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Assessing the Cost Effectiveness of Prefabricated Construction Technologies in Delivering Housing Projects in the Nairobi Metropolitan Area, Kenya

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Abstract: **The rising demand for affordable housing in Kenya has highlighted the need for cost-efficient construction methods. This study assesses the cost implications of prefabricated construction technologies; Expanded Polystyrene (EPS) panels, precast concrete systems, and converted shipping containers—in housing projects within the Nairobi Metropolitan Area. Using a mixed-methods case study approach, it draws on data from 105 survey responses and 54 interviews and site visits.**

Findings show precast systems are the most cost-efficient at KES 25,413/m², followed by EPS (KES 44,429/m²) and containers (KES 51,526/m²). Despite their potential, uptake is constrained by high initial investment, limited financing, and material import costs. The Finance Act 2025 offers hope through mortgage interest tax relief for construction loans, potentially improving access to prefab housing finance.

The study concluded that with supportive financial frameworks and scaled implementation, prefabrication can reduce construction costs and enhance affordable housing delivery. It recommends targeted incentives, improved financing access, and further research on lifecycle costs and comparative performance.

Keywords: **prefabrication, cost efficiency, EPS panels, precast systems, shipping containers, affordable housing, Nairobi Metropolitan Area, Finance Act 2025.**

I. INTRODUCTION

A. Background of the Study

The rising demand for affordable housing, particularly in urban centers, has placed significant pressure on the construction industry to deliver projects more efficiently and at reduced costs. Traditional construction methods often fall short in meeting these cost-efficiency demands due to their prolonged timelines, labor intensiveness, and susceptibility to material waste and delays (Gunawardena & Mendis, 2022).

Prefabrication, also known as industrialized construction (IC) or off-site construction (OSC) (Kedir et al., 2022), a building process that involves creating building components, elements or modules in a factory setting, after which they are transported to the construction site for assembly and installation (Agarwal & Gupta, n.d.) offer a compelling alternative by optimizing cost performance through off-site fabrication, reduced on-site labor requirements, and streamlined assembly processes. By shifting a significant portion of construction to controlled factory settings, prefabrication minimizes material wastage, enhances resource utilization, and improves budget predictability (Kedir et al., 2022). This contributes to overall reductions in project costs, especially for repetitive or large-scale developments.

Globally, many countries have leveraged prefabrication to manage construction expenses while maintaining quality. For example, Malaysia has successfully lowered public housing costs by mandating the use of prefabricated elements, supported by incentives such as levy exemptions (Kedir et al., 2022). Similarly, Japan and China have implemented prefabrication at scale to achieve both cost and productivity gains (Mirus et al., 2018; Shen et al., 2019).

Despite these global advancements, the adoption of prefabricated construction in developing countries like Kenya remains limited, partly due to perceptions of high initial costs, limited access to necessary machinery, and import duties on materials such as EPS and shipping containers (Aghimien & Ayoola, 2017; Aigbavboa & Aghimien, 2018). However, when applied at scale and supported by appropriate planning, prefabricated construction technologies have the potential to significantly reduce the cost per square meter and make affordable housing delivery more feasible (Gunawardena et al., 2016).

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This study aims to assess the cost implications of adopting prefabricated construction technologies in Kenya's housing sector, identify the cost-related barriers, and explore opportunities for improving cost-efficiency in project delivery through prefabrication.

B. Statement of the Problem

Kenya is grappling with a significant and growing housing deficit, currently estimated at over two million units nationally and rising by approximately 200,000 units annually (National Housing Corporation, 2023). In the Nairobi Metropolitan Area alone; encompassing Nairobi, Kiambu, Kajiado, Machakos, and parts of Murang'a Counties, the housing shortfall remains acute, driven by rapid urban population growth at a rate of 2.3%, which continues to outpace housing supply (Cytonn, 2022). Yet, only about 50,000 new units are delivered annually across the country, and of these, merely 2% are deemed affordable to the majority (National Housing Corporation, 2023).

This affordability gap is largely attributed to the high costs associated with conventional construction methods. These traditional approaches often require lengthy timelines, significant labor input, and are susceptible to material wastage and inefficiencies, ultimately inflating unit costs beyond the reach of most Kenyans (Gunawardena & Mendis, 2022). In contrast, prefabricated construction technologies offer opportunities for significant cost savings by promoting efficiency through off-site production, reduction of on-site labor, and faster assembly (Kedir et al., 2022). These technologies have the potential to lower overall construction costs and deliver affordable housing at scale. While timber is widely used globally in prefabrication, its large-scale use in Kenya is constrained by forest protection laws that limit commercial exploitation and emphasize sustainability. (The Forest Conservation and Management Act, 2022) requires licenses for harvesting and prioritizes reforestation efforts, reducing the viability of timber-based prefabrication in the local context.

Despite ongoing efforts by the Kenyan government, including the allocation of Kshs 73.7 billion toward affordable housing under the Bottom-Up Economic Transformative Agenda (BETA), the cost of construction remains a primary barrier to meeting housing demand at scale (Parliamentary Service Commission, 2023) . If left unaddressed, the high cost of traditional building methods will continue to undermine affordability and slow progress toward national targets of delivering 200,000 housing units annually and achieving 50% affordable housing provision by 2027 (National Housing Corporation, 2023).

