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Technical Study of the Implementation Method for Lightweight Brick Wall Construction: Analysis of Cost, Time, and Quality in Building Construction Projects

Mutia Ramadhany [1], Aulia Choiri Windari [1*]
[1]Department of Civil Engineering, Faculty of Engineering and Computer Science, Jakarta Global University, 16412, Indonesia

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ABSTRACT

The construction of lightweight masonry walls plays a crucial role in supporting building stability, aesthetics, and comfort. This study aims to analyze the implementation methods of lightweight masonry walls in terms of cost, time, and quality in the Sky House Alam Sutera project. The research uses a descriptive-analytical approach with case study and literature review, involving field observation, interviews, technical documentation, and analysis of the project Budget Plan (BoQ) and technical standards. The results indicate that the material requirements per floor include 84,000 lightweight bricks, 60 sacks of cement, and 36 m³ of sand, with an estimated total cost of approximately IDR 260 million, including labor and overhead. The deployment of five parallel work teams allows wall installation per floor to be completed in about 28 days, including finishing, quality inspection, and curing. The use of thin bed mortar increases installation efficiency while maintaining proper thickness and alignment. Consistent quality control through visual inspection, compressive testing, and daily documentation ensures compliance with technical standards. The study emphasizes careful planning, labor coordination, and strict quality supervision to achieve efficiency in cost, time, and quality in multi-story building projects.

Corresponding Author:

Aulia Choiri Windari
Department of Civil Engineering, Faculty of engineering and Computer Science, Jakarta Global University, 16412, Indonesia
Email: auliachoiri@jgu.ac.id

1. INTRODUCTION

The construction of brick walls is one of the architectural works that plays a crucial role in supporting building stability, aesthetics, and functional performance. Walls function not only as space dividers but also contribute to thermal comfort, acoustic performance, and overall structural safety [1]. In modern construction practice, conventional clay bricks are increasingly being replaced by lightweight bricks due to their lower weight, faster installation process, and better dimensional precision [2]. This development reflects advancements in material technology that significantly influence construction work methods, cost efficiency, execution time, and final product quality.

In construction management theory, project success is commonly measured through the integration of cost, time, and quality, known as the triple constraint [3]. These three aspects are interrelated and must be balanced carefully. Accelerating project duration without proper planning may reduce work quality, while excessive cost efficiency efforts can compromise material standards [4]. Therefore, evaluating construction methods from an integrated perspective is essential to ensure optimal project performance.

From a technical standpoint, the implementation method of brick wall construction greatly affects productivity and quality outcomes. The use of lightweight bricks combined with thin bed mortar systems has been shown to increase installation efficiency and reduce surface irregularities [5]. Quality in masonry work involves not only material strength but also accuracy in alignment, joint thickness, flatness, and supervision consistency, in accordance with applicable technical standards such as SNI 03-4166-2002 and SNI 03-2847-

2019. Efficient work procedures and appropriate material technology can significantly improve productivity and reduce material waste [6].

Several previous studies have discussed brick installation efficiency and material performance. Found that lightweight bricks can reduce execution time by up to 25% compared to conventional bricks [7]. Examined cost deviations caused by ineffective work methods [8], while analyzed time and cost acceleration strategies in construction projects [9]. However, most existing studies focus on a single aspect, such as time efficiency, cost analysis, or quality performance, without integrating these three aspects into a comprehensive technical evaluation framework.

This indicates a research gap in analyzing the implementation method of lightweight brick wall construction based on an integrated cost-time-quality perspective. In high-rise building projects, where work volume is substantial and coordination complexity is high, such integration becomes increasingly important to ensure project efficiency and compliance with technical standards. Therefore, this study aims to analyze the implementation method of lightweight brick wall construction in terms of cost, time, and quality through a case study approach at the Sky House Alam Sutera project. This research seeks to provide a comprehensive technical evaluation and practical recommendations that can enhance efficiency and work quality in multi-story building construction projects.

2. METHOD

This study is classified as descriptive-analytical research with a case study approach combined with a literature review. The case study was conducted on a high-rise building construction project involving lightweight brick wall work as one of the main architectural elements [7]. The literature review approach was carried out to examine various theories, standards, and previous research related to cost, time, and quality in construction implementation [3]. The combination of these two approaches aims to produce a comprehensive analysis so that the conclusions obtained are not only based on field practice but are also reinforced by theoretical foundations and previous research findings [6].

