. In this project, embodied carbon emission of cement during the transportation and construction stages was calculated.

Sl. No.	Factors	RII	Rank
1	Carbon footprint	0.848	1
2	Energy usage	0.716	2
3	Reduce usage of cement	0.708	3
4	Pollution	0.692	4
5	Recycle	0.644	5
6	Disposal	0.644	6
7	Life cycle cost	0.556	7
8	Reuse	0.552	8
9	Packaging of cement	0.548	9
10	Processing of cement	0.440	10
11	Source reduction	0.408	11
12	Recovery	0.344	12
13	Collection of cement	0.288	13
14	Distribution of cement	0.280	14
15	Sorting of cement	0.260	15

The major factor causing environmental impact of supply chain management during the consumption of cement in construction site have been identified using green indices. Greenindices are a technique of summarizing environmental impacts into a simple score. Green indices incorporating 15 factors were prepared to evaluate the environmental impact during the consumption of cement in construction site. To facilitate the answers, a five-point Likert- type scale (from 1 = No effect at all to 5 = Critically Important) was adopted for rating by the respondents.

Relative Importance Index, $$\mathbf{RII} = \frac{\sum \mathbf{W}}{(\mathbf{a} \times \mathbf{n})}$$

W = Weight provided to every factor by the respondents (range 1-5)
a= Maximal weight (i.e. 5)
n = Total number of respondents

ANALYSIS AND FINDINGS

After collecting the data the relative importance index (R.I.I) was calculated the major environmental impact by the consumption of cement was analyzed using Relative Importance Index (RII).

Calculation of embodied

Carbon of cement

Embodied carbon was calculated using the life cycle assessment. In this project, the carbon emissions during the transportation and construction stages are considered.Project chosen for the analysis was a 5 storey building located near Kalikkotta palace, Tripunithura, Ernakulam

Table -1: RII Value and Ranks

.CO2 emissions of a building during the transportation and construction stages

$$C_{EM} = C_T + C_C$$

C_{EM}= Embodied CO2 emissions (kgCO2)
C_T, C_C= Equivalent CO2 emissions at transportation and construction stages

$$CT=\sum_{i=1}^{n}[(m_i/T)\times d_i\times T\times f_{t,n}] = 1$$

T = capacity of transportation vehicle (Ton)
d_i = 2-way distance between material supply point to construction site (km)
ft,i = carbon emission factor for material transported over unit distance (kgCO2/km).
Cement used in the project is Ultratech cement andits nearest manufacturing plant is located at Reddipalayam, Tamil Nadu. Rail and road transportation modes where used for the transfer of cement. Rail transport was used to transfer the cement produced from manufacturing plant to the nearby metro hub, in this case Kochi, Kerala.

Emission at construction stage

Cement used for construction of substructure, superstructure and envelope materials of buildings is considered for calculation of embodied carbon

$$CC=\sum_{i=1}^{n}[(Q_{c,i}\times f_{c,i})]$$

j = total number of construction activities
$Q_{c,i}$= quantity of construction activity i
$f_{c,i}$= carbon emission factor for fuel/electricity used for the construction

Table -2: Total embodied carbon at transporation stage

Sl. No.	Material	Quantity (mi) (Tonnes)	Capacity of vehicle, T (Tonnes)	Distance, di (Km's)	Carbon emission coefficient, (f t,i) (Kg.CO2e /T.Km)	Eq.CO 2 at transportati on stage (Tonnes)
1	Cement (Freight Train)	720.1	2420	1108	0.026	20.74
	Cement (12 W Truck)		21	74	0.296	15.77
	Solid Block (6 W Truck)	453.6	9	172	0.5	3
CT, Embodied carbon at Material Transportation Stage (in Tonnes)						75.53

Table -3: Total embodied carbon emission of buildings

Site	Embodied CO_2e at transportation stage (Tonnes)	Embodied CO_2e at construction stage (Tonnes)	Total Embodied CO_2e (Tonnes)
Site 1	75.53	598	673.53
Site 2	85.4	625.9	711.3
Site 3	75.2	562.62	637.82
Site 4	90.1	614.8	631.77
Site 5	75.3	517.9	704.9
Site 6	65.3	743.3	808.6
Site 7	80.8	656.3	737.1
Site 8	105.3	625.9	731.2
Site 9	77.8	745.01	822.81
Site	81.8	621.5	703.3

RESULT AND DISCUSSION

Remedies

The impact of transportation is an important contributor to the embodied carbon of buildings. The main factors which affect the transport emission of materials are quantity of material to be transported, size of the material, transportation distance, mode of transport and the number of trips.

1. Introduce low carbon fuels
2. Increase vehicle fuel economy
3. Introduce low carbon fuels
4. Increase vehicle fuel economy
5. Improve transportation system efficiency
6. Reduce carbon intensive travel activity
7. Improving the machine efficiency
8. Selection of material with lower cabon intensity

CONCLUSION

From the literature studies, fifteen Green supply chain factors during consumption of cement in construction sites were identified. Green Indices are prepared to analyse these factors. Based on the collected data, the impact of the green supply chain factors were evaluated using Relative Importance Index (RII) method. Among the factors, Carbon footprint is the major environmental impact caused due to the consumption of cement in buildings during the construction of cement were discussed.

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