



IMPACT OF LEAN GREEN SUPPLY CHAIN MANAGEMENT ON THE IMPLEMENTATION OF CONSTRUCTION PROJECTS

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الملخص العربي:

في هذه الدراسة ، سيتم فحص العلاقة بين الاستراتيجيات الصديقة للبيئة والخالية من الهدر من أجل تطوير إطار تنفيذ إدارة سلسلة التوريد الصديقة للبيئة والخالية من الهدر في صناعة البناء و التشييد في مصر، واحتضان التحديات التي ستواجهها الشركات في حالة اعتماد هذا النهج ، والعوامل التي تؤثر عليها سيتم ذكرها وتحديدها. تساهم هذه الدراسة في المساعدة في تبني التفكير الاستراتيجي الصديق للبيئة والخالي من الهدر في صناعة البناء والتشييد في مصر وإبراز العلاقة بين توفير التكلفة والسيطرة على التلوث ، وبيان العوامل المختلفة التي تؤثر على تنفيذها ، وذلك بمساعدة الخبراء في هذا المجال. ، ومناقشة التحديات والعوائق الذي ستواجهه المؤسسات لتحقيق هذا النهج.

الكلمات المفتاحية : الاستدامة؛ ادارة سلسلة الامدادات ؛ صديق للبيئة؛ الأستراتيجية الخالية من الهدر؛ صناعة البناء والتشييد؛ تحديات البيئة؛ التقنيات الخالية من الهدر مصر والاستدامة؛ تحديات التوفير في التكاليف.

ABSTRACT:

The amount of environmental pollution and lack of resources caused by the construction firm is the main problem and day by day its increasing however, the approach of green and sustainable strategies is concerning the enterprises because of risking the high cost of achieving it and meeting the market expectations. Firms need to re-evaluate the cost effectiveness of green and lean initiatives from a combined perspective and how important the construction industry needs to stand with the environmental management tools to address these problems and prevent any more harm affecting the environment.

In this study, the relation between the green and lean strategies in order to develop a framework of lean green supply chain management implementation for the construction of residential buildings in Egypt will be examined, embracing the challenges that will be faced, and the factors impacting it will be stated and identified.

The contribution of this study is to help in adopting the lean green strategy thinking in the construction industry of residential buildings, highlighting the relation between cost saving and pollution controlling, stating the different factors impacting its implementation, with

the help of the experts in this field, and discussing the challenges that the enterprises will face to achieve this approach.

KEYWORDS: Sustainability; Supply Chain Management; Green; Lean Strategy; Construction Industry; Environmental Challenges; Lean Techniques; Egypt and Sustainability; Challenges; Cost Saving

1-INTRODUCTION

Human society is undergoing an inexhaustible construction expansion in every possible way, the divergent types of buildings and constructions have become the number one demand to human beings throughout the years which unequivocally serves the whole world's economy, and as large the construction project scale and higher speed are as faster and higher the economy will be developed. The profits of the construction enterprises will be heightened. The expeditious rate of the construction industry growth is one of the main reasons behind the shortage in resources, air, water, and noise pollution, a lot of studies affirmed this fact. According to new research by the construction blog Bimhow, the construction sector contributes to 23% of air pollution, 50% of climatic change, 40% of drinking water pollution, and 50% of landfill waste. In separate research by the U.S. Green Building Council (USGBC), the construction industry accounts for 40% of worldwide energy usage, with estimations that by 2030 emissions from commercial buildings will grow by 1.8% as shown in Fig (1).

