**BOOK CHAPTER**

**SUSTAINABILITY IN CONSTRUCTION SECTOR THROUGH LEAN METHODS**

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**INTRODUCTION**

Lean construction involves applying lean manufacturing principles and methods to the entire design and construction process, incorporating operational research and practical advancements in design and construction. Unlike manufacturing, construction is a project-based production process. Lean construction focuses on aligning and holistically addressing various aspects of the built and natural environment, including design, construction, operation, maintenance, salvage, and recycling, simultaneously. In the Indian construction sector, several changes have occurred that are impacting the country's economy, both directly and indirectlyTop of Form. Therefore, there is an urgent requirement of management strategy that can manage such growing number of changes and meet with desired quality/production aspect.One of the alternatetechniques, known aslean construction (LC), helps to increase productivity while using fewerpeople, less time, andfewer failed building projects.The Indian construction industry plays a major role in the country’s growth and development. As per Central Statistical Office, 2019, India’s contribution to GDP is 8%. Rapid urbanization is one of the major challenges faced by the Indian Construction Industry and the various steps. Lean Construction is one of the most appropriate methods in improving the productivity and efficiency of the construction sector. The concept of Lean had been emerged from Toyota Production and later became more familiar in the construction industry. Even though a lot of studies had been already carried out, due to certain factors it has not gained much popularity among construction professionals.By 2030 India’s 40% of the population will be shifted to Urban areas (Lakmal, 2014). The success of the construction projects mainly depends on the Decision making (Espino , et al., 2014). Poor quality in decision-making leads to deliver poor quality of works leads to poor quality of work ( Elonen & Artto, 2003) resulted in 70% of the time overrun projects, and a large amount of material wastage. Material waste is identified as one of the major factors which badly affects the environment and reworking leads to an increase in construction cost and time (Jaillon, et al., 2009), (Aziz & Hafez, 2013), ( Love, 2002). Certain new methods had to be adopted in the construction sector to improve the productivity and sustainability (Lu & Yuan, 2011), (Akinade, et al., 2015). One of such method which was borrowed from Toyota manufacturing was Lean Method emerged in 1990 helps in increase in productivity, less wastage of time, and maximum output. Traditional Methods of construction phases have a low value on the project’s overall performance and productivity. The traditional methods in the construction sector provide only less low value on the project's overall performance and increase individual tasks and lesser productivity. Lean construction helps to reduce uncertainty in construction projects, boost dependability and productivity, decrease waste, enhance workflow, and helps to improve overall project delivery efficiency. These resulted in more profits and lower costs (Ballard & Howell, 2003)(Mossman, 2009)Traditional Methods of decision-making can be overcome with the help of Building Information Modelling (Sacks, et al., 2018). Waste is one of the other major issues faced by the construction sector. The building and infrastructure categories are all included in the construction industry, which is the world's largest user of resources, energy, and materials (Koskela, et al., 2002). Further the generation of large amounts of Green House gas emissions ( Degani & Cardoso, 2002). 5% of the GDP had been reduced because of environmental impact resulting in an overall increase in construction costs and time (Stern, 2006). Although the lean ideology does not aim to expressly address environmental issues, it helps to increase project efficiency and plays a major role in waste reduction, both of which have an impact on environmental performance (Bae & Kim, 2008). Based on the survey of literature LC is a method for reducing construction waste and fulfilling the needs of customers (Tezel, et al., 2018). A lot of studies had been conducted to identify Lean tools and techniques in the construction industry. A major issue faced by the construction industry is the lack of understanding of the number of existing lean construction tools and practices and their specific application in planning, design and construction of building and infrastructure projects. The study analyzes the studies from several perspectives on lean wastes, principles, and tools to reveal the strong relationship between construction and environmental sustainability.

Six fundamental ideas that underpin lean construction are as follows:

Value definition: What does value look like from the perspective of the customer?

Define the value stream as follows: Which procedures are necessary to provide that value?Getting rid of garbage focuses on eight key waste categories

Process flow for work: establishing a consistent, reliable process

Pull scheduling and planning: Discuss and coordinate work with others.