The data sources consist of both primary and secondary data. Primary data were obtained through direct observation at the project site, interviews with contractors, and technical documentation of lightweight brick wall work execution. Meanwhile, secondary data were sourced from relevant student theses, construction and project management textbooks [1], national and international scientific journals [2], and applicable technical standards such as SNI 03-4166-2002 on brickwork and SNI 03-2847-2019 on structural concrete [10]. Real project data, such as the Bill of Quantities (BoQ), execution schedules, and work quality reports, were also used as references for technical calculations. The obtained data were diverse and valid to support the analysis of cost, time, and quality in this study [8].

The analysis was carried out systematically in three main steps. First, the cost of brickwork was calculated based on unit price analysis of construction work, considering material components, labor wages, and equipment. This calculation refers to the Work Unit Price Analysis (AHSP) standards and the project BoQ documents [11]. Second, labor productivity was analyzed by comparing the volume of work with execution duration, in order to determine the level of time efficiency achieved on-site [8]. Third, quality evaluation was conducted based on technical criteria established by SNI, including alignment, flatness, compactness, and mortar thickness in the brickwork [10]. The results of these three steps were then compared with ideal standards to obtain conclusions regarding the effectiveness of the implementation method used [12].

3. RESULTS AND DISCUSSION

3.1. Implementation Method of Brick Wall Construction

The implementation method for red brick wall construction in building projects begins with the preparation stage, which includes cleaning the work area, providing materials and equipment, and inspecting the condition of the foundation base. Next, the building axes are determined, and wall positions are marked according to the working drawings. Measuring lines and a spirit level (water pass) are used as references to ensure alignment so that the brickwork does not deviate. The bricks must be soaked in water before installation to improve mortar adhesion. The mortar used is a mixture of cement and sand in a 1:4 ratio, applied with a thickness of approximately 10-12 mm. Installation is carried out gradually, starting from the building corners as reference points and continuing toward the center of the wall until a certain height is reached, interspersed with the installation of practical columns according to execution standards (SNI 03-4166-2002).

The next stage involves quality inspection and finishing. Inspection ensures uniform mortar thickness, flat wall surfaces, and alignment within permissible tolerances. On-site supervision also includes checking the neatness of joints and comparing layer heights. Once all brickwork is completed, remaining mortar on brick surfaces is cleaned, and joints are refined. Finishing is carried out with plastering and rendering according to the project's technical specifications. Additionally, during the work process, it is important to protect materials from extreme weather such as rain or excessive heat to prevent deterioration of brick quality. With a well-planned method and proper quality supervision, the final brick wall construction will achieve optimal strength, durability, and appearance in accordance with building quality standards [3].

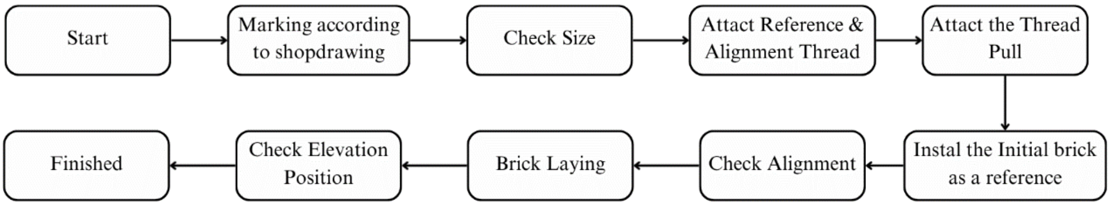

Figure 1. Flow Chart of Lightweight Brick Wall Construction Stages.

The implementation of lightweight brick wall construction in building projects begins with the preparation of the foundation sloof, including checking the flatness and quality of concrete casting. Next, strings are stretched between wall corners to determine positions and ensure wall alignment. On the base layer, mortar or Thin Bed Mortar is spread evenly and then smoothed using a trowel along the edges. A spirit level is used to ensure block height according to standards, while a theodolite is used if necessary. Blocks with Thin Bed Mortar are placed at the wall ends as references, pressed to a mortar thickness of ±10 mm, and checked again for level. This process is repeated for each wall end to ensure the lightweight brickwork is vertical and flat.

