

LEAN CONSTRUCTION FOR THE SAKE OF WHAT?

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ABSTRACT

Lean construction includes impactful and powerful tools and techniques. For many years, it has been recognized as a management approach that helps the construction industry become more efficient and productive. The aim of implementing Lean Construction is mainly to reduce costs and time or to increase the value achieved for the client. However, with the need for a more sustainable construction industry, this paper calls for a discussion of our underlying assumptions on what constitutes waste and value, and whether we have the proper definition of the customer. Through a literature review and analysis, the authors highlight the original focus on value and waste behind implementing Toyota Production Systems and review the IGLC body of knowledge. The authors argue that as a community, we have been too focused on reducing economic waste and delivering value to the paying customer. As a community, we need to agree what value and waste mean and for whom. We must expand the stakeholder definition to also include future generations and nature. Moreover, we should discuss our underlying reasons for investing in implementing Lean Construction. Perhaps it is time for us to discuss “Lean Construction for the sake of what”?

KEYWORDS

Lean Construction, value, waste, costumer, sustainability

INTRODUCTION

Lean Construction has been applied to construction production processes for decades to increase value and reduce waste, as seen from a customer perspective. This has been a ground rule and is a common point of departure for discussions within the Lean Construction Community. Much has been written about this as a foundation for understanding Lean construction and waste, e.g. (Ballard & Howel, 1988) and (Koskela et al., 2002). Lean Construction has often been adopted to improve economic returns for businesses without directly targeting social or environmental outcomes. However, besides impacting the economy, the construction industry also significantly impacts other important parameters, such as resources, life quality, and climate change. With the passing of time and change in agenda, it could be time for a discussion on the underlying assumptions of the benefit of applying lean construction.

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We claim that Lean Construction could support improvement on the triple bottom line of sustainability: economic, social, and environmental (Elkington, 1997). However, this requires a shared understanding and a reinterpretation of some foundational terms: value, waste, and customer. This paper will elaborate on the central terms in the Lean vocabulary, unfold what these terms have covered in the past, and discuss whether these interpretations align with the changing agendas around sustainability.

METHODOLOGY

This paper discusses our shared understanding of Lean and how it affects how we implement it in practice. Our hypothesis is that we have been focusing on a limited utilitarian approach to lean construction, especially on improving economic benefits for the owner and supply chain. Firstly, we present an overview of the global construction industry's current sustainability challenges and negative impact. Secondly, we analyze key definitions in Lean, such as value and waste, based on the literature by asking: What is value? Value for whom? What is waste? And waste for whom? Thirdly, we present an overview of the historical focus of the IGLC community by analyzing how IGLC papers discussed value and waste considering (or not) a broader view on social, environmental, and economic perspectives. Finally, we discuss how our definition of waste and value can limit our view of the beneficiary of lean practices, therefore asking: lean construction for the sake of what?

LITERATURE REVIEW

WHAT IS THE AGENDA AND THE PROBLEM OF TODAY?

The world is changing, and so are the perspectives on what constitutes value, waste, and who the customers are. In “Our Common Future,” Brundtland (1987) states the need to consider the needs of future generations. This report is defined in paragraph no. 27 sustainable growth as “meeting the needs of the present without compromising the ability of future generations to meet their own needs”; hence, value creation should be seen from a more long-term perspective and not just from the immediate end-user or customer. With this understanding, value is not limited to the immediate desires of current investors or customers; it is also a duty to consider long-term impact.

Currently, the industry severely impacts future generations as it accounts for 39% of the global carbon emissions, of which 11% is embedded carbon from materials used (WorldGBC, 2019). Furthermore, the industry creates 40% of the world's solid waste (Breene, 2016), utilizes 25% of the total amount of virgin timber, approximately 16% of the water used per annum, and is responsible for nearly 30% of biodiversity loss (WEC, 2020).

More customers are setting requirements for more sustainable solutions and thereby pointing to sustainability as a measure of value. In a small batch analysis from 2023, including 11 ongoing infrastructure projects primarily in Scandinavia, Christensen (2023) found that 45% of the project tenders had some sustainability-related requirements. Most were related to documenting impact, not reducing it, and only 18% of the projects included economic incentives for reducing carbon. Customers expect the supply chain to respect the environment and demonstrate social responsibility; however, the primary competitive model is still cost-based.