Find methods to improve existing and upcoming projects through continuous improvement.

**What Role Does Lean Play in the Construction Sector?**

Let's take a deeper look at the state of the construction business right now to better understand how Lean fits into it:

70% of building projects run beyond schedule and budget.

Waste accounts for 57% of building project costs.

Building sector usage accounts for 50% of all raw material use.

600 million tons of construction and debris were produced in the United States.

Landfills received 145 million tons of construction and waste materials.

2. **LEAN PRINCIPLES AND THEIR IMPACT ON ENVIRONMENT**

The Toyota Production System (TPS) gave rise to the lean mindset, which increases customer satisfaction, reduces waste, and improves project efficiency (Womack & Jones, 1996). It is a systematic method which helps in waste reduction and provides a major contribution to improvement in production Before the emergence of Lean a lot of philosophies had been used in the construction sector but all these didn’t gives much result. Lean construction, a term coined by the international organization of lean construction (IGLC) at their first conference in 1993, came into being. Project completion and increased profits can be attained with the help of philosophies (Salem, et al., 2006)(Howell & Ballard, 1998)(Tommelein, 2015). Lean is built on a set of guiding principles intended to get rid of waste and help businesses to do better way at what they do. Five Lean Principles were outlined by (Womack & Jones, 2003) as a means of reducing waste in business. According to Womack and Jones, one strategy for enhancing organizational performance in terms of value creation is Lean Thinking. The primary objective is to “optimize the total value,” not “minimize the cost. According to Picchi and Granja (2004), there are five Lean Principles: "identifying value from the customer perspective," "mapping the value stream," "achieving flow within the work process," and "strive for perfection and continuous improvement." Fig 3 shows a detailed view of the Lean Principles. To overcome all these process the concept of sustainability has emerged (Andelin, et al., 2015).A philosophy known as lean building is based on lean manufacturing ideas. The principles of lean production in the construction industry are grounded in the theories of transformation (T), flow (F), and value creation (V) in production management, as outlined by Koskela in 1992. According to the TFV theory, production can be categorized into three distinct approaches: transformation (achieved through resources, equipment, and employees), materials flow, and customer focus. The shortcomings of traditional project management methodologies led to the emergence of lean construction, which has significantly improved both management practices and project outcomes.

An organization may see improvements in quality, productivity, and service delivery if it implements the lean strategy, which could ultimately result in large cost savings. The 5s process, first run studies, fail-safe, and meetings for quality and safety were among the lean construction tools that were assessed by "Site Implementation and assessment of lean construction techniques (Salem, et al., 2006)." LPS controls all seven channels by establishing connections, starting discussions, and getting pledges to take action at the appropriate level and moment (Mossman, 2009). The ability to judge success is one of the key advantage of LPS since it substitutes idealistic planning with practical planning. Lean Tool increased visualization helps to visualize things like workflow, performance goals, and particular required actions. First-run studies frequently use images, pictures, and graphics to illustrate job instructions or show a process (Abdelhamid & Salem, 2005).

It is important to carefully review the initial attempt at a chosen assignment in order to generate ideas and suggestions for exploring different approaches to completing it. The study’s development is advised to follow a PDCA cycle (Forbes, et al., 2003). “Plan means to choose a work process to research, gather people, examine the process in the process, come up with ideas for eliminating steps, and assess the process for quality, productivity, and safety. The 5s method is “a place for everything and everything in its place” (also known as the visual workplace). Its five levels of housekeeping can aid in reducing resource waste. In concurrent engineering the participation of all the parties in the early design is essential for the success of the Lean process development, according to (Gil, et al., 2000). The customer may support concurrent engineering efforts that lower projects cost, therefore the client – engineering relationship should not be disregarded. Concurrent engineering efforts might also be affected by collaboration with suppliers and subcontractors.

