

# Review On Implementation of Green Supply Chain - A Comparative Analysis between Small, Medium and Large Scale Construction Industries

Toke Monika Prabhakar<sup>1</sup>, Dr. Sumant Kulkarni<sup>2</sup>

ME Student, Department of Civil Engineering, D.Y. Patil Institute of Engineering, Ambhi, Talegaon, Pune, India<sup>1</sup>

Professor, Department of Civil Engineering, D.Y. Patil Institute of Engineering, Ambhi, Talegaon, Pune, India<sup>2</sup>

**ABSTRACT:** The significance of GSCM in greening the building sector in addition to the inherent gaps in the literature formed the inspiration of the analysis, in which an extensive, theory enabled GSCM exploration is going to be performed on the construction market addressing the implementation of different eco-friendly practices across all key development (from first advancement of the look to end of recycling) and life demolition, drivers for and obstacles to the implementation of theirs (antecedents) and their various performance implications (outcomes), all with the amount of individual stakeholders, Architects/Consultants, i.e. Developers, Contractors/Subcontractors and also material Suppliers. The study will even check out the impact of (stakeholder) firm size plus ownership, so that any intrinsic differences could be fully understood and also delineated. Furthermore, the analysis is going to try to produce a higher-level abstraction on the GSCM concept in building with the application of established/emerging management theories, based on how and where these theories could, separately and in conjunction, help with providing a much deeper, more and broader simplified conceptualization of GSCM perspectives. Because of the medical idea that good theoretical ideas are essential for managerial and decision-making activities also the development of any area (Paulraj and Chen, 2004)[11], the theoretical underpinnings of this particular research are likely to improve the useful application of GSCM within the building market and in common, along with add significantly towards further theoretical development of the industry. The particular goals of this particular research are therefore as follows: one. Understand the different GSCM elements because of the building segment, specifically eco-friendly practices, drivers for and obstacles to the implementation of theirs, and the impact of it's on the financial and environmental performance (long-term and short-term) of companies across every supply chain stakeholder two. Recognize the crucial inter relationships between these GSCM aspects vital for greening the building market three. Understand the effect of firm size in addition to ownership on the GSCM aspects four. Offer several theoretical perspectives in realising the multifaceted reality of GSCM within the building market. In general, this detailed, theory enabled Resulting insights and GSCM investigation are likely to give policymakers and practitioners with an all-inclusive comprehension of the different circumstances needed for greening the building supply chain and consequently the sector.

**KEYWORDS:** Green Supply Chain, Construction Industries, Environmental Issues

## I. INTRODUCTION

### 1.1. Criticality of responding to environmental issues

Because of the mankind's quest for industrial modernization and economic growth, the similar problems of resource depletion, climate change, and environmental pollution have grown to be among the best problems of the 21st century (IPCC, 2007). The entire worldwide greenhouse gas (GHG) emissions, the primary driver of climate change, amounted to roughly 52.7 gigatonnes of carbon dioxide equivalent (GtCO<sub>2</sub>e) in 2014, the best amount reported since the pre-industrial ph levels (UNEP EGR, 2014). Furthermore, the increased the yearly price of GHG emissions during the period 2000 2010 was faster (2.2 %) than during the period 1970 2000 (1.3 %) (UNEP EGR, 2016)[16]. The consequences of these emissions, largely in the type of climate change and rising ocean levels are plainly apparent. For example, 2015 was probably the hottest year recorded after today's record keeping plus ten of probably the warmest years on record have happened since 2000 (UNEP EGR, 2016). Likewise, the speed of rising ocean levels has accelerated recently (EPA, 2017).

The major thrust for economic growth and also industrialization is amplifying the depletion of all natural resources. At today's prices of use, the earth will quickly exhaust many essential information such as renewable resources, as several

of them require much longer periods being replenished. For instance, examination by the U.S. Electrical energy Information Administration (EIA) reveals that at the present price of use, fossil fuels are completely depleted within the next 25 years (EIA IEO, 2013)[13]

The necessity for immediate action to tackle these issues has bestowed growing responsibility on businesses and governments equally to minimize the green impacts of the activities of theirs (IPCC, 2007)[5]. Though there are already efforts before to deal with these environmental problems such as for instance natural design or design of the atmosphere (Dowie, 1996), Fiksel, green and environmental conscious purchasing (Galle and Min, 1997)[10], environmentally friendly manufacturing (Owen, 1993, Florida and Atlas, 1998)[5], re-manufacturing and lean (Van der Laan et al., 1996; Florida, 1996), reverse logistics (Pohlen, and also Farris, 1992; Kopicki, Legg, and also Novak, 1993) [11]and implementation of environmentally friendly control systems (Starkey, 1998)[16], they haven't been as helpful as they might be because virtually all of these green/environmental initiatives have been undertaken in a "fragmented" and "disconnected" manner from one another (Rogers and Carter, 2008)[18]. Organisations and governments worldwide have finally understood the demand for additional systematic and also integrated approaches to dealing with ecological problems.