The next stage involves gradually installing blocks using Thin Bed Mortar vertically to bond the blocks. After placing blocks at the wall end, the second layer is installed to maintain string alignment and prevent block movement. Mortar is mixed with water according to packaging instructions, and using a mixer is recommended for a more homogeneous mixture. In hot conditions, a little extra water should be added to prevent the mortar from drying too quickly. Blocks and panels must be protected from rain, and if the mortar begins to dry, water is added and remixed. Each new block layer is cleaned with a soft brush dipped in water in hot weather.

The installation process continues with string alignment from end to end, spreading Thin Bed Mortar vertically first, then horizontally, for one block at a time so that the entire block surface is evenly covered. When placing a block, the surface facing the vertical mortar is lifted and the opposite side is installed first. The block is then tapped evenly with a rubber mallet, ensuring that mortar does not squeeze out. If any block protrudes, the surface is leveled using a 1-2 mm leveling trowel or block fragments. For walls that will be covered with plasterboard, only the leveling trowel is needed without sanding. Excess mortars are removed with a trowel, and wall surfaces are protected from rain to maintain installation quality. This method ensures precision, alignment, and final wall quality according to construction standards [7].

Figure 2. Marking Checklist

3.2 Practical Column

The installation of practical columns is a critical phase in masonry construction, serving to stabilize brick walls and distribute structural loads effectively. To ensure the structural integrity, vertical precision, and durability of the wall system, a systematic sequence of anchoring, steel reinforcement fabrication, and formwork assembly must be strictly followed. The complete step-by-step procedural workflow is detailed below

To begin the practical column installation, start by marking the locations for eight reinforcement pins, with four positioned at the top and four at the bottom. Drill the floor slab approximately 5 cm deep at the corners, thoroughly clean the holes, and install the pins with epoxy, ensuring they remain completely stable. Next, tie the practical column steel to these top and bottom reinforcement pins using binding wire while carefully maintaining vertical alignment. Once the steel framework is secure, install Formwork 1 according to the height of the brickwork, and position Formwork 2 slightly lower by about 5 cm to adequately cover the sides of the bricks. Following this, add a temporary window made of wooden boards onto Formwork 2 with a sufficient slope, and secure it by tying binding wire at the top, middle, and bottom sections. Before pouring the concrete, meticulously measure and verify the verticality of the practical column formwork using a plumb line. The concrete can then be cast, and the formwork can be safely removed after a curing period of 8 hours. Finally, continue the brick installation up to a maximum height of 1.5 meters, repeating this entire concrete pouring cycle until the column is fully completed.

3.3 Material Quality Testing

When executing wall masonry work using materials such as bricks, concrete blocks, or lightweight bricks, specific quality standards must be maintained across all surfaces and arrangements. First, the corner surfaces must be flat, compact, neat, uniform, and completely without gaps. To ensure overall structural accuracy, all vertical flat surfaces must be plumb and entirely free of waviness. Additionally, the vertical and horizontal brick arrangement must be neatly organized, specifically avoiding the use of small cuts. Finally, the joint thickness must be meticulously controlled depending on the material used, maintaining a thickness of 2 to 5 mm for celcon or lightweight bricks, and 5 to 10 mm for traditional red bricks or concrete blocks.

Important notes for lightweight brick installation include special treatment at intersections with other structural elements. If lightweight bricks meet floor slabs or beams, styrofoam is installed as protection and movement dampers. At intersections with columns or precast elements, a water stop is used to prevent water seepage. Work must follow SNI 03-4164-1996 standards, with quality control including visual inspection of each layer, minimum brick compressive strength of 25 kg/cm², mortar slump testing, and complete documentation through photos and daily QC checklists to ensure wall quality meets requirements.

3.4 Material Requirement Calculation

The specific volume of construction materials is needed for both a single unit and a full floor consisting of 30 units. For 1 Unit (40 m²), the project requires 2,800 pieces of bricks, 2 sacks of cement, and 1.2 m³ of sand. Consequently, to construct a total of 30 Units (1 floor), the aggregated material requirements scale up proportionally to 84,000 pieces of bricks, 60 sacks of cement, and 36 m³ of sand.