More reporting systems and legislation refer to a triple bottom line to define value. The triple bottom line consists of Environmental, Social, and Governance (ESG) to evaluate the value, sustainability, and ethical impact of a company or investment. ESG criteria provide a set of standards for a company's operations. ESG has provided a critical set of metrics for investors, policymakers, and stakeholders as they seek to align financial goals with sustainable and ethical values (MSCI, 2024).

The industry is needed to improve living conditions for many. However, the industry also has a significant negative impact through the non-sustainable consumption of virgin materials, the creation of waste, and negatively impacting ecosystems. Beyond legislative requirements and reporting, the paying client still gives little weight to these longer-term impacts. Therefore, focusing only on value in the eyes of the paying customers will not support a timely transition to a more sustainable future. In the following, we will elaborate on the terms, value, waste, and customers to initiate a debate on these terms and the implications seen in the light of society's needs and expectations.

WHAT IS VALUE IN CONSTRUCTION? AND VALUE FOR WHOM?

In Lean Manufacturing, value refers to the features or aspects of a product or service that a customer is willing to pay for. When looking at Toyota, in *The Machine that Changed the World* by Womack et al. (2007), value refers to how well they manufactured cars, how durable and consistent they allowed people to move safely, etc. In Lean, value is defined by what the customer perceives as valuable and is the sole determinant of what constitutes value. Therefore, value for whom? In traditional lean manufacturing, it means value for the paying customer. To summarize:

- Customer-centric: The paying customer is the ultimate judge of what constitutes value (Ohno, 1988).
- Not just cost: Value is not solely based on the price of a product, but rather the perceived benefit the customer receives.
- Identifying value-added activities: Lean practices aim to identify and focus on activities that directly add value to the product from the customer's perspective, eliminating unnecessary steps or waste (Ohno, 1988).
- For employees: Value can mean meaningful work, reduced frustration, and a safer work environment (Ohno, 1988). Increased job satisfaction through recognition of contributions and greater trust and respect within the organization (Liker, 2004).

When we think about the construction industry, Value is generated through a process of negotiation between customer ends and means. The first role of the designer is to make explicit to customers the consequences of their desires, subsequent to which customers may choose to modify their ends (Ballard & Howell, 1988).

In the construction industry, understanding customer value is a challenging task. To adequately understand value in construction, customer involvement is required to avoid decreases in productivity and value losses in the process and product. However, construction projects don't always take the time to involve customers at the appropriate level to influence design. Giménez et al. (2020) have studied how to make requirements measurable using the Kano Model. This model not only looks for what the owner wants to see in the building but also what they are indifferent to and what has a negative value realization (value-reducing features). The Kano Model seeks to accomplish the following: (1) identify the desired value of the different clients in the process, (2) understand the value generation process, and (3) recognize and manage value losses.

Accounting for different supplier and employee needs is not new. Internal customer value is the perceived value that employees derive from their work within an organization, based on the idea that employees are internal customers who can be valued and supported in the same way as external customers (Lo Iacono et al., 2024). Although customers, supply chain, and employees participate in value creation and also receive value, the value creation literature has been dominated by the paying customer perspective, with little attention given to value creation from the other's (e.g. employee's) point of view or even understanding the nature as a stakeholder in the value generation process.

In Lean Construction respect for people and continuous improvement has been present since the foundations. Lean Construction emphasizes collaboration through tools like the Last Planner System (LPS) and Integrated Project Delivery (IPD), fostering transparency and teamwork. Employees gain clarity about their roles, responsibilities, and project goals, reducing misunderstandings and conflicts. 5S, standardization, and visual management have also been documented to have several benefits and value for employees, such as:

- Enhanced team dynamics and morale. Better alignment of efforts, leading to a sense of accomplishment (Ballard, 2000).
- Lower stress levels and reduced risk of burnout. Greater job satisfaction due to manageable workloads as work environments are structured to minimize chaos, last-minute changes, and unrealistic deadlines. (Koskela, 1992).
- Safer work environments reduce the likelihood of accidents and injuries, and improved job site conditions promote physical and mental well-being (Alarcón, 1997).
- Increased autonomy and ownership of work processes and enhanced skills and career development opportunities (Salem et al. 2006).
- Reduced uncertainty and better job continuity and a sense of security and stability within the organization (Howell, 1999).

From a future generation perspective, literature seldom considers them a customer, so the impact or value creation for future generations is seldom considered. Value definitions are typically based on direct human impact perspectives and often do not consider nature as a stakeholder. As we emphasize respect for people and resources, we should also include respect for nature in this principle.

WHAT IS WASTE IN CONSTRUCTION? AND WASTE FOR WHOM?