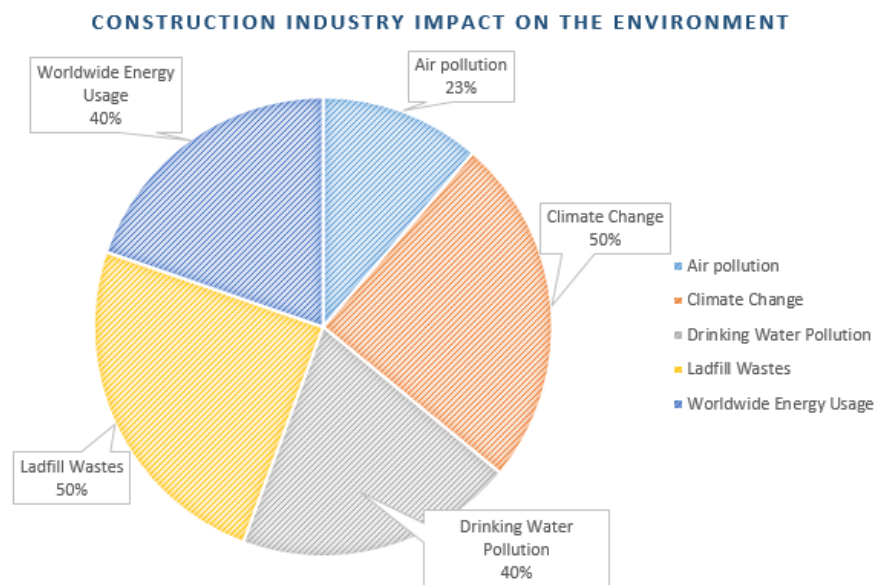


Fig.1: The Construction Industry Impact on the Environment

Mother Nature and her resources are heavily utilized by the construction industry and mounting environmental concerns have put tremendous pressure on the industry's businesses to lessen their ecological impact. Additionally, green and sustainable thinking is essential to maintaining the peace between Mother Nature and humans. It is also crucial to

strike a balance between client demand, resource availability, and environmentally friendly buildings. Reducing energy use and waste, utilizing recyclable and renewable materials, safeguarding the environment, etc. are all examples of sustainable construction. The constructed environment of the future will be provided by what we construct now, and it will affect how well future generations can meet their requirements (Dickie and Howard, 2000).

2-LEAN AND GREEN CONCEPTS

2.1-Green Supply Chain Concept

Green supply chains apply green manufacturing to the supply chain, but they are significantly more sophisticated than traditional ones because they also include "green" logistics in addition to standard raw materials and products. The "green" information is tied to large flows of green manufacturing. The official definition of a green supply chain (GSC) is "the coordination of the supply chain in a way that integrates environmental considerations and takes inter-organizational activities into account." [5] Green supply chain management can efficiently reduce all aspects of the construction process that are harmful to the environment, including resource consumption during construction. Moreover, it lower manufacturing costs, safeguard the environment and significantly contribute to the building industry's sustainable growth. Also, energy efficiency, a decrease in greenhouse gas emissions, water conservation or processing, waste reduction, a rise in the use of biodegradable packaging, product and packaging recycling, and reuse, and other green procurement practices are just a few examples of green supply chain management practices. In 2009, an analysis of more than 20 publications on green supply chain initiatives, Eltayeb and Zailani [6] came to the conclusion that the green supply chain may be broadly divided into three key components: a design for the environment, green purchasing, and reverse logistics.

According to earlier research, the implementation of the GSCM in the construction industry is depending on some practices, green design, green transportation, green building, and reverse logistics which include the 4Rs' (reduction, redesign, reuse, and remanufacture) have all been highlighted by Rakesh and Ravi. [7] and Sreejith and Vinaya [8]



Fig.2: Green Supply Chain Management Elements in Construction industry

2.2-Lean Concept

As per Locher, Lean is a systematic approach that aims at maximizing value by minimizing waste and streamlining the services or products at the pull of the customer demand ^[1], anything that doesn't bring value that customers are willing to pay for is considered waste according to the lean philosophy. If we can sum up the lean concept, we can say it's "doing more with less" – less everything included in the process of a project, Greater efficiency is the goal of lean. In order to provide clients with exactly what they want, the least amount of work, energy, equipment, time, facility space, resources, and capital should be used.

The lean supply chain is a multifaceted strategy that reduces costs by getting rid of non-value-added tasks by implementing lean tools. To achieve this, the supply chain's components and operations (purchases, shipping, order administration, warehousing, production, transportation, and distribution) are subjected to lean principles and practices in order to turn it into a value chain, by minimizing the many forms of waste generated by construction projects, the construction industry's efficacy is being increased (in both conversion and workflow). A lean SC will therefore embody the fundamental ideas of lean thinking, such as the ability to supply goods fast to the customer, with little waste, the most flexibility, little inventory, and the highest quality. Customer-centric thinking always gets the ball rolling. What is the value to the customer? What problem does the consumer need to solve, to put it another way, and to encourage real action? That is what lean thinking is all about, the work or the acts that directly and indirectly add value for the client is where lean practice starts.