1. **Identifying Value**

When defining value from the customer's perspective, the principle of value in construction is taken into account from the viewpoint of the customer. Construction value is defined in a subjective and nuanced way. As shown in lean construction articles, numerous additional researchers agree with this value assessment.
Two methodologies employed to assess the worth of a construction design are value management and value engineering. Value management is defined as the "conceptualization of production (from a value viewpoint)," where the emphasis is on generating value for the customer by fulfilling their requirements. On the other hand, value engineering involves scrutinizing a technical building design to identify cost-saving opportunities while preserving functionality. Value management primarily concentrates on formulating a design brief in a manner that aligns with the client's specifications, thereby enhancing the client's perception of value in the process (Kelly & Male, 1992).

The second fundamental principle of lean thinking is value stream mapping, where every step required to produce and deliver a product to the customer is delineated (Womack & Jones, 1996). The initial phase involves comprehending the current state of affairs. Therefore, the identification and mapping of the value stream play a pivotal role in the application of lean thinking. The value stream map delineates the processes responsible for product creation and highlights alternative routes to enhance production efficiency. The value stream encompasses all phases that contribute value to the product's design, production, and delivery. To achieve effectiveness in the construction project delivery process, all non-value-adding activities must be eliminated. The aim is to reduce the number of actions that do not generate value for the customer, as these tasks consume time, space, and financial resources.

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**c. Allowing Customer Pull**

The concept of "pull" refers to the strategic necessity of delivering the product to the client precisely when they require it. Pull involves the capability to provide goods to the client as soon as it is feasible (John, 2000). To fulfill customer demands, the pull principle leverages just-in-time approaches, which are subsequently tailored and delivered with greater predictability in alignment with the client's preferences. In the context of construction project delivery, several risks and uncertainties may hinder the timely and resource-efficient delivery of the product to the client (Dulaimi & Tanamas, 2001).

**d. Pursuing Perfection**

The zero waste principle aims to achieve the precise production of quality and quantity that aligns with the consumer's needs, delivered at the right time, at a fair cost, and with minimal waste generation. Continuously enhancing the flow process and eliminating obstacles or non-value-adding tasks are key to attaining process perfection. At the strategic level, this concept is pivotal as it emphasizes the need for the organizational structure and methodologies employed in delivering construction products to become ingrained as a cultural way of life. Striving for perfection involves ongoing reflection on what is being done, how it's being executed, and the most effective utilization of the skills and knowledge of all participants in the process to drive positive alterations and improvements (Dulaimi & Tanamas, 2001).

**3. INTEGRATION OF DIGITAL TOOLS IN LEAN**

Building Information modelling and Internet of Things are the two advanced technologies which are widely used in the construction of buildings and infrastructure (Henao, et al., 2019), (Lee, et al., 2020), ( Xu, et al., 2018), (Woodhead, et al., 2018), ( Kanan, et al., 2018). The Lean Construction can benefit from industry 4.0 in the construction sector (Sepasgozar, 2020) which includes essential technology for Cyber- Physical Construction Systems (CPCS) (Dave, et al., 2018), ( Shirowzhan, et al., 2020). The integration of BIM and Cyber Physical Systems helps in improving information exchange and providing real time data (Ying, et al., 2020), (Ding, et al., 2019).

But there's an opportunity to apply contemporary digital technology (Zhang et al., 2020; Sepasgozar et al., 2018) to help implement this idea in construction sites in a suitable way. Performance gains could result from digital solutions that integrate policies into the system in a language that is understandable to all project stakeholders. In order to monitor performance in real-time, sensors are also necessary. BIM and IoT are robust technologies with a wide range of untapped uses that may enhance the use of lean. Researchers want to utilize BIM in conjunction with other developments and technologies to maximize its potential for a range of applications, including safety. (In the 31st International Symposium on Automation and Robotics in Mining and Construction Proceedings, ISARC 2014), life cycle cost optimization (Luo & Wu, 2019) quality control, and shared communication channels among stakeholders. BIM is known as one of the foundational proven technologies in the construction industry. The industry's deliverables, connections, and roles are affected by the innovative technology, procedures, and policies that make up BIM (Marzouk, et al., 2018). BIM makes it possible to reduce total project costs, precisely schedule projects, and increase project quality (Succar & Kassem, 2015In order to decrease document mistakes and rework and, consequently, save the time required for the design process, BIM has been used to develop and maintain parametric models of buildings (Bynum, et al., 2013). This makes it possible to create digital models and manage projects as well as design and operate the construction process.