Waste is widely recognized as a non-value-adding activity, although its definition varies across industries (e.g., Denzer et al., 2015). For instance, Ohno (1988) emphasizes the cost perspective, stating that waste increases costs without adding any value for the customer.

Ohno (1988) defines the following types of waste (Muda) for production:

- Transportation: Unnecessary movement of goods, materials, or information.
- Inventory: Excess inventory that is not immediately needed.
- Motion: Unnecessary movements by people or machinery.
- Waiting: Idle time caused by delays in processes.
- Overproduction: Producing more than what is required.
- Over-processing: Performing tasks or adding features that are unnecessary.
- Defects: Errors in products or services that require correction or rework.

In addition to Muda, Ohno (1988) introduces the concepts of **Mura** and **Muri**, both of which represent different types of waste. **Mura**, or unevenness, refers to irregularities in workloads, production levels, or demand, leading to inefficiencies such as overburdening workers or machinery during peak times and underutilization during slow periods. This can cause issues like fluctuating production schedules, bottlenecks, and downtime. **Muri**, or overburden, describes the excessive strain placed on workers, machines, or systems, often due to pushing beyond capacity or using inappropriate resources. This type of waste results in fatigue, breakdowns, errors, and accidents, such as requiring employees to work overtime consistently without proper breaks or overloading machinery beyond its operational limits. According to Ohno (1988), Mura often causes Muri, as inconsistencies in demand or workload lead to overburdening. Muri can create Muda, as overburdened systems and workers are prone to generating waste (e.g., defects, delays). In contrast, Koskela (1992) adopts a resource-based

approach, defining waste as activities that consume time, resources, or space without adding value. Furthermore, Liker and Meyer (2006) expand on Ohno's (1988) definition by adding a new type of waste: Unused employee creativity. This refers to the loss of time, ideas, skills, improvements, and learning opportunities that occur when employees are not engaged, or their input is not heard.

Lean incorporates flow and value in production. A smooth process flow can increase value to the customer by minimizing waste. Inefficiencies in the flow of work (Koskela, 1992) may result in production waste (Ohno, 1988). For whom these wastes impact can vary:

- **Customers:** Defects, overproduction, and delays (waiting) can result in lower product quality, longer delivery times, and reduced customer satisfaction (Ohno, 1988; Liker, 2004).
- **Direct Impact on Operations:** Waste affects the efficiency of production processes directly, leading to increased costs, longer lead times, and reduced flexibility (Ohno, 1988; Liker, 2004).
- **Employees:** Wastes like unnecessary movement (motion) or waiting can lead to frustration, decreased morale, and lower job satisfaction (Ohno, 1988; Liker, 2004).
- **Environment:** Overproduction, excessive transportation, and poor inventory management can have environmental impacts through increased energy consumption, waste generation, and resource depletion (Liker, 2004; King & Lenox, 2001).

The previously mentioned wastes can be characterized as traditional production waste, which aims to make a process more efficient and has been well documented in the Lean Construction literature. These wastes typically are associated with economic loss for the owner or for the companies involved in producing the project, especially Muda. Environmental waste can be defined as the excessive use of resources and the release of noxious substances into the air, water, or land that endanger people and degrade the environment (US EPA 2007). Few papers look at environmental waste in construction, and it is not the focus of improvement in traditional lean management (Belayutham & Gonzalez, 2013). From a lean standpoint, environmental waste does not add value to the client; instead, it increases costs through the excessive consumption of resources. In theory, production waste may cause environmental waste (Arroyo and Gonzalez, 2016). However, when we think about waste produced for future generations, there may be cases where reducing waste to the immediate client is in conflict with reducing waste for future generations. For example, to build a project that uses land in a biodiverse forest territory to make new construction developments. The project could provide value for people today, but deprive future generations of the CO₂ capture capacity of the forest and produce lost of biodiversity. Another example would be making oil and gas extraction more efficient today, leading to faster production of GHG and toxic gases for humans for centuries to come.

In addition, most management approaches in construction are technically oriented methodologies focused on project and contract management, neglecting central social aspects related to peoples' behavior both in individual and collective domains (Pavez & Alarcón, 2007, Arroyo & Gonzalez, 2016). Therefore, even when lean practices can reduce waste for employees, increase morale, and reduce frustration, it can be argued that the classical definition of production waste from a lean standpoint also neglects the social dimension and the direct waste generated by employees beyond the production floor, and communities impacted by construction projects.

