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Evaluation of the Effectiveness of Lean Construction Tools Implementation during the Execution Phase of a Construction Project in Moscow

The paper addresses the problem of persistent cost escalation in the Russian construction industry, which, under conditions of macroeconomic instability, inflation, and rising logistics costs, has become a critical factor reducing the competitiveness of construction companies. The necessity of implementing management technologies aimed at reducing production waste without significant capital investment is substantiated. Lean construction, which adapts the principles of lean manufacturing to the specifics of construction projects, is proposed as such an approach.
The study examines the application of 5S, Value Stream Mapping (VSM), and standardized work methodologies in a residential development project in Moscow, together with supplementary tools including 4M, 5W+1H, and the one-piece flow principle. The research methodology comprised time-motion studies, photographic documentation, employee interviews and questionnaires, and a comparative assessment of key performance indicators before and after implementation.
Key types of waste on the construction site are identified: waiting for materials and equipment, unnecessary worker movements, excess inventory, defects and rework. The implementation of lean construction tools in three pilot areas (finishing works, installation of engineering systems, and installation of a ventilated facade) resulted in a 66 % reduction in tool search time, a 50 % decrease in equipment downtime frequency, and a 60 % reduction in schedule deviations. Economic effects are estimated: savings on labour costs, reduced equipment rental expenses, and lower overheads.
Barriers limiting the scaling of lean practices are identified (staff resistance, lack of digital monitoring tools, the need to adapt foreign methods). Directions for scaling the experience are proposed, including the development of industry standards and training programmes. The paper is intended for specialists in construction management and project management.
Keywords: *lean construction, production costs, 5S, VSM, 4M, 5W+1H, one-piece flow, efficiency, construction project, Moscow*

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The construction industry in the Russian Federation is currently experiencing a period of high uncertainty and cost volatility. These problems are particularly acute in major cities such as Moscow, where the combined impact of high labour costs, logistics and inflation on building materials leads to a constant rise in the cost of construction projects. In these circumstances, there is a need to introduce modern management technologies aimed at reducing waste and increasing process transparency.

The vast majority of construction projects are characterized by unique features, which precludes the direct application of the assembly-line principles of classical lean manufacturing. One promising approach is lean construction, which builds on the principles of lean manufacturing and adapts them to the specific nature of construction projects. A shift towards this approach is enshrined in the Strategy for the Development of the Construction Industry and Housing and Utilities Sector of the Russian Federation. The aim of this paper is to assess the applicability and effectiveness of implementing key lean construction tools at a specific site in Moscow.

In pursuit of the stated objective, the following tasks were accomplished:

- a description of the practical tools of lean construction was provided;
- models for the business diagnosis of a construction company were defined in the context of improving the efficiency of production operations, as well as the implementation, maintenance and evolution of lean construction methods and philosophy;
- a matrix of tools for the philosophy of lean construction was developed;
- organizational schemes for construction project management, based on the principles of lean construction, were described.

The progressive development of the construction industry is inconceivable without the adoption of advanced management methods. The improvement of administrative activities in construction is shifting towards the rationalization of financial, material, technical, human and other resources, the use of innovative building materials and the implementation of breakthrough technologies. Modern lean technologies integrate all these aspects, which are utilized across a wide range of industries.

Researcher T. Abdelhamid emphasizes that classical methods such as the critical path, the earned value method and similar approaches do not guarantee a high probability of achieving targets within the specified timeframe [1].

Lean technology is rightly considered one of the most dynamically scalable systems for strengthening a business's competitive position. Its origins are linked to the Japanese corporation Toyota Motor and are widely known as the Toyota Production System (TPS).

Lean manufacturing focuses on the efficient use of available resources and the elimination of processes that consume resources without adding value to the final product. Such operations are identified as waste (muda). Their elimination shortens the production cycle and reduce the final cost of the product.

The approach is based on the principles of systematic waste elimination, the immersion of staff in a process of continuous improvement, and the synchronization of all links in the production chain. Unlike traditional construction management, the Lean approach involves the decentralization of management decisions, the active involvement of front-line production units, the standardization of operations, and the visualization of technological processes.