**LEAN TOOLS**

Tools and practices such as value stream analysis, 5S, just-in-time, visual management, preventative maintenance, continuous improvement activities, and Kanban are all examples of tools used in lean construction. Implementing a lean strategy within an organization has the potential to significantly impact productivity, service delivery, and quality, resulting in substantial cost savings over time.

In the study conducted by "Site Implementation and Assessment of Lean Construction Techniques" (Salem, et al., 2005), various lean construction tools were evaluated, including Last Planner, enhanced visualization, daily huddle meetings, first-run studies, the 5S process, fail-safe techniques, and quality and safety meetings. Performance criteria and measurement standards were employed to gauge the effectiveness of these lean construction tools. The project revealed that Last Planner, enhanced visualization, daily huddle meetings, and first-run studies exceeded expectations in terms of results. However, the 5S process and Fail-Safe techniques for quality implementation did not yield the desired outcomes as anticipated by the tool advocates and the study team. It was evident that training and behavioral adjustments are necessary for the effective utilization of lean tools. Most of the chosen lean construction tools for the project were either recommended with some modifications or deemed ready for use.

**a. Last Planner System**

The Last Planner System (LPS) serves as a method for streamlining workflow and managing project variability within the construction industry. It functions as a production control system that places a strong emphasis on the interconnection between scheduling and production control to enhance resource flow. The Last Planner is responsible for overseeing production unit control, which involves completing individual tasks at the operational level, and operational planning, which involves structuring product design to optimize workflow (Ballard & Howell, 1998).

In the realm of construction transformation, seven critical flows must coexist in the workplace: people, information, equipment, materials, past work, safe spaces, and a secure working environment. LPS effectively manages all seven of these channels by establishing connections, initiating discussions, and securing commitments to take action at the appropriate time and level (Mossman, 2009). The utilization of lean-based tools like the Last Planner has been linked to reduced accident rates and claims (Ballard & Howell, 2004).

According to Ballard & Howell (1997), the primary objective of LPS is to enhance productivity by removing obstacles within the process. One of its key advantages lies in its ability to assess the success of Last Planners based on their capacity to fulfill their commitments, thereby replacing idealistic planning with practical planning.

1. **Increased Visualization**

The objective of the enhanced visualization lean tool, as outlined by Moser & Santos in 2003, is to efficiently convey critical information to the workforce by strategically positioning multiple signs and labels across the construction site. This facilitates the visualization of various aspects such as workflow, performance objectives, and specific required actions by the employees. This tool shares similarities with visual controls employed in lean manufacturing, which are associated with ongoing process control as part of continuous improvement activities.

1. **Daily Huddle Meetings**

The daily huddle meeting approach hinges on two-way communication as a means to engage employees effectively, as indicated by Salem et al. in 2005. Employee satisfaction, encompassing aspects such as the significance of their work, self-esteem, and opportunities for personal growth, is likely to increase when employees are well-informed about the project, actively participate in problem-solving activities, and receive relevant training facilitated by various technologies. This lean construction technique involves conducting brief daily meetings to promptly update team members on their progress since the previous day's meeting, especially if any issues have arisen that could potentially impact task completion, as noted by Salem et al. in 2006.