### 1.2. A supply chain strategy to greening or maybe eco-friendly supply chain management Green supply chain management (GSCM)

Perhaps incorporating ecological issues into supply chain management (Srivastava, 2007)[32], has emerged in the recent past as an integrated and systematic method of dealing with the environmental issues of different sectors such as for instance general production, automobile, electrical and electronics (Kant and Malviya, 2015)[25]. This's because professionals and policymakers have begun to understand that the life cycle green impacts of product/project are dispersed across its supply chain development from design to end of life (Hervani et al., 2005; Wu et al., 2011)[16]. The primary objective of GSCM is to guarantee effective, extensive and effective implementation of 'green practices' or perhaps activities/initiatives to decrease the ecological footprint across the different supply chain stages (Klassen and Awaysheh, 2010; Perotti et al., 2012) [18] by means of handling the 'antecedents,' i.e. drivers as well as barriers affecting the implementation of environmentally friendly practices (Walker et al., 2008; Drohomerecki et al., 2014; Luthra et al., 2015)[20] to get the desired 'performance outcomes', i.e. environmental performance along with short term and long term economic performance (Holt and Rao, 2005; Green et al., 2012).[25]

For seamless application of GSCM in any industry, it's crucial that these 'green practices' and associated 'antecedents' and 'performance outcomes' are handled with the amount of individual stakeholders (in a field) therefore the conflicting interests of theirs will be healthy for a single, sector wide greening (Hervani et al., 2005; Gold et al., 2010; Drohomerecki et al., 2014)[32]. This's because the general greening of any product/project may be the sum total of complementary and occasionally overlapping efforts undertaken at the different supply chain development (from the original style to the end-of-life demolition) by related stakeholders, and also laggardness of any phase or perhaps stakeholder might negatively impact the complete greening efforts (UN Global Compact, 2010)[33]. Moreover, it's essential to control the impact/influence of firm qualities including ownership and size on the different areas of GSCM (Zhu et al., 2008a; 2008b)[21]. This's because an ordinary supply chain is going to comprise many firms with different ownership and sizes and also general greening of the supply chain is directly connected to the dedication & participation of all the involved firms. Overall, the use of GSCM provides considerable possibilities for curtailing the adverse environmental implications related to every sector.

### 1.3. Green supply chain management within the building sector

Among the different sectors, the building market continues to be labeled as the only one with the best opportunity to fight climate change and resource depletion (IPCC, 2007; Dommissie and Pinkse, 2009; GhaffarianHoseini et al., 2013)[41]. This's because the building market will be the single biggest contributor, accountable for one third of worldwide co2 emissions, one third of worldwide resource usage, forty % of the world's power usage, forty % of worldwide waste created, along with twenty five % of the world's full water consumption (UNEP SBCI, 2016). With continuously growing urbanization [approximately seventy % of the world 's population is anticipated to exist in areas that are urban by 2050 (UN DESA, 2014)] plus the ensuing increased building activities, green effects could be anticipated to get greater down the road. This's much additional intense in developing countries/emerging economies, pushed by the desire to meet up with the increasing challenges of growing populations and growing middle classes (UNEP SBCI, 2014). Thus, the requirement to combat/curtail the adverse environmental effects or perhaps greening the building market is now important to make certain the survival of the future generations of ours.

Like any other sectors, the building market may also significantly profit from the application of GSCM. This's because the green ramifications of a construction/building task (and so the industry) are distributed across its supply chain (Ng et al., 2012)[9]. For example, eco-friendly methods, the main tenet of GSCM, is put on to control the green impacts linked to a broad range of tasks in the building supply chain, beginning from the extraction of raw materials of

construction items for their distribution and manufacturing; building design, procurement, onsite construction, maintenance, end and renovation of daily life demolition (Hatmoko, 2008). Additionally, provided the inherent intricacy of the building supply chain with multiple stakeholders (Developers, Suppliers, Contractors, and architects/consultants) involved at various supply chain phases of a task (EdumFotwe et al., 1999)[10], with each making a good reputation for adversarial relationships and low trust with other people in the supply chain (Korczyński, 1996; Akintoye et al., 2000)[13], the scope of GSCM appears to be greater for the field for dealing with its antecedents like the conflicting passions and issues of various stakeholders and in getting them to apply environmentally friendly methods on the very best of the abilities of theirs in a coherent fashion vis-à-vis various other supply chain stakeholders. Further, companies in the building segment, that is noted for its bad performance and also low profit margins (Agapiou et al., 1998, Ning and Yeo, 2002, Ireland and Cox, 2002) [18], may wear GSCM as a supply of competitive advantage to obtain substantial monetary performance together with improved environmental performance. Besides, with an ordinary construction project containing hundreds, if not thousands of companies with different ownership and size, GSCM is crucial in ensuring the involvement and dedication of all companies within the supply chain.

However, despite its possible, very little is thought about the use of GSCM within the building market. Today, no scientific studies published over the building market were equipped to perform a systematic and comprehensive GSCM investigation addressing the different supply chains stages & stakeholders. Any restricted attempts up to now by investigators and practitioners designed for the use of GSCM within the building market were mostly fragmented and disjointed, focusing on aspects primarily from a person stakeholder's point of view like the Developer (Abidin, 2010) or maybe the Contractor (Qi et al., 2010)[23], covering just a narrow selection of GSCM problems, for example, certain eco-friendly practices for instance natural purchasing (Varnas et al., 2009)[42], or maybe antecedents of certain green practices like drivers of green building (Qi et al., 2010) or maybe barriers to earth friendly purchasing (Sohail and Sourani, 2010), or maybe particular performance outcomes such as for instance environmental performance (Tam et al., 2006)[25]. The myopic dynamics of these investigations means that the intertwined dynamics of the different supply chain stages and stakeholders, that are central to greening the building segment, aren't adequately shot and also known, and consequently run the chance that policymakers and practitioners might wrongly be dealing with the incorrect issues and also neglecting the ones that have much more significance. Moreover, just a small quantity of research has regarded as the effect of firm characteristics on GSCM aspects.