Table 1. Estimated Material Costs (Assuming Jabodetabek 2025)

Material	Requirement/Floor	Unit Price	Total Cost
Bricks	84,000 pieces	Rp 800/piece	Rp 67,200,000
Cement	60 sacks	Rp 70,000/sack	Rp 4,200,000
Sand	36 m³	Rp 250,000/m³	Rp 9,000,000
Total	–	–	**Rp 80,400,000**

3.5 Case Study: Sky House Alam Sutera, 30 Units/Floor

3.5.1 Material Cost Analysis

Before starting the lightweight brick wall work for the Sky House Alam Sutera project, the first step is to determine the material requirements per unit and per floor. This is crucial to ensure the project runs according to budget and to prevent material shortages on-site. The analysis includes the number of bricks, cement, and sand needed based on the wall area per unit and the total floor area. Based on the table 2, it can be seen that the material cost per floor is dominated by the purchase of lightweight bricks, followed by sand and cement. Careful planning of material requirements helps prevent waste and ensures the project proceeds smoothly according to schedule

Table 2. Material Requirements per Floor (30 Units, 1,200 m² Wall)

Material	Unit	Quantity per Unit (40 m²)	Quantity per Floor (30 Units)	Unit Price	Total Cost
Bricks	pieces	2,800	84,000	Rp 1,150	Rp 96,600,000
Cement	sacks	2	60	Rp 65,000	Rp 3,900,000
Sand	m³	1.2	36	Rp 380,000	Rp 13,680,000
Subtotal Material	–	–	–	–	**Rp 114,180,000**

3.5.2 Labor Cost Analysis and Total Estimation

In addition to materials, labor is also a significant component of project costs. For this project, labor costs were calculated based on the number of teams, daily wages, and daily productivity per team. This calculation allows an accurate estimation of total cost per floor before on-site implementation.

Table 3**.** Labor Costs and Total Estimation

Component	Quantity	Daily Wage	Total Cost
1 Team (1 mason + 1 worker)	1 team	Rp 200,000	Rp 24,000,000
Total Teams	5 teams	–	Rp 120,000,000
Subtotal Material + Labor	–	–	Rp 234,180,000
Overhead 10%	–	–	Rp 23,418,000
Total Estimated Cost per Floor	–	–	**Rp 257,598,000 ≈ Rp 260 million**

Table 3 shown the total estimated cost per floor, including materials, labor, and overhead [8]. Accurate cost planning helps project management control the budget and ensures that all resources are used efficiently.

3.5.3 Estimated Construction Time

Time planning is also critical to ensure smooth project execution. The construction duration is calculated based on the wall area per floor, team productivity, number of parallel work teams, and additional time for finishing and quality control.

Table 4. Estimated Construction Time per Floor

Description	Area / Quantity	Productivity / Capacity	Duration
Wall masonry work	1,200 m²	5 teams × 10 m²/day	24 days
Finishing, quality inspection, curing	–	–	±4 days
Total Construction Time per Floor	–	–	28 days

Based on the table 4, the total estimated construction time per floor for the Sky House Alam Sutera project is approximately 28 days. This duration includes curing, quality inspection, and finishing, ensuring that the construction results meet the established standards.

3.6 Discussion of Results

Based on the analysis of material and labor costs for the Sky House Alam Sutera project, the material requirements per floor which include 84,000 lightweight bricks, 60 sacks of cement, and 36 m³ of sand resulted in a material cost of Rp 114.18 million. Labor costs for 5 parallel teams working over 24 days reached approximately Rp 120 million, making the total estimated cost per floor, including 10% overhead, around Rp 260 million. This calculation highlights the importance of careful planning to ensure more efficient use of resources and to minimize waste [3]. With a clear cost estimate, project management can control the budget and anticipate potential increases in material prices on-site. Thorough cost planning becomes one of the key factors for project success in maintaining the balance between cost, time, and quality [8]. This aligns with modern project management principles that emphasize the integration of planning and resource control [13].