**d. Plan Do Check Act**

First Run Studies frequently use images, pictures, or graphics to illustrate job instructions or show a process (Abdelhamid & Salem, 2005). It is important to carefully review the initial attempt at a chosen assignment in order to generate ideas and suggestions for exploring different approaches to completing it. The study's development is advised to follow a PDCA cycle(H & Ahmed, 2003). "Plan" means to choose a work process to research, gather people, examine the processes in the process, come up with ideas for eliminating steps, and assess the process for quality, productivity, and safety (Salem, et al., 2006). "Do" refers to putting ideas into action right away. "Check" refers to describing and quantifying what actually occurs. "Act" means to get the team back together and announce the better procedure and performance as the benchmark to be met.

1. **5S Process**

The 5S methodology revolves around the principle of "a place for everything and everything in its place," also known as the Visual Workplace. Its five-tiered approach to housekeeping serves to reduce wastage of resources. This tool shares similarities with the 5S housekeeping system in lean manufacturing, as discussed by Singh et al. in 2014. In construction sites, organizing materials is often utilized to facilitate the implementation of 5S. The adoption of 5S brings several benefits, including enhanced lead times, cycle times, increased machine uptime, improved morale, teamwork, and a culture of continuous improvement through kaizen activities. Furthermore, it contributes to improved safety, productivity, quality, and reduced setup times, as highlighted by Kumar et al. in 2022.

1. **Fail Safe for Quality and Safety**

This approach stands in contrast to the traditional concept of quality control, which involves inspecting a sample size and making decisions after dealing with defective components. It bears similarities to Poka-Yoke devices used for visual inspection in lean production. Fail-Safe principles can be applied not only to quality control but also to safety, where the focus is on potential hazards rather than potential defects. There is also a connection to the safety risk assessment tool employed in conventional manufacturing. For both components, action strategies aimed at preventing adverse outcomes are essential. The principles of implementing lean construction follow a specific sequence of initiatives, with increasing opportunities for improvement, as elucidated by Shingo in 1986.

1. **Concurrent Engineering**

Concurrent engineering is defined as the simultaneous execution of multiple development tasks within interdisciplinary teams, all aimed at achieving an optimal outcome in terms of functionality, quality, and productivity, as stated by Kamara in 2003. Beyond the use of charts, diagrams, and algorithms, concurrent engineering requires a collaborative effort from a multidisciplinary team, emphasizing the critical role of communication and information exchange in generating innovative ideas.

The active involvement of all stakeholders in the early design stages is crucial for the success of lean product process development, as emphasized by Gil et al. in 2000. Customers may endorse concurrent engineering endeavors that reduce project costs, underscoring the significance of maintaining a strong client-engineering relationship.

Concurrent engineering efforts might also be affected by collaboration with suppliers and subcontractors.

1. **Value Stream Mapping**

According to Womack and Jones (1996), a value stream is "the set of all specific actions required to bring a specific product through the three critical management tasks of any business". This encompasses the problem-solving activity, which extends from concept through comprehensive design and engineering to production launch, as well as the information management effort, which proceeds from raw materials to a final product in the customer's hand.

1. **BENEFITS OF LEAN CONSTRUCTION**

In 1992, Koskela formulated a hypothesis on how lean production principles could be applied to the construction sector to yield similar benefits as observed in the automotive industry. Koskela thoroughly examined the components of lean production theory and its foundational principles as a production philosophy. The challenges that practitioners might encounter when implementing this approach were outlined within the context of this production philosophy.

Koskela identified three distinct levels of lean production:

A comprehensive management philosophy.

An efficient, waste-free mode of production.

A set of tools for continuous quality improvement.

Furthermore, in his work from 2000, Koskela emphasized that the construction process should be perceived not as isolated conversion activities but as a continuous flow. Adopting this process-oriented perspective brings advantages such as the elimination of non-value-adding tasks like waiting, material transfer, and material inspection.

Two key elements that are recognized in the general management philosophy of lean production are the restructuring of the workforce to enable new operating procedures and the cultural shifts required for the success of the lean production philosophy.It is essential for business planning to embrace a lean production philosophy to consider what would be the ideal organizational structure for the new style of working because lean adoption in different sectors could produce varied outcomes (Wu and Wang, 2016). In order to support its new operational and managerial structures, the company must also create new tools and procedures or modify existing ones to meet its unique environment. It should be emphasized that the methods and resources are designed to support the first two sections.