Thus, the intrinsic disparities within the eco-friendly behavior of various companies (in regards to ownership and size) within the supply chain aren't adequately understood. Additionally, given the small quantity of GSCM related studies in the building segment, a lot of vital factors of GSCM like natural transportation, consumer impact on environmentally friendly methods and long term organizational advantages of environmentally friendly practices on earnings, market share and also go back on investment seem to have noticed minimum investigation.

Finally, not one of the GSCM related studies in the building market seems to have tried established/emerging management/organizational theories to underpin the findings of theirs. For professionals and policymakers confronted with the truth of handling complex sustainability challenges, the buildup of empirical proof is of limited value unless accompanied by common principles that could inform broader application (Rogers and Carter, 2008)[38]. Thus, it restricts the transferability and the generalizability of the results and frameworks created with the building industry inside a nation context to that of other, too across several sectors (Walker and Touboulic, 2015).[43]

#### 1.4. Objectives of this particular research

The significance of GSCM in greening the building market in addition to the inherent gaps in the literature formed the inspiration of the analysis, in which an extensive, theory enabled GSCM exploration is going to be performed on the construction market addressing the implementation of different eco-friendly practices across all key development (from first advancement of the look to end of recycling) and life demolition, drivers for and obstacles to the implementation of theirs (antecedents) and their various performance implications (outcomes), all with the amount of individual stakeholders, Architects/Consultants, i.e. Developers, Contractors/Subcontractors and also material Suppliers. The study will even check out the impact of (stakeholder) firm size plus ownership, so that any intrinsic differences could be fully understood and also delineated. Furthermore, the analysis is going to try to produce a higher-level abstraction on the GSCM concept in building with the application of established/emerging management theories, based on how and where these theories could, separately and in conjunction, help with providing a much deeper, more and broader simplified conceptualization of GSCM perspectives. Because of the scientific idea that good theoretical ideas are essential for managerial and decision-making actions and the

Development of every area (Paulraj and Chen, 2004)[39], the theoretical underpinnings of this particular research are likely to improve the useful application of GSCM within the building market and in common, along with add significantly towards further theoretical development of the industry.



The particular goals of this particular research are therefore as follows:

1. Comprehend the different GSCM elements because of the building segment, specifically eco-friendly practices, drivers for and obstacles to the implementation of theirs, and the impact of it's on the financial and environmental performance (long-term and short-term) of companies across every supply chain stakeholder
2. Identify the crucial inter relationships between these GSCM aspects vital for greening the building sector
3. Understand the effect of firm size in addition to ownership on the GSCM aspects
4. Offer several theoretical perspectives in realizing the multifaceted reality of GSCM within the building market.

In general, this detailed, theory enabled Resulting insights and gscm investigation are likely to give policymakers and practitioners with an all-inclusive comprehension of the different circumstances needed for greening the building supply chain and consequently the sector.

**1.5 Sectorial gaps in green supply chain management application**

Regardless of the substantial improvement & use of GSCM within the previous ten years, a key problem determined in this particular assessment would be that the uptake of GSCM across numerous sectors is irregular. The building segment, and that is the emphasis of the thesis, has seen only extremely minimal application. For example, an evaluation of 177 GSCM related studies by Kant and Malviya (2015) [21] demonstrates the emphasis of GSCM is primarily in sectors like auto, overall production, chemical and electronic industry. Table 2.3 reveals the sectorial gaps in the GSCM literature found by Kant and Malviya (2015). As observed in the table, the comment might just connect one study in GSCM that has several importances on the building market.

**Table 1.1 Frequency of GSCM studies by sector**

Industry	Frequency
Automotive industry	15
Manufacturing industries	14
Electronics industry	11
Chemical industry	7
Computer industry	5
Textile and apparel industry	5
Fashion industry	4
Logistics industry	4
Printing Industry	4
Apparel industry	2
Food and beverage industry	2
Hotel Industry	2
Semiconductor industry	2
Pulp and paper industry	2
Service industry	2
Mining industries	2
Construction industry	1

This loss of program of GSCM within the building market may be due to the inherent intricacy of the field as well as its supply chain (Vrijhoef, 1998; Hatmoko, 2008)[21]. Because of the small amount of GSCM studies in construction, the range of the critique in this particular chapter will expand to include green/environmental studies in building which have examined isolated but related factors of GSCM. These're described as GSCM related studies. Nevertheless, before conducting the assessment, it's essential to recognize the intrinsic attributes of the building supply chain like the functions & duties of its key stakeholders; the order/information flow in the supply chain; the materials/deliverables run in the supply chain as well as the uniqueness/differences and also parallels with some other sectors like production. This may expose several of the likely opportunities and challenges within the use of GSCM in construction, which can

condition the emphasis on the assessment of GSCM related studies in building and in framing re-research questions. The second part, therefore, covers the natural attributes of the building supply chain.