From the time perspective, using 5 parallel work teams allows wall installation per floor to be completed in 24 days, plus approximately 4 days for finishing, quality inspection, and curing, resulting in a total duration of about 28 days. This strategy demonstrates the effectiveness of parallel labor utilization to enhance project productivity without compromising the quality of results. Productivity calculations per team enable daily evaluation of target achievements, allowing delays to be anticipated promptly [3]. This systematic approach also supports coordination between workers and site supervisors, ensuring smooth workflow and adherence to schedule. Detailed time planning is crucial for large-scale projects, so that each stage of execution does not interfere with others. Realistic time estimation also aids project management in planning logistics and material handling [13].

The quality of lightweight brick wall construction is maintained through visual inspection of each layer, brick compressive strength testing ≥25 kg/cm², mortar slump testing, and daily QC photo documentation and checklists. Consistent quality control ensures correct height, alignment, and mortar thickness according to SNI 03-4164-1996 standards. By applying the thin bed mortar method, material efficiency can be achieved without compromising the structural strength of the wall [14]. Protecting materials from weather, such as shielding lightweight bricks from rain, is also important for maintaining quality. Strict quality supervision helps minimize risks of errors, cracking, or use of defective materials. Additionally, daily documentation supports accurate evaluation and reporting of project progress [3].

A comparison of figures 4, 5, and 6 reveals a clear and consistent influence of wind speed on the voltage generation and charging behaviour of the energy harvesting system across all configuration ratios (1:3, 1:2, and 1:1). As the wind speed increases from 6 m/s (Figure 4) to 7 m/s (Figure 5) and 8 m/s (Figure 6), both the initial voltage rise and the final steady-state voltage increase significantly, indicating enhanced mechanical excitation and more effective energy conversion. At 6 m/s, the 1:2 and 1:1 configuration exhibit similar steady-state voltages, while the 1:3 configuration remains notably lower. When the wind speed increases to 7 m/s, the performance gap widens, with the 1:1 configuration clearly outperforming the others in both charging rate and final voltage. This trend becomes more pronounced at 8 m/s, where the 1:1 configuration achieves the highest output voltage and fastest charging, followed by the 1:2 configuration, while the 1:3 configuration consistently shows the lowest performance. Across all wind speeds, the curves tend to converge toward a quasi-steady condition after approximately 30–50 s, suggesting that the ultimate voltage is constrained by the electrical circuit and energy storage capacity rather than aerodynamic input alone. Overall, the comparative results demonstrate that increasing wind speed substantially enhances energy harvesting performance and that the 1:1 configuration provides the most favourable and stable output across all tested conditions. These observations align with recent studies suggesting that higher flow velocities intensify the mechanical impact frequency and strain rate, which are critical for overcoming the internal impedance of the rectification circuit [22]. Specifically, the superior performance of the 1:1 ratio supports the principle that optimizes geometric alignment between the excitation source, and the substrate is essential for maximizing energy transfer in collision-based harvesters [23].

4. CONCLUSION

The analysis of lightweight brick wall construction in the Sky House Alam Sutera project indicates that integrating cost, time, and quality planning is crucial for project success. Material requirements per floor include 84,000 lightweight bricks, 60 sacks of cement, and 36 m³ of sand, with an estimated total cost of approximately IDR 260 million, including labor and overhead. The use of five parallel work teams allows wall installation per floor to be completed in approximately 28 days, including finishing and quality inspection. The application of the thin bed mortar method has proven to accelerate installation while maintaining proper alignment and mortar thickness. Quality control through visual inspection, compressive strength testing, and daily documentation ensure that the results meet construction standards. These findings demonstrate that careful planning and consistent supervision are essential for achieving efficiency and maintaining construction quality.

For future projects, it is recommended to conduct more detailed material planning to prevent waste and ensure availability on-site. The use of parallel labor teams is still advisable to increase productivity, but supervision coordination is necessary to maintain quality. The application of the thin bed mortar method should continue, as it speeds up installation and minimizes errors. Quality control must be consistent, including daily documentation and material testing. Project time planning should be realistic, incorporating allowances for finishing, quality inspection, and curing to ensure schedules are met. Regular evaluation and revision of construction methods are also recommended to enhance efficiency in cost, time, and quality for subsequent projects.