In a business environment that is constantly evolving, lean thinking provides the agility to consistently deliver value. Your company will move toward a stronger, more sustainable future if you adopt Lean thinking because lean thinking and practice encourage systematic and continuous learning, an organization that practices lean is, in comparison to its peers, highly adaptive to its ever-changing environment.

To summarize this, according to Reichhart and Holweg, a lean supply chain (LSC) is "as minimizing waste in the downstream SC while making the correct product available to the end consumer at the right time and location".^[3] Through the reduction or elimination of non-value-adding procedures connected to excess time, personnel, equipment, space, and stocks across the SC, LSC represents a strategy based on cost reduction and flexibility, focused on process improvements.^[4] Companies can save a significant amount of money for worthwhile investments by having an LSC free of waste and non-value-adding activities, improving their efficiency and competitiveness.

According to the Lean Construction institute, there are eight wastes that should be taken into consideration to apply lean thinking to any construction project

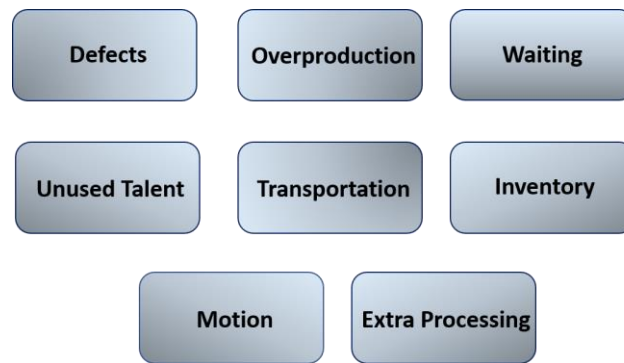


Fig.3: The lean wastes in construction industry

3-INTEGRATION BETWEEN LEAN AND GREEN SUPPLY CHAIN MANAGEMENT

To be able to find a common ground between both Lean and green supply chain management, let us define the supply chain process starting with the supplier to the customer. A supply chain is a whole process of producing and delivering a good or service, starting with the procurement of raw materials and ending with the delivery of the good or service to the final consumer. Supply chain management in the construction industry focuses on the three core elements of a successful building project Quality, Time, and Cost, so using SCM in the construction industry is essential for enhancing coordination and communication among all stakeholders in the construction value chain, as well as for maintaining the quality and profitability of a project. Proper SCM may boost revenues, cut costs, and have an impact on a company's bottom line because there are so many locations along the supply chain in the construction industry that can either add value through efficiency or lose value by increasing expenses.

The elements of the supply chain can be summed up into supply, delivery, storage, processing/construction, and hand-over.



Fig.4: Generic Supply Chain

for a supply chain with a green and lean focus. working with upstream suppliers and downstream customers, as well as an analysis of internal operations and processes, are all necessary in addition to the procedure for product development to reduce all types of waste and also the negative impact on the environment, as well as the increase of effectiveness and less time consumption

- The **Supply** element impacts the environmental waste, and on the other hand, waste in the form of defects and errors will be found.
- **Transportation** is used to deliver the goods, which cause by all means CO² and greenhouse emissions, and also it may be found in high cost and delays which is a type of waste
- **Storage** wastes a high inventory and impacts the environment will spills and hazards
- **Construction Process** causes CO² emissions, excessive pollution, and energy consumption, over processing & production is one of the wastes, adding to that the high WIP level, defects, and re-work
- **Distribution** waste is mainly finding errors and rework which will cause re-work
- **Hand-Over** Rejections and returns are a huge waste adding to that the consumption of wastes and disposals which have a big impact on the environment

Each of the lean thinking and green practices have some goals that need to reach, and techniques to be used, and each element in the supply chain has an impact on either the environmental perspective or the economical state, stating these will give a framework to start from so we can highlight the common ground between both lean and green so we can be able to implement it on projects.