### 1.6 Construction supply chain - key features and stakeholders

As observed in figure 1.1, the important stakeholders in the building supply chain are Developers, Main Contractor, Architects/Consultants, Suppliers and Subcontractor. The primary responsibilities and roles of these stakeholders are as follows:

- The Developer could be the person who initiates the task and also consequently benefits from a hierarchical position with strength in the supply chain to affect the entire project through the decisions of its on creating the project and also procurement system (Haslam and Bresnen, 1991). Because of this, Developers are deemed to be the most crucial stakeholder within the building supply chain (Briscoe et al., 2004). Thus, their strategic decisions are essential for making environmentally friendly supply chains, as their green building requirements will play a pivotal part in the eco-friendly behavior of different downstream supply chain stakeholders.
- The Architects/Consultants are generally accountable for the structure style and professional management providers like a planning of tender documents, specialized analysis of tender bids for the number of the key contractor and ultimate commissioning of projects.

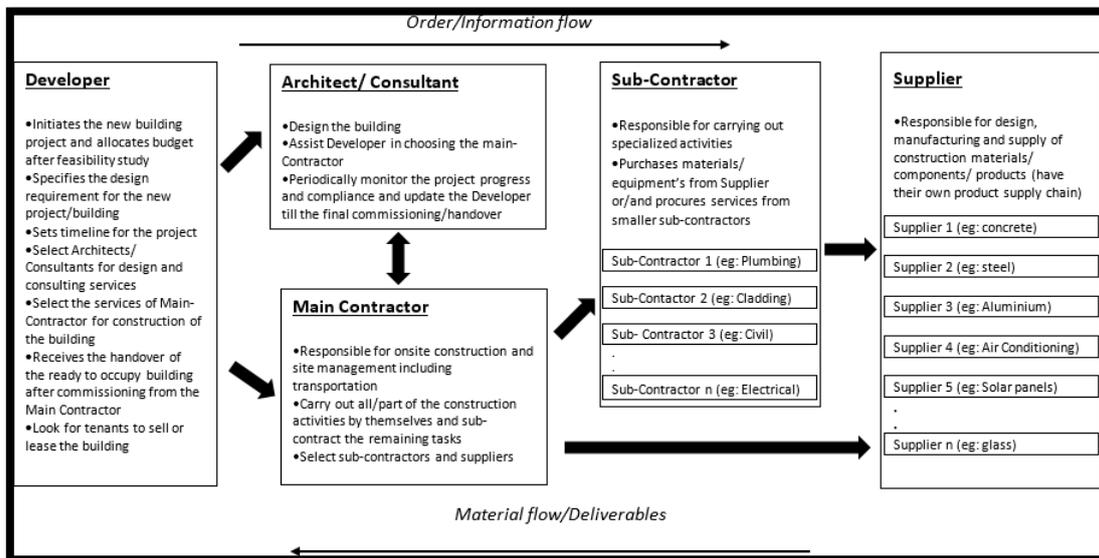


Figure 1.1 Construction supply chain

- The primary Contractors are accountable for the conclusion of the task to a pre-established time, quality and cost. Thus, they play a major part within the project's financial success (Hatmoko, 2008). They usually play the role to be a 'facilitator' to handle demand aspect on the Developers/Architects and supply side from Suppliers and subcontractors (Cox et al., 2006)[31].
- The Subcontractors, also, play crucial roles in building jobs. They assist the primary contractor to perform professional works. It's not unusual for almost as ninety % of a building project to become subcontracted (Matthews et al., 2000)[26] and consequently, subcontractors might add almost as ninety % of a primary contractor's turnover (Ndekuri, 1998)[45]. This reveals the key contribution and position of subcontractors within the achievements of the venture.
- The Suppliers on another hand supply materials or maybe parts for building projects in time as well as at a fair price (Venkataraman, 2004)[42], that may achieve a benefit of almost as 50 60 % of the entire price of the task (Stuckhart, 1995). They help the venture results through smaller cycle time, inventory level reduction plus increasing service level (Venkataraman, 2004)[28]. For greening the building supply chain, these elements justify the benefits of choosing and also handling eco-friendly vendors inside a construction job.
- To sum up, main Contractors, Architects/Consultants, Developers, Subcontractors & Suppliers have strategic positions in the supply chain and consequently are crucial in producing environmentally friendly supply chains.



**1.7. Order/information flows**

In an ordinary construction supply chain, the Developer appoints Architects/Consultants primarily based on appropriate selection criteria being their customer representative, to supply each layout and professional control services. After the construction style is finalized, the Developer then simply finalizes the tender documents with Architects/Consultants and floats the tender. The primary Contractor will be selected by the Developer according to the specialized (typically examined by the Architect/Consultant) along with commercial proposal/bid (typically evaluated by Developer) submitted by the Contractor. As soon as the primary contractor is selected, primarily based on the capabilities of theirs, they often do the building activities themselves or maybe hire specialist subcontractors to handle certain activities such as for instance the assembly of the structure façade, HVAC systems, building management systems (BMS). The complexity might additionally improve as Subcontractors might quite possibly subcontract the works of theirs, wholly or partly, to various other subcontractors. Lastly, the primary Contractor as well as the Subcontractors are going to have to depend on many Suppliers to supply them with raw materials as well as elements to perform their required tasks.