In total, the Lean production paradigm classifies seven categories of waste [2]:

1. Unnecessary staff movement — effort caused by the absence or irrelevance of production standards, poor work discipline and an inefficient workplace layout.
2. Unnecessary transport — excessive movement of raw materials, semi-finished products and components.
3. Overproduction — the production of volumes exceeding actual demand.
4. Idle time — inactivity of staff and equipment whilst awaiting work.
5. Excess inventory — capital tied up in the form of the company's working capital.
6. Defects and rework — the manufacture of products whose parameters do not meet customer requirements, necessitating corrections to the process, product or service.
7. Over-processing — endowing a product with properties or characteristics that are excessive from the customer's perspective [2].

A highly effective approach to problem-solving is the One-piece flow method. This is a step-by-step algorithm for resolving production incidents: first, the nature of the problem is identified, after which measures are implemented to eliminate it and prevent future recurrences.

The starting point in the One-piece flow method is a clear definition of the problem. For this purpose, the 4M Matrix and 5W+1H tools are used.

According to the logic of the 4M Matrix, the entire pool of potential sources of problems and losses is grouped into four clusters: personnel (Man), machinery (Machine), materials (Material) and methodology (Method). Breaking things down into these categories allows the essence of the problem to be articulated with the utmost clarity.

The 5W+1H toolkit enables the deviation to be analyzed in detail. When identifying root causes, one must answer the following set of questions: "who?", "what exactly?", "where?", "when?", "to what extent?" and "how often?".

The next stage is identifying the root cause of the failure. Techniques such as the Ishikawa diagram and the 5 Whys method are used here.

The Ishikawa diagram visualizes a systematic approach to identifying the root causes of a problem. Factors are classified into groups and listed under each group. Graphically, the model resembles a fish skeleton.

The 5 Whys method aims to identify the fundamental causes of emerging difficulties. Its essence lies in repeatedly (usually five times) asking "why?" to find the root cause. The number of iterations may vary; the key is to identify the root cause itself.

The third stage is the selection of a method to resolve the problem. At this stage, it is necessary to generate corrective actions and select from them the most effective and least costly ones. The key steps in implementation are reaching consensus with the implementers and drawing up an implementation roadmap.

Step four: implementation of corrective measures. This involves carrying out the approved plan in strict accordance with the timetable and conducting ongoing monitoring of progress in collaboration with the parties involved.

Phase five: managing the outcomes. It is necessary to analyze how the implemented measures have affected the future frequency of problems and what preventive mechanisms can be put in place for the future.

The final stage is the development or updating of the standard. Ultimately, to resolve the problem, it is necessary to draw up new regulations or amend existing ones [3, 4].

Another significant tool for radically reducing the volume of losses occurring on a construction site is the 5S system. The methodology is structured into five phases[1]:

1. Sorting — separating critical tools and documentation from unnecessary items and removing the latter from the work area.
2. Order — assigning strictly defined and clearly marked locations to essential items.
3. Cleanliness — developing cleaning procedures, providing staff with the necessary equipment, and monitoring adherence to the schedule.
4. Standardization — formalizing rules to systematically support organization, order and hygiene.
5. Improvement — the continuous evolution of existing standards.

The method is founded on the principle that every employee has the right to propose initiatives for improvement[1] [5].

The use of Lean Construction tools can significantly streamline operations not only directly on the construction site, but also in factory-based house-building workshops. Optimized processes help to reduce costs, improve quality and eliminate unnecessary movements.

These tools provide the opportunity to analyze all technological processes on site and transform the sequence of operations, technological equipment and resource base to multiply productivity.

It is also worth noting other tools that are quite important when implementing lean construction tools in the construction sector.

One of these is Value Stream Mapping. This tool allows all operations to be visualized. It can be applied from the design stage right through to the operation of the building. The tool enables the description of both business processes and construction and installation works on the building site[2].

It helps to identify inefficient areas, bottlenecks and redundant processes that do not add value. On a construction site, this may include processes such as the delivery of materials, the movement of workers and the handover between contractors.

Standardized work is a method focused on identifying waste and continuous improvement. Its purpose is to provide a detailed representation of processes and their step-by-step improvement[3].