Lean construction advantages fall into three categories: social, economic, and environmental. One method for raising the sustainability of the building industry is lean construction.There were several instances of how lean building methods were used.given in 2002 by Forbes et al. This includes a Brazilian business that worked with the University of Sao Paulo on a research effort toenhance the fusion of the manufacturing and design processes, and utilised LastPlanning a 90-day building project and using the Last Best Offeris a home development in Quito, Ecuador, employing the planner control system. several of the following benefits are each presented: Motivation and dialoguewithin the design team affected how design aspects were integrated withdirect process considerations, lean construction implementation, andTechnologies for Sustainable Construction, 332controls greatly increased production effectiveness in terms ofbuildability, manufacturing cost management, and non-material waste minimizationwasteful but unproductive. Added advantages include adecreased rework and a reduction in project length from 90 to 83 days. Lean implementation and increased quality control were made possible by The Last Planner.approaches, including Performance Factor (PF) and Percent Plan Complete (PPC)improved. On the building site, it was demonstrated that forward-thinking planningpermits one to maintain a connection between current actions and the master pull schedule.Marzouk et al. (2011) evaluated the effects of implementing leandecision-supporting design procedures in construction consultant businessesutilizing a computer simulation tool in the early stages of construction projects. It was determined that using lean construction concepts throughout the design process greatly enhanced process efficiency, as measured by reducedlonger process times and more resource use.

1. **ORGANIZATIONAL CHALLENGES IN THE LEAN CONSTRUCTION IMPLEMENTATION**

**6.1 Process-Related Barriers**

Process-related issues include long implementation periods, gaps in standards and methodologies, a lack of implementation ideas and understanding, and insufficient lean knowledge and grasp. While Alarco'n et al. (2002) and Abdullah et al. (2009) found that prolonged implementation timeframes were the issue in numerous organizations, Mossman (2009) highlighted the lack of time for innovation. Many businesses have given up due to the lengthy implementation process of lean principles. Adopting lean should not be viewed as a one-time event, but rather as an ongoing process of progress. To facilitate the application of lean, it requires long-term planning, training, the adoption of a continuous improvement culture, and system development (Mossman, 2009; Rother, 2010). The lack of existing standards for lean implementation is one of the biggest challenges to its adoption. Standard methods for a corporation to implement lean are lacking; this has made it difficult for organizations planning to do so. 2004 (Bernson). The difficulties of a standard were outlined by Bernson (2004). choosing the proper amount of detail, avoiding local customization, and using a top-down implementation style are all examples of approaches to lean.

**6.2 Barriers relating to people**

In many firms, problems with human attitudes and reluctance to change make lean construction difficult to adopt. Misconceptions regarding lean practice, a lack of committed leadership, inadequate leadership, a lack of cooperation, a lack of teamwork, and a lack of comprehension of client briefs are Some psychological variables (Howell, 1999; Olatunji, 2008; Common 2000; Forbes and Ahmed (2004); Mossman (2009); et al. toward moving Companies require employee engagement to change business culture for sustainability. (Hanna et al., 2000) Culture. The success of environmentally friendly Employee participation in culturally responsible practices Organizations must undergo adaptation as they are perceived as intricate systems comprising individuals. It is crucial for all members of a business, particularly in the context of Sustainable Construction Technologies, to align their attitudes and values with environmental considerations. Employees need to recognize the necessity for change and possess the ability to develop suitable responses to achieve this change. Employee commitment to their organizations is bolstered when they have a clear understanding of the company's future objectives, as highlighted by Walker et al. in 2007.

One of the pivotal elements in fostering a creative workplace is organizational culture. The human dimension within an organization's culture holds significant importance, as it plays a decisive role in determining the success of corporate performance and the management of change. According to Moffett et al. (2002), to alter an organization's culture, adjustments must be made to people's values, norms, and attitudes, ensuring they align with and contribute to the overall culture of the organization. Additionally, it's worth noting that each organization requires a unique set of cultural values. Flexibility becomes even more essential when an organization is dealing with uncertain situations that demand diverse perspectives.