**1.8. Material flow/deliverables**

In terms of material flow/deliverables, the raw materials like cement, pre-fabricated parts including glass façade and solutions like HVAC are prepared and assembled onsite by the main/sub-Contractors. Upon conclusion of the structure, the last percentage of the structure is going to be performed by the Consultants, plus noncompliance (if any) at this point is reverted to the primary Contractor to rectify to buy the structure commissioned. After commissioning, the structure is handed over on the Developer and is prepared for occupation. In general, this material and information flow perspective of building supply chain further shows the demand for involvement and commitment of all the crucial supply chain stakeholders for the detailed greening of construction supply chains.

**1.9. Key differences along with other supply chains**

For highly effective greening of the building supply chain, it's essential to recognize the uniqueness and variations of building supply chains vis-à-vis some other supply chains. For example, as opposed to the unilateral, long term dynamics of the connection between suppliers and manufacturers in standard manufacturing supply chains, building supply chains are complicated, fragmented and diverse and also entail a wide range of stakeholders in dyadic, short term/temporary relationships that last just until project completion (Miles and Rezgui, 2009)[8]. In a big building project, for instance, the quantity of organisations required might be in hundreds, if not many. This suggests that for extensive and effective use of GSCM, every stakeholder must execute environmentally friendly methods on the very best of the abilities of theirs in a coherent fashion vis-à-vis others (Compact UN Global, 2010)[10]. Furthermore, the building supply chain has a track record of adversarial relationships and low trust between stakeholders (Korczyński, 1996; Akintoye et al., 2000)[9]. Latham (1994) highlights the adversarial attitude between the key Contractors and the Suppliers of theirs within the situation on the UK construction sector. Thus, addressing and understanding the conflicting interests of every stakeholder potentially may improve the active participation of theirs in the greening efforts. Ghurka(2003) present a fascinating summary of the differences between a regular and manufacturing a construction and supply chain supply chain, as found in Table 2.2

**Table 1.2 Comparison of manufacturing and building resources chain**

Traditional/manufacturing supply chain	Construction supply chain
Build to stock model is widely used	Build to order model is widely used
High degree of standardization with repeatability	Each project has unique design and material specifications with little or no repeatability
Reliable demand forecast and planning can be done	Uncertain demand forecast and inadequate tools for planning
Generally, only one organization is responsible for the production process	Multiple organisations with different objectives involved in the production process
Predefined supplier and distribution network	Project-specific suppliers and distribution network

### 1.9.1. Potential parallels with any other supply chains

Despite the variations available along with other sectors, the building market might continue to gain from 'borrowing' best strategies and also management suggestions like GSCM from various other sectors, provided they're thoroughly crafted and also contextualized (Harty 2008; Kumaraswamy et al. 2008)[22]. For example, elements like as "supply chain partnering" and "supply chain collaboration", typical in some other sectors like manufacturing, now are observed in the building market. For instance, Developers have started entering into partnerships with these Contractors and key Contractors are checking out the options of extending partnering/collaborative agreements down the supply chain to key content Suppliers and small sized Subcontractor firms (Fernie and Tennant, 2014)[14]. Furthermore, the eco-friendly behaviour of a building material/product Supplier, a vital person in the supply chain in greening the industry, who's accountable for the removal and processing of raw materials, distribution and manufacturing of construction material/products, is much like that of any manufacturing sector.

Overall, the insights in an ounce subsection, which includes the functions & duties of crucial supply chain stakeholders, the products and info flow perspectives in the building supply chain, plus their similarities and differences with supply chains in any other sectors, helps to improved frame the literature review and also synthesis of restricted and fragmented GSCM related studies in construction (discussed in the following section) to understand the present condition of GSCM within the building market like the appropriate gaps in the literature. The second part, covers the results on the evaluation of GSCM related studies in the building market.

## II. LITERATURE REVIEW

### 2.1.1. Gaps pertaining to green practices

This food section critically examines the gaps pertaining to green practices sub themes, namely, core environmentally friendly methods and facilitating green practices.

#### 2.1.1.1. Gaps pertaining to core green practices

As stated previously, core environmentally friendly practices are activities/initiatives undertaken to minimize the ecological footprint across every one of the unique practical phases of the supply chain, i.e. from design to end of life of the structure.

**Design phase:** It's obvious that just a few scientific studies (Liu et al., 2012; Ng et al., 2012)[21] have examined environmentally friendly design methods, that entail combining ecological factors during design phase, despite being fully necessary of the field, as choices built during this particular phase will likely have a major impact on the life cycle environmental impact of the structure. Additionally, these couple of scientific studies hasn't deemed the person supply chain stakeholders' perspectives. As an outcome, the specifics of the appropriate eco-friendly design contribution of single stakeholders, i.e. Developers, Architects/Consultants, Contractors and also (material) Suppliers is not clear. For instance, in the situation of Suppliers, green product/material look will likely have an immediate effect on the life cycle energy effectiveness of the structure. Nevertheless, there's very little comprehension of the effect, as not one of the pre-existing research seems to have examined the eco-friendly material/product design factors of Suppliers. Similarly, Contractors, primarily based on their onsite project expertise, may bring about green building design by suggesting design characteristics which eat far fewer energy and materials during construction. Once again, there's very little comprehension of the job of Contractors in environmentally friendly construction design. A very clear comprehension of the functions and contributions of specific stakeholders in earth-friendly design is vital for providers and also policymakers seeking to market sector wide energy efficient design practices.