It involves a fixed sequence of actions, clear time standards and quality control. Standardization is particularly important when

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[1] National Standard of the Russian Federation GOST R 56906–2016. Lean production. Workspace organization method (5S). Effective January 2016. URL: https://docs.cntd.ru/document/1200133736 (rus.).

[2] GOST R 57524–2017. Lean production. Value stream mapping. Introduced 2018-07-01. Moscow, Standartinform, 2018; 22. (rus.).

[3] National Standard of the Russian Federation GOST R 56908–2016. Lean production. Work standardization. Effective January 2016. URL: https://docs.cntd.ru/document/1200133738 (rus.).

carrying out repetitive tasks (such as plastering or installing partitions), where consistent quality and predictable completion times are required.

An advantage of the method is the ability to assess the workload of all operators, which in the construction industry is most applicable to the existing organization of work by teams and brigades. This makes it possible to increase the productivity of the entire brigade by redistributing work between teams and operators, as well as through the effective organization of these tasks.

The main trend in the evolution of lean construction tools is primarily linked to the synchronization of participants and beneficiaries of the investment project.

The application of lean construction tools makes it possible to identify and eliminate bottlenecks more quickly, achieve a sustained increase in efficiency and quality, and reduce time and financial losses.

The subject of the study is a residential complex of varying storeys, being developed by a major construction company in the South-Eastern Administrative District of Moscow. The project is characterized by a tight schedule, a significant number of contractors and complex logistics on the construction site. The choice of this particular site is justified by its typicality for the conditions of large-scale urban construction.

Methods of data collection:

- time and motion studies;
- analysis of work schedules;
- interviews with workers, foremen and site supervisors;
- photographic documentation of the construction site;
- staff surveys on working conditions and the effectiveness of collaboration.

To assess the impact of the implemented tools, both qualitative and quantitative analysis methods were used, including a comparative measurement of indicators before and after the tools were applied.

Lean construction tools were implemented between June and August 2025. Three pilot areas were selected:

1. Finishing works in common areas.
2. Installation of building services.
3. Installation of a rainscreen cladding.

At each stage, the current status was recorded, losses were identified, improvements were formulated, and the results were assessed using metrics for time, losses and staff satisfaction (Table).

Prior to implementation, the following issues were observed:

- delays in material deliveries of up to two days;
- up to 30 minutes per day were wasted searching for tools;
- a high proportion of work in progress;
- a lack of coordination between contract units;
- overcrowded storage areas and frequent disruptions to material supply routes.

After the implementation of the tools:

- delays were reduced by 40 %;
- time lost was reduced to 10 minutes;
- deviations from standard times were reduced from 35 to 10 %;
- discipline and safety in work areas improved;
- adherence to delivery schedules improved;
- the number of unfinished tasks in finishing areas decreased.

The results demonstrate the high sensitivity of construction processes to the implementation of even basic elements of lean construction. It is important to emphasize that the implementation of these tools is possible without significant financial outlay — the main resources required are organizational effort and staff skills.

However, certain limitations and challenges were identified during the implementation process:

- a low level of motivation among contractors to transition to new forms of collaboration;
- a lack of digital monitoring and control tools;
- the need to adapt foreign methodologies to the realities of Russian regulations;
- time-related costs associated with retraining staff and adjusting established working habits.

To achieve sustainable results, it is important to secure support from project management, conduct regular status audits, and implement visual control tools at all stages of the project lifecycle.

The selection and application of lean construction tools must take into account identified and potential systemic losses.

The research findings can be applied in the development of regulatory recommendations and standards at the federal level. Lean construction tools can be particularly effective within state-funded capital construction programmes, as well as in renovation and infrastructure renewal projects.

Projects involving innovative clusters and world-class campuses based at federal universities could serve as one of the most promising avenues for implementing a hybrid construction management model.

It is recommended that:

- a set of rules (SR) entitled “Lean Construction: Key Provisions” be developed and approved;
- lean assessment be introduced into the system for reviewing design and working documentation;
- regional and federal training programmes be implemented to teach engineering and technical staff lean management methods;
- the provision of pilot projects with the mandatory application of Lean tools (particularly 5S and VSM);
- the creation of standard VSM charts and standard operating procedures adapted to Russian construction practice.

The systematic implementation of lean construction principles requires a package of measures aimed at integrating the new paradigm into the existing management structure. Without changing the current operational algorithm, in which Lean tools become an integral part of the system, the effect will be fragmented.