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REFERENCES

[1] K. Srimuang, T. Imjai, F. Kefyalew, S. N. Raman, R. Garcia, and S. Chaudhary, "Thermal and acoustic performance of masonry walls with phase change materials: A comparison of scaled-down houses in tropical climates," Journal of Building Engineering, vol. 82, p. 108315, Apr. 2024, doi: 10.1016/j.jobe.2023.108315.

[2] A. Bilgil, O. Şimşek, Ö. Sevim, and İ. Demir, “Development of lightweight and thermally efficient clay bricks using expansion additives: Effects of firing temperature and additive ratios on physicomechanical properties,” Journal of the Australian Ceramic Society, vol. 61, pp. 1351–1363, 2025, doi: 10.1007/s41779-025-01170-7.
[3] Z. Mustapha, B. B. Akomah, and S. K. Ansah, “Construction projects success: Time, cost, quality and safety,” International Journal of Research and Innovation in Social Science (IJRISS), vol. 7, no. 9, pp. 680–688, Sep. 2023, doi: 10.47772/IJRISS.2023.70958.
[4] J. Zhou, Y. Tang, and Y. Tian, “Multi-objective trade-offs for construction projects with dual constraints of schedule risk and resources under a risk-driven perspective,” Sustainability, vol. 17, pp. 1–34, 2025, doi: 10.3390/su17051926.
[5] A. Thakur and S. Kumar, “Evaluation of cost effectiveness of using autoclave aerated concrete (ACC) blocks in building construction,” Materials Today: Proceedings, vol. 51, pt. 1, pp. 1063–1068, 2022, doi: 10.1016/j.matpr.2021.07.095.
[6] L. Jia, T. Qiu, R. Yu, W. Lu, and Z. Liu, “BIM-enabled two-phase optimization framework for automated masonry layout efficiency,” Buildings, vol. 15, pp. 1–23, 2025, doi: 10.3390/buildings15173051.
[7] P. Praveen and D. Jaysawal, “Comparative study of clay bricks and AAC blocks,” International Journal of Structural Design and Engineering, vol. 5, no. 1, pp. 10–14, 2024.
[8] S. A. Mohammed and A. Hasan, “Analyzing cost deviation factors in Iraqi construction projects: A comprehensive examination of influencing variables,” Engineering, Technology & Applied Science Research, vol. 14, no. 3, pp. 13897–13901, 2024, doi: 10.48084/etasr.6999.
[9] O. M. ElSahly, S. Ahmed, and A. Abdelfatah, “Systematic review of the time-cost optimization models in construction management,” Sustainability, vol. 15, pp. 1–20, 2023, doi: 10.3390/su15065578.
[10] H. Medriosa and F. A. Akbar, “Analisis struktur gedung IRNA (Instalasi Rawat Inap) Rumah Sakit Umum Pasaman Barat menggunakan SNI Beton Bertulang 2847:2019 dan SNI Gempa 1726:2019,” Ensiklopedia of Journal, vol. 3, no. 4, pp. 7–14, Jul. 2021, doi: 10.33559/eoj.v3i4.796.
[11] J. I. Deza, H. Ihshaish, and L. Mahdjoub, “A machine learning approach to classifying construction cost documents into the International Construction Measurement Standard,” arXiv preprint arXiv:2211.07705, pp. 2–12, 2022, doi: 10.48550/arXiv.2211.07705.
[12] A. Ibrahim, T. Zayed, and Z. Lafhaj, “Enhancing construction performance: A critical review of performance measurement practices at the project level,” Buildings, vol. 14, pp. 1–42, 2024, doi: 10.3390/buildings14071988.
[13] M. Ghazal and A. Hammad, “An integrated planning and control framework (IPCF) for construction projects—Step 1: Development of the construction data hub (CDH),” Buildings, vol. 13, pp. 1–24, 2023.
[14] A. Abasi, B. Banting, and A. Sadhu, “Experimental evaluation of compressive properties of early-age mortar and concrete hollow-block masonry prisms within construction stages,” Materials, vol. 17, pp. 1–20, 2024, doi: 10.3390/ma17163970.