**Purchasing/Procurement phase:** Purchasing/Procurement is an important practice of every building project which contains all the activities regarding acquiring goods, services and also consultancy essential to complete the task objectives (Martins, 2009; Sears et al., 2008)[11]. Green purchasing or perhaps integration of green considerations into buying actions, programs, and policies (Varnas et al., 2009)[13] has, thus, the substantial opportunity in greening the building supply chain. Nevertheless, as observed in Table 2.5, just a small quantity of research has checked out the eco-friendly purchasing aspects (Ofori, 2000; Varnas et al., 2009)[15]. Moreover, these experiments have often disregarded stakeholders' perspectives completely (Ofori, 2000) or even viewed just distinct people like Developers (Varnas et al., 2009) in the investigations of theirs. The green buying practices of many stakeholders are thus not clear. For instance, rather than choosing the lowest bid, that continues to be the standard method of building procurement for several years (Hatmoko, 2008)[18], it's essential to understand' what green/environmental concern is created through the Developer while procuring the services of Architects/Consultants & Contractors'. In the situation of Contractors, this specific understanding is particularly crucial as their green purchasing activities include ecological considerations in equally components purchasing choices and in the number of Subcontractors.

**Transportation phase:** On the list of main shortcomings apparent from the shoes review is the fact that environmentally friendly practices or transportation undertaken to minimize the ecological impact of all transportation related activities seem to be missing entirely. This's shocking since construction projects normally have a considerable amount of transportation activities, and they entail both personnel transportation as well as material transport. Based on Ng et al. (2012)[21], transportation of materials/supplies by itself accounts for about 68 % of the co2 emissions in construction jobs.

**Construction/manufacturing phase:** Studies on environmentally friendly building methods, or maybe practices targeted at minimizing the undesirable environmental impact throughout the actual physical building of structures, also have been narrowly scoped with only particular methods like pre fabrication (Jaillon et al., 2009) and onsite waste management (Begum et al., 2007)[25] being studied. Although environmentally friendly building practices are appropriate and then Subcontractors and contractors, the absence of studies in this specific place means that there's minimal knowledge of the different development methods targeted at minimizing the adverse green implications throughout the build phase. This's a key matter, as building stage by itself should bring about much more than twenty % of any building 's lifetime power consumption (Ng et al., 2012)[28].

In the situation of building material Suppliers, the corresponding exercise is "green manufacturing", that requires similar methods at the production sites. Nevertheless, not one of the scientific studies seems to have checked out the eco-friendly manufacturing practices of building material Suppliers. This's an additional main shortcoming because creating material manufacturing itself accounts for ten % of worldwide power consumption (UNEP, 2010).

**Endoflifephase:** End of life environmentally friendly practices are practices undertaken at the conclusion of a building's useful life in order to handle energy efficient demolition activities and also to maximize recyclability and recovery of building materials. Nevertheless, these also, are minimally talked about in the literature despite being recognized to considerably lower the ecological load regarding the building market. As Blengini (2009)[30] describes, they'll decrease the entire life-cycle power of a developing by around thirty %, along with GHG emissions by about eighteen %. Based on Thormark (2002)[31], tail end of daily life control is fully necessary to minimize the embodied energy of building materials. This's because recycling many supplies, like aluminium or steel, can easily confer savings of over 50 % the embodied energy and substantial reductions within the connected GHG emissions (Yan et al., 2010)[48].

To sum up, core environmentally friendly methods, such as the extents of theirs of the implementation at a person stakeholder level, aren't adequately known with the building market. Gaining a comprehensive comprehension of the pertinent core eco-friendly methods for every stakeholder individually is crucial because altogether, they decide the life-cycle environmental impact of a building job and also when aggregated, for the building market like an entire. It likewise seems sensible to learn these practices together/holistically as you will find interactions between them; for instance, eco-friendly design factor in terminology of construction materials/components being utilized can have implications for natural purchasing, environmentally friendly building plus end of life environmentally friendly practices.

#### 2.1.1.2. Gaps pertaining to facilitating green practices

As in the past mentioned, facilitating green practices are activities/initiatives undertaken at the intra firm level to create green resources and capabilities. It's once again obvious from that just a small quantity of research has examined facilitating green methods, which far too precise practices such as for instance environmental management methods and ISO 14001 certification (Ofori 2000; Tam and Shen 2002; Creed and Zutshi, 2014)[25]. The spaces in the data are therefore clearly evident. For example, there's very little comprehension of the different environmentally friendly instruction and environmental auditing activities completed by various stakeholders in the building market. A comprehensive comprehension of the nature/details of these methods like as length of the training/auditing activities, coverage of the training/auditing activities (select employees or all employees; all the departments or maybe select departments) and frequency of the training/auditing physical activities will be helpful in realizing the environmental objectives of the field. Still, others such as for instance cross functional integration (or maybe control across various departments and functions) acknowledged to facilitate the realization of going green objectives in some other sectors (Zhu et al., 2012)[29] seem to be lacking in the building literature. Given that building companies are generally characterized by more and more departments and functions, the field is anticipated to gain from coordinated cross practical teams in green related decision making, ideal exchange of green related info, ensuring commitment of departments to a typical eco-friendly goal, mutual assistance, along with constant improvement (Adetunji et al., 2008)[31]. Nevertheless, at present, there's absolutely no knowledge of exactly how this could be attained or maybe the

degree to which it's attained in the building market. Likewise, some other related facilitating green methods because of the building market may be lacking in the literature (given the small quantity of studies), and for that reason has to be investigated more.