**6.3 Other Barriers**

Various barriers to the implementation of lean principles include government regulations and the decentralized nature of the construction industry. Government policy issues in different countries, such as inconsistent policies and fluctuating commodity prices, impede the adoption of lean construction practices, as noted by Olatunji in 2008 and Alinaitwe in 2009. The fragmented nature of the construction sector has long been recognized as a hindrance to its transformation. Within the UK construction industry, the intricate and fragmented structure presents a significant challenge to the successful adoption of any process improvement. Johansen et al. (2002) describe the traditional construction process as characterized by fragmentation and loosely connected individuals who participate only in specific phases. The impact of the industry's fragmentation has been underscored in numerous studies, including those by Bashir et al. in 2010 and Mossman in 2009.

1. **Discussion & Conclusion**

Lean construction is the application of efficient management process which helps in waste reduction and increase in efficient( Kazaz, et al., 2015).This is one of the new management techniques which helps in reducing time, money and environment (Ansah & Sorooshian, 2017)(Kazaz, et al., 2015), (Singh & Kumar, 2020),(Marhani, et al., 2012), ( Tam, et al., 2007). Lean Construction methods helps in limited misuse of materials and time and produce most extreme conceivable measure of significant worth (Zhang & Chen, 2016), (GIURDANELLA, et al., 2006). This method helps to provide a general frame work of work among contractor, client and customers (Dineshkumar, et al., 2015), (Carvalho & Jr, 2017), (Ngowtanasuwan, 2013), A systematic review was conducted on papers of Lean tools and Principles and their acceptance in Indian Construction Industry. The most commonly used Digital Methods are BIM, A3, Esteem Chain Mapping, 5s, Visual Site (Jiang, et al., 2016), (Sapuay, 2016), (Generalova, et al., 2016), (Alhuraish, et al., 2016), ( Issa, 2013), (Andelin, et al., 2015), ( Jørgensen & Emmitt, 2008), ( M & Jr, 2017), (Mostafa, et al., 2017), (Anvari, et al., 2016), (Mostafa, et al., 2016).

During 1950s Toyota Motor Company used the method of Lean Production. Toyota framework has both the idea Just in Time (JIT) and Automation. In order to meet exceptional customer requirements, Lean creation refers to the planning and production of items that are differentiated from mass and art types of generations by the destinations and strategy (G, et al., 2002), (Jamil & Fathi, 2016), (Martens & Carvalho, 2017), (Mohammad, et al., 2016). In 1992 Koskela has proved how Lean Manufacturing Concepts make changes in the manufacturing sector and conceptualized in three complementary ways specifically as transformation, flow, value ( Li & Froese, 2016), (Martens & Carvalho, 2017). Lean Project Management is different from other management tools which has a clear set of objectives for the delivery process, helps in enhancing client execution at the project level and helps to control the project through out the life span (Lodgaard, et al., 2016), (Molavi & Barral, 2016), (Khodeir & Othman, 2018), ( Brioso, 2015),

In accordance with the principles of lean philosophy, the effective and consistent flow of work at a construction site necessitates the meticulous organization of the entire inventory network responsible for constructed facilities. This organization aims to enhance value while minimizing waste. It is widely acknowledged that tools originally developed within Lean Manufacturing and Lean Production, as perfected by Toyota and others, have been adapted to meet the requirements of Lean construction. Similarly, tools and techniques sourced from various fields, including sociology and business, are employed as needed. Implementations of lean construction also make use of tools and techniques commonly found in project management, such as Critical Path Method (CPM) and work breakdown structure.

Three notable tools and methodologies that are particularly emphasized in lean construction are the Last Planner System, Target Value Design, and the Lean Manufacturing Method, as discussed in Issa's work from 2013 and Pamfilie et al.'s research from 2012.

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