Regular meetings must be introduced: weekly and daily sessions at which identified issues will be discussed in detail and a set of preventive and corrective measures will be developed. Each week constitutes a reporting cycle, beginning with a joint site inspection by

Key performance indicators

Indicator	Before	After	Change, %
Time spent searching for tools	30 min	10 min	– 66
Frequency of equipment downtime	4 times/week	2 times/week	– 50
Deviations from schedule	1.5 days	0.6 days	– 60

all project members and a parallel management meeting. In addition, a daily morning briefing is held to update the decisions recorded during the site walk-around. Its purpose is to set priorities for those responsible and develop strategies for tackling current tasks. Peak efficiency is achieved through the standardization of the meeting room: the latest information is displayed on the walls in an optimal layout. A daily morning operational meeting is also held to adjust the decisions made during the site walk-through. Its aim is to identify the most urgent tasks for those responsible and discuss ways to resolve them. Maximum efficiency is achieved because the meeting room is arranged to a standard — the necessary materials are displayed on the walls in the most effective order.

Every evening, a meeting is held with subcontractors to assess the actual progress of work and any losses incurred, and to approve the work plan for the following day using production analysis sheets.

Participants also carry out daily site inspections independently to assess the effectiveness of the improvements and measures being implemented.

If there is a deviation from the work plan, a work analysis is initiated. If a single type of work deviates from the plan, the standardized work tool is applied. In the event of a deviation from the plan for a set of works, a project is launched which involves analyzing all types of work with the aim of implementing measures to address the root causes of the problem.

To implement these tools at the initial stage, staff will need to be trained in the basics of lean construction and a motivation system will need to be established.

Thus, the implementation of lean construction tools is possible at any stage of construction in any organization.

The implementation of lean construction tools at a site in Moscow has shown that even limited measures yield tangible results in the form of reduced costs, shorter lead times and increased staff satisfaction. For systematic implementation, methodological, regulatory and educational support must be developed. The data presented can be used both within the framework of the thesis and in the development of practical recommendations for the Ministry of Construction of the Russian Federation.

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Оценка эффективности внедрения инструментов бережливого строительства на этапе реализации строительного проекта в г. Москве

В статье рассматривается проблема устойчивого роста себестоимости строительства в Российской Федерации, которая в условиях макроэкономической нестабильности, инфляции и удорожания логистики становится критическим фактором снижения конкурентоспособности строительных компаний. Обосновывается необходимость внедрения управленческих технологий, направленных на сокращение производственных потерь без значительных капитальных затрат. В качестве такого подхода предлагается бережливое строительство (Lean Construction), адаптирующее принципы бережливого производства к специфике строительных проектов.

На примере жилого комплекса в г. Москве проводится анализ применения методик 5S, VSM, стандартизированной работы, а также дополнительных инструментов, таких как 4M, 5W+1H и принцип «одна за одной» (Onepiece flow). Методика исследования включала хронометраж, фотофиксацию, интервьюирование и анкетирование персонала, а также сравнительный анализ показателей «до» и «после» внедрения.

Выявлены ключевые виды потерь на строительной площадке: ожидание материалов и техники, лишние перемещения рабочих, избыточные запасы, дефекты и переделки. Внедрение инструментов бережливого строительства в трех пилотных зонах (отделочные работы, монтаж инженерных систем, устройство навесного вентилируемого фасада) позволило сократить время на поиск инструмента на 66 %, снизить частоту простоев техники на 50 % и уменьшить отклонения от графика работ на 60 %. Оценены экономические эффекты: экономия фонда оплаты труда, сокращение затрат на аренду техники и снижение накладных расходов.

Выявлены барьеры, ограничивающие масштабирование Lean практик (сопротивление персонала, отсутствие цифровых инструментов мониторинга, необходимость адаптации зарубежных методик). Предложены направления масштабирования опыта, включая разработку отраслевых стандартов и программ обучения. Статья предназначена для специалистов в области организации строительства и управления проектами.

Ключевые слова: *бережливое строительство, себестоимость, 5S, VSM, 4M, 5W+1H, one-piece flow, эффективность, строительный проект, Москва*

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