Arroyo & Gonzalez (2007) proposed adding the following categories of environmental and social wastes in construction:

- **Environmental Wastes:** air emissions, solid waste, wastewater, noise disturbance, over-illuminating, and excessive soil usage.

- **Social Wastes:** Lack of health, lack of safety, suboptimal working conditions, loss of employment, lack of education and training, knowledge not capitalized, unused innovation, underestimating social acceptance, lack of societal dialog.

However, the Lean Construction literature does not agree on what constitutes social and environmental waste, and the dominant focus is on the paying customer instead of future generations, employees, and communities.

WHAT HAS BEEN THE FOCUS OF THE IGLC COMMUNITY?

In this section, we explore the evolving role of sustainability within the IGLC community. Over the past decade, there has been a significant increase in research papers on sustainability. While many touch on the topic peripherally, only a few have deeply integrated sustainability with key Lean Construction principles, such as value creation, waste reduction, and applying Lean methods and tools.

Traditionally, design and construction have prioritized cost, quality, and time without addressing potential sustainability impact. Lombardo et al. (2023) emphasize that sustainability must be explicitly embedded in the early stages of a project's lifecycle to ensure meaningful impact. In Lean Construction, sustainability extends beyond waste reduction—it encompasses resource conservation, environmental protection, and promoting a healthier built environment. This perspective aligns with the UK Government's definition of sustainability, which stresses the need to meet present demands without compromising the needs of future generations (Houvila & Koskela, 1998).

A key link between Lean and sustainability is the concept of value. Novak (2012) argues that focusing on value can shift construction management beyond cost and efficiency constraints towards a broader vision of sustainable prosperity. However, defining value remains complex and subjective, as clients often prioritize economic factors over long-term sustainability goals (Maia et al., 2011).

The synergy between Lean and sustainability becomes particularly evident in practices like prefabrication, which supports Green Design-Build (GDB) objectives by minimizing waste and optimizing resource efficiency (Luo et al., 2005). Bae and Kim (2007) categorize the impacts of Lean Construction on sustainability into the three ESG dimensions. While these dimensions are essential for the entire life-cycle of a building, Lean Construction's focus has traditionally been on the production phase. Johnsen and Drevland (2016) explore how Lean Construction contributes to sustainability by improving planning, worker engagement, and process efficiency. They emphasize that, although LC enhances economic and social sustainability in the production phase, it overlooks the design and operational stages. Moreover, its environmental impact, such as carbon emissions, remains limited. Their research, therefore, calls for a broader exploration of life-cycle phases and environmental strategies to strengthen Lean Construction's overall contribution to sustainability. Vrijhoef and Koskela (2005) further argue that achieving sustainable value requires balancing economic, environmental, social, cultural, and historical considerations—often necessitating trade-offs.

However, the concept of sustainability remains ambiguous in much of the literature. Based on an IGLC literature review, Sarhan et al. (2018) identify key limitations in Lean Construction that hinder its alignment with sustainability. First, the narrow focus on customer prioritizes client satisfaction over broader societal and environmental value, overlooking long-term sustainability considerations. Expanding the concept of value creation to include community well-being and ecological impact could enhance its contribution to sustainability. Second, Lean Construction research and practice largely focus on the construction phase, neglecting whole life-cycle impacts such as operations, maintenance, and end-of-life disposal. A holistic perspective is necessary to maximize sustainability benefits beyond project delivery (Sarhan et

al., 2018). Third, the definition of waste in LC remains too narrow, primarily addressing economic inefficiencies while often ignoring environmental and social dimensions. Incorporating carbon emissions, resource depletion, and social impacts into Lean Construction waste reduction strategies would strengthen its role in achieving sustainability goals. Thus, to fully integrate Lean Construction and sustainability, value creation must be redefined, life-cycle thinking must be adopted, and waste management must be expanded to reflect environmental and social responsibilities (Sarhan et al., 2018).

Slosharek et al.'s (2021) sustainability perspective is process-oriented and extends beyond a purely reductionist approach focused on minimizing waste and emissions. Instead, it is value-driven, emphasizing resource renewal, process optimization, and holistic efficiency by integrating environmental parameters directly into construction workflows. They argue that sustainability should not only be about reducing waste and emissions but also about optimizing construction processes through Lean Construction and Production Planning to achieve resource efficiency, workflow stability, and long-term environmental benefits.