In a nutshell, for those facilitating green practices, details about the nature of theirs and the extents of theirs of implementation (both known and) that is unknown aren't adequately understood. Given that facilitating practices not just immediately improve environmental performance (Zhu et al., 2012), but also help enhancing the center environmentally friendly practices as well (Sarkis et al., 2011; Zhu et al., 2012)[29], obtaining a comprehensive knowledge of them, and also at a person stakeholder level, is pivotal for the greening the building supply chain as well as the industry.

To summarize, an extensive knowledge of each center and facilitating green methods, plus the extents of theirs of implementation for every stakeholder is able to direct practitioners and also policy manufacturers with a good comprehension of 'what', 'how', 'how much' and 'why' to carry out these environmentally friendly practices, which may inevitably result in better environmentally friendly practices adoption across the field.

### 2.1.2. Gaps pertaining to green drivers and barriers

As previously stated, it's crucial for policymakers and practitioners to recognize the 'antecedents' or maybe barriers and drivers of center and facilitating green methods, since they could explain elements like the reason some companies are hands-on in applying green methods while others are reactive; and also why some show considerable implementation of environmentally friendly practices while others display limited or maybe no implementation. Like any other sectors, the building market may also take advantage of exploring these barriers and drivers primarily based on the source of theirs of origin (internal or external). While the literature has some info on the dynamics of these external and internal green drivers and barriers, the understanding is far from comprehensive.

Among the reasons for this not enough complete awareness of environmentally friendly barriers and drivers is which the reports which have examined these drivers and barriers in the building market are restricted in quantity. Additionally, these experiments are often descriptive or maybe generic, i.e. with no stakeholder focus (Zhang et al., 2011; Liu et al., 2012)[14], or perhaps have studied drivers for certain eco-friendly practices for instance natural building (Qi et al., 2010)[49], or even barriers for specific green practices such as natural purchasing (Sohail and Sourani, 2011)[39] with minimal stakeholder focus. Additionally, some essential drivers seem to be missing. For example, customer pressure, that is labeled as a major driver for greening in some other sectors, has seen little or maybe with no study in the context of construction. Consumer strain for environmentally friendly buildings could be anticipated to be considerable given the substantial water and energy savings in addition to overall health benefits from non-use/less use of dangerous substances in such buildings (WGBC, 2013)[46]. Likewise, many other drivers and barriers might additionally be lacking within the literature.

Thus, an extensive exploration is warranted to unearth the nature/details of different barriers and drivers. This involves determining the different barriers and drivers primarily based on the source of theirs of origin (internal and external), plus their perceived importance/relevance by various stakeholders. For instance, outside pressure out of the federal government in the type of laws on Developers might be lower or higher when compared with the governmental pressure on Contractors. Additionally, even if most Developers confront similar federal regulation, some could think it over extremely significant, while others might think it over much less vital or perhaps could decide to disregard it all together. In the same way, lack of going green workers, a barrier to eco-friendly methods in construction, may be regarded as a lesser or greater barrier by individual firms and different stakeholders based on their capability to control it. To put it briefly, the perceived value of these internal and external barriers and drivers can differ among the supply chain stakeholders and companies based on the conflicting interests of theirs and the ability of theirs in handling these barriers and drivers. In order to summarize, an extensive knowledge of internal and external green drivers, along with external and internal barriers for every supply chain stakeholder (i.e. Developer, Architects/Consultant, Contractor/Subcontractor plus Supplier) is crucial for policymakers and practitioners to anticipate the sector's natural behaviour and also to create techniques for every stakeholder so as to maximise/leverage the drivers and minimise/eliminate the barriers for enhancing sector wide effective and highly effective green practices. This can lead to the subsequent investigation question.

### 2.1.3. Gaps pertaining to green performance methods widely used and performance advantages from green practices

Understanding the results or perhaps performance enhancement from environmentally friendly practices (implementation) is crucial as it directly pertains to decision making at all levels: operational, tactical, and strategic. This's particularly crucial for the building segment, because the field is noted for its bad performance and also low

profit margins (Agapiou et al., 1998, Ning and Yeo, 2002, Ireland and Cox, 2002)[44]. It doesn't matter how helpful and innovative a brand new building strategy or maybe procedures might be, the acceptance of it's in the field will count a lot on the difficulties, among others, associated with budget overruns, the danger of quality and delays (Wamelink and Kornelius, 1998, Koskela and Vrijhoef, Saad, 2000, 1996)[25]. Thus, for the field, adoption of GSCM philosophy, an environmental feature program in itself, would need credible proof of performance improvements. Nevertheless, this very first requires suitable (green) performance measures being publicly available. Thus, for starters, the spaces pertaining to the utilization of natural performance measures across stakeholders in the building market are examined.