Table 1: Lean and Green Supply Chain Management Objectives

Supply Chain Element	Lean Objective	Green Objective
Supply	Quality	Less waste
Delivery	Speed Efficiency Less cost	Less gases Less emissions
Storage	Reduce inventory level cost	Less material waste
Construction	Less (Cycle Time, WIP, interruptions) Quality production	Less waste Less pollution Less energy
Distribution	Reliability less errors effectiveness	Less emissions Less gases
Hand-Over	Less re-work and customer satisfaction	Less waste and recycling

To achieve these objectives which will impact the quality, time, and cost in a very positive way some techniques and practices can be used that a lot of researchers studied it. For Green Supply Chain below are some solutions to achieve the objectives:

- Buy goods and services from suppliers who use green technology, follow environmental laws, and adhere to ISO 14000 by using green purchasing practices.
- Use environmentally friendly shipping and delivery methods for both inbound and outgoing shipments. This includes clean transportation options and hybrid autos.
- Reduce energy consumption, and waste from processing, and construction, and repair used and nonconforming items. Buy goods and services from
- Recycle waste and recover material.
- Reduce the wastes of the construction process
- Recycle products after consumption and recover material

For Lean Practices, below are some practices that can be used:

- Reduce delays and stock levels of incoming materials by switching to JIT (Just-in-Time) shipping from suppliers.
- To cut down on delays and lead times, use quick and economical transportation technologies for shipping.
- For inventory control, improve the Economic Order Quantity (EOQ) model and the Material Requirement Planning (MRP) system to raise the holding cost of hazardous items and incorporate the cost of recycling/disposal in the per unit cost.
- Apply lean techniques for example TPM, SMED and the 5S to processing to cut down on lot sizes and delays, balance operations, improve flow, lessen stoppages and changeovers, and lower the number of defects and nonconformities.
- At the customer's end, apply quality assurance

4-IMPACT OF APPLYING LEAN AND GREEN SUPPLY CHAIN MANAGEMENT ON THE CONSTRUCTION INDUSTRY

Many construction firms all around the world have embraced green techniques to abide by national and international laws as well as to profit from their efforts to lower the CO² footprints of their logistics and construction operations. In addition to putting an emphasis on the supplier chain, the construction process, and the whole project delivery system, this also includes a focus on their products through green construction and sustainable development. as well as Lean attempts to produce the best level of work quality with the shortest lead time and lowest cost achievable in the context of a building

project. Lean construction, which is used to achieve this, applies lean production principles and practices to the construction process over the whole project life cycle.

This approach will impact the delivery time of any of the projects, cost and speed, also the WIP, %defects and errors, and %gas emissions more recycling will be used and that will overall impact customer satisfaction.

5-CHALLENGES IN IMPLEMENTATION

Due to the recession that we are going through during this year the green practices won't be really in sync with that, as known, it is more costly than the traditional supply chain, and that leads to financial constraints in addition to lack of sustainable practices organizations visions and missions, shortage of resources, lack of technology, unskilled workforce, lack of top management commitment^[18] and the lack of demand and public awareness last but not least organizational culture resistance to change^[19]

but on the other hand, environmental concerns are getting more highlighted and focused on, here comes lean thinking importance which will help implement green practices with less cost, and although the inherent goal of both lean and green practices is to reduce waste, some lean tactics, such as just-in-time delivery, may involve more transportation, packaging, and handling, which is in opposition to the green philosophy. Additionally, the initial high cost of implementing green initiatives may discourage businesses from doing so, but it may be justified and made up for by the savings realized by eliminating non-value-adding operations through lean initiatives across the SC. Long-term gains from using green practices will also eventually start to show up in the form of cost savings from lower energy use, material recycling and recovery, enhanced brand recognition and market share, and lower waste treatment/discharge costs. As a result, businesses will see the complementary advantages of deploying green and lean efforts

6- CONCLUSION

This paper presented a literature review on the lean and green supply chain management elements, highlighting the importance of each on the environment and also on the three elements of any construction project (cost, time, quality), also discussed some practices that can be used, and the challenges that is in conflict with the implementation of construction projects in this direction. But day by day the construction sector is being considered as an application case by the researchers. Based on this study, an assessment could be developed that collects data from the different construction companies, the assessment model could be used to determine the performance of LGSCM implementation in construction projects In-depth examination of the developed model's instruments as well as empirical investigations to support their validity will be done in future study.

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