Despite its potential, Lean Construction alone is not sufficient to achieve comprehensive sustainable development. It must be supported by informed client demands, holistic sustainability strategies, and systemic approaches. Abdin and Pasquire (2005) stress the importance of integrating sustainability at a fundamental level, while Degani & Cardoso (2002) highlight the need for Lean Construction to align with global sustainability objectives, such as reducing embodied energy waste in construction materials.

In summary, while Lean Construction holds potential for contributing to sustainability, there is a consensus within the IGLC community that it must evolve to include a broader understanding of sustainability. This includes expanding the definition of value, adopting life-cycle thinking, and addressing environmental and social dimensions in waste reduction strategies. By broadening the scope of Lean Construction to encompass the entire life-cycle and integrating comprehensive sustainability measures, Lean Construction can play a more significant role in achieving long-term, holistic sustainability in construction projects.

WHAT SHOULD THE IGLC COMMUNITY FOCUS ON IN THE FUTURE?

If blindly implemented, using Lean Construction could lead to less sustainable solutions. Therefore, it is important to ask from what perspective Lean Construction would deliver value. If we consider sustainability and broaden our perspective, Lean Construction could enable more sustainable solutions to deliver value and reduce waste for multiple stakeholders. Thus, Table 1 presents a non-comprehensive overview of value generation for different project stakeholders.

If we are not careful as a community, we may be implementing lean to only improve for the sake of gaining economic benefits, meaning considering the customer only the paying client and maybe the profit of the involved organizations. If we believe in respect for people and continuous improvement, we must consider employees, community, and society as a customer. Finally, and probably most important, if we care about future generations and the natural habitats, they should also be considered as our customers. We have to make sure we understand who our customers are, and as a Lean Construction International Community, we should challenge our research to consider future generations as a customer as well, given the current state of affairs. Furthermore, our community should explore the existing potential of Lean methodologies such as Target Value Design, the use of BIM for sustainability analysis, and CBA to balance out and integrate the different stakeholder perspectives. By leveraging these approaches, we can create more transparent processes that drive better decision-making and ultimately deliver greater long-term value for all stakeholders. Thus, more research is needed on how Lean methodologies can support broad perception of value and to create a more sustainable construction industry.

Table 1: Increasing value and reducing waste for different stakeholders

Stakeholder	Increased Value	Waste reduction
Customer	Value is what meets or exceeds their expectations, such as quality, price, timeliness, and customization.	Elimination of production waste (Muda) such as defects and waiting.
Organizations in the supply chain	Value includes profitability, productivity, and competitive advantage.	Eliminating waste enhances operational efficiency and reduces costs. Processes designed to minimize overburden (Muri) or unevenness (Mura) lead to a more fulfilling workplace.
Local Communities	Value for the communities involved in construction projects, so they also benefit from it, in terms of improved access to resources and improvement in life quality.	Eliminating negative impacts on people and communities, such noise, local emissions, disturbance of access to transportation, food, health, education, etc.
Wider society	Value encompasses sustainability, minimizing environmental impacts, and seeking to improve the environment given the current need to reestablish natural equilibrium and society.	Eliminate social and environmental waste as well as economic waste.
Future generations	Value for future generations so they can fulfill their needs.	Eliminate the waste of catastrophic consequences for future generations, including wars due to lack of basic resources, such as water and stronger and, more often, natural disasters.
Nature	Value for the environment so our planet returns to its natural equilibrium, and biodiversity is restored and can thrive.	Eliminate negative Impacts to nature including all ecosystems, flora and fauna, and planet Earth.

CONCLUSIONS

In Lean Construction, the focus on efficiency and waste reduction can align with sustainability goals by reducing the use of resources and improving energy efficiency. However, conflicts arise when the economic efficiency goals override broader environmental and social concerns. A strict focus on reducing waste and delivering value to the client could lead to less sustainable solutions. Prioritizing cost-effective waste reductions might overlook the impact of materials. For example, some materials might be cheaper and more functional but have a heavy impact on climate change. With a strict focus on client value delivery, we might, therefore, overlook the opportunities for materials with less negative impact. Lean prioritizes immediate project efficiency and cost savings, while sustainable practices often require upfront investments for long-term benefits. Focusing on process optimization might limit the flexibility in adopting evolving sustainable practices and technologies unless the processes are flexible and open for mid-project changes. There could also be a conflict between the desire to minimize inventories and reducing transportation. While transport of materials might not be costly, it most often hurts carbon emissions. If employees are not considered in the equation (respect for people principle is not hold) workers can be more productive but do not see their work hours reduced, not have access to create wealth, and not make.

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