### III. CONCLUSION

In this final chapter, first, a brief review of the research background and process carried out is provided. Next, the chapter briefly revisits the findings of this study in relation to the research questions and highlights its contributions to theory and practice. Finally, the limitations of this study along with avenues for future research are discussed. The research aimed to identify several aspects related to GSCM in the construction industry in the India by performing two different method to different links of the supply chain. However, the aim of the research had to be modified in order to focus only on the contractors' side considering the low response rate obtained on the suppliers' questionnaire. Thus, the main objective of the dissertation was partially accomplished. Only one side of the supply chain was evaluated therefore further research about how suppliers are responding and how effective GSCM could be undertaken. In terms of large contractors, the information gathered on the interviews helped to the understanding of how the first link of the construction supply chain is dealing with environmental issues and more specifically with GSCM. The reason behind the low response rate on the suppliers' side might be the size of the companies sampled. In fact, most SMEs have fewer resources dedicated to these types of initiatives and are less pressurised by external forces to implement them. In terms of the environmental impacts caused by construction, it can be concluded that large contractors have a good degree of awareness. The highest scores on this matter corresponded to most of the impacts identified as significant by the Environment Agency (2003). This included waste, health and safety hazards, use of raw materials and energy consumption, as well as socio-economic impacts. The responses showed that cost and quality of goods are the most important in identifying a critical supplier, followed by other factors resulting from legislation pressures. Notably, distance was not considered as important regardless of its impacts on the environment. Moreover, large contractors seem to have the financial and market power to implement GSCM. However, in the construction industry GSCM is still reaching a small percentage of the entire population because of the nature of the market. One crucial aim of the dissertation was to find out what types of strategies large contractors are requiring from their supply chain. The findings confirmed that process-based strategies are more common than product-based strategies. In the case of product-based only 19% were compulsory, mainly caused by Eco-design and LCA. . Confirming the fact that large contractors are trying to support their supply chain on these issues. EMS, looked at the most complex strategy of them all was elected by almost all respondents hence confirming its favourable implementation by most large contractors at some point. In terms of the drivers for large contractors for implementing GSCM strategies, the results showed that the two most important categories were sustainability and economic motivators. However, legislation as a single driver was the most important for the majority of the companies, confirming that this is a major pressure on GSCM implementation. Unlike some sectors, large contractors do not perceived themselves as major targets for NGOs, so the construction industry is not felt as being under significant pressure. In terms of the barriers that large contractors and suppliers are experiencing during the implementation of GSCM, the most significant were lack of resources and short term planning, followed by problems on access to information and expertise, together with lack of government pressure. In the end, economic benefits are not yet proven to flow from improved environmental performance. Negative economic impacts from investment in training and environmentally friendly products have outweighed benefits. GSCM is still developing in the construction industry, as confirmed on the interviews.

1. From the site investigation by applying ABC & EOQ in SP CONSTRUCTION PUNE following conclusion are drawn ABC analysis is kind of method, which provides the means for classifying those items that make the largest effect on a company's overall inventory cost performance
2. ABC classification to identify and define the safety stocks, which is a protection so that does not lack of material as well as stocks average, maximum and minimum, so as to assess the amount necessary to avoid a lack of raw material and without any accumulation in inventory.
3. Total investment cost of the material which widely used in SP CONSTRUCTION in Case study 1 without use of EOQ is Rs. 7381170 & with use of EOQ is Rs. 2285250 also with using of EOQ cost saving in material is 70 %. Using green supply chain management
4. Total investment cost of the material which widely used in JADHAV CONSTRUCTION Case study 2 without use

- of EOQ is Rs. 83736580 & with use of EOQ is Rs. 44647030 also with using of EOQ cost saving in material is 50 %.
- Using green supply chain management
- Total investment cost of the material which widely used in VAISHNAVI CONSTRUCTION Case study 3 without use of EOQ is Rs. 17128583 & with use of EOQ is Rs. 16577282 also with using of EOQ cost saving in material is 10 %. Using green supply chain management
  - By applying ABC analysis we can easily classified the material which requires more investment & by using EOQ we can easily control or reduce the total investment cost of the material.
  - The inventory control technique by adopting proper material management system large amount of cost can be reduced in large projects and that saved cost can be used in some small project as our country already running short money.
  - In the material management the main important factors are planning, assessing the requirement, sourcing, purchasing, transporting, storing, and controlling of materials, minimizing the wastage and optimizing the profitability by reducing cost of material.
  - Failure in managing site inventory will result in cost overrun, delays in project completion and reduce overall project performance.
  - In the material management also observe the major factors of poor inventory control are Improper management of time, cost and manpower.
  - Inventory is the major part of their 25% cost of total production there is a need for inventory control by way of reducing cost and optimum utilization of materials stock is very high level.

#### RECOMMENDATIONS FOR FURTHER RESEARCH

It would be worth to exploring in more detail the suppliers, specifically their attitudes and resources to implement GSCM practices, the knowledge and internal capabilities to respond to their customers' pressures, and finally the strategies they are using to overcome the barriers. In terms of the construction supply chain efficiency and environmental performance, it would be interesting in the future to investigate if GSCM in the construction industry is generating benefits to the companies involved. In the end, the main purposes of GSCM are minimising the damage to the environment while generating positive economic impacts in order to achieve sustainable construction. Finally, it was not possible to estimate in this research the percentage of virgin materials compared to the percentage of recycled materials purchased by large contractors, so another issue would be to monitor the evolution of the markets of recyclable materials in the coming years as an interesting indicator for GSCM in the construction industry.

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