This study therefore investigates the potential of cost-effective prefabricated construction technologies, focusing on EPS panels, precast concrete systems, and converted shipping containers, to accelerate delivery while lowering housing costs in the Nairobi Metropolitan Area. By examining their influence on construction costs, this research provides insights into how these innovations could help bridge Kenya's housing affordability gap.

C. Main Objective

To assess how prefabricated construction technologies influence the cost efficiency of housing projects in the Nairobi Metropolitan Area.

D. Guiding Research Question

How do prefabricated construction technologies influence the cost efficiency of housing projects in the Nairobi Metropolitan Area?

E. Scope of the Study

This study examined the adoption of structural prefabricated technologies; precast concrete panels, EPS systems, and converted shipping containers, used in forming primary building elements like walls and slabs. It focused on housing projects for Kenya's middle-income households, earning Kshs 23,671–119,999 per month (Cytonn, 2025), specifically bungalows, maisonettes, and apartments within the Nairobi Metropolitan Area (Nairobi, Kiambu, Machakos, Kajiado, and parts of Murang'a). Non-structural prefabricated components such as doors and finishes were excluded, with emphasis placed solely on technologies influencing construction speed and cost-efficiency.

II. LITERATURE REVIEW

A. Definition of prefabricated construction

Prefabrication is the practice of manufacturing building components of a structure in a factory or other manufacturing site and transporting fully or partially assembled units to the construction site for final installation (Shivani Soni, n.d.). A prefabricated building is a structure made up of elements such as wall panels, roofs, and floor slabs that are manufactured in a factory or manufacturing plant. These components may be either fully or partially assembled in the factory before being transported to the construction location for installation (Nishant et al., 2024). This definition was used in the present study.

B. Forms of Prefabricated Construction

Prefabrication in construction is classified into five main categories, based on the degree of off-site fabrication and assembly (Mark Daniels, 2020):

i. Materials – This is the most basic level, involving raw or lightly processed materials like floor tiles or plywood, and factory-made components such as precast concrete walls and roof trusses (Mark Daniels, 2020).

ii. Panelized (2D) Systems – These are two-dimensional panels that incorporate structural, electrical, and insulation elements. They range from basic open panels to fully enclosed systems with finishes added in the factory (Smith et al., 2023). Variants include: Structural Insulated Panels (SIPs), Insulated Precast Concrete Panels, Insulated Concrete Forms (ICFs), Timber Frame Panels, and Lightweight Steel Frame Panels (Nishant et al., 2024).

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iii. Volumetric Modular Systems – Fully enclosed, factory-built three-dimensional units (e.g., rooms or kitchen/bathroom pods), transported and assembled on-site (Smith et al., 2023; Mark Daniels, 2020).
iv. Hybrid Prefab Construction – A combination of modular and panelized systems, often using pods for service-intensive spaces (Gunawardena & Mendis, 2022).
v. Manufactured Homes – Complete homes built entirely in factories and transported to the site, commonly used for temporary structures like site offices (Smith et al., 2023).

C. Understanding the Cost Drivers in Prefabrication

Cost is a fundamental consideration in any construction project, and prefabricated construction presents unique cost related advantages and challenges (Mwita, 2022). While it requires a relatively high initial investment, particularly for setting up factory infrastructure, equipment, and technology, these costs can be amortized over multiple projects, resulting in long-term savings (Mwita, 2022; Auti & Patil, 2019). Prefabrication significantly reduces construction costs by optimizing material use, minimizing waste, and lowering labor requirements (Kedir et al., 2022).

Material savings are achieved through factory-controlled processes that reduce waste and allow for bulk purchasing. Studies report that prefabrication can eliminate plaster waste (100%), reduce timber formwork waste by 73.91–86.87%, and lower concrete and steel bar waste by 51.47–60% and 35–55.52%, respectively % (Tam & Hao, 2014). Labor costs are also reduced through minimized on-site work, enhanced automation, and improved working conditions in factories.

Economies of scale are another benefit, mass production and repeated use of standardized components lower unit costs, while the reusability of elements adds further savings (Rocha et al., 2022; Nishant et al., 2024). Prefabrication also offers cost predictability, limiting budget overruns and variation orders common in traditional projects, an advantage especially critical in public sector developments (Cassino et al., 2011).

However, transportation and erection costs remain significant. These include logistics, handling, storage, and the use of specialized equipment like cranes, which must be carefully managed to avoid cost overruns (Auti & Patil, 2019; Olearczyk et al., 2014). Despite these, the overall cost benefits, especially in large-scale projects, make prefabrication a viable and cost-effective solution.

D. Cost Related barriers to Adoption of Prefabrication

High Upfront Costs: Establishing a prefabrication facility and investing in specialized equipment and skilled labour can be expensive. These initial costs may be a barrier, particularly for smaller-scale construction firms or projects with limited budgets (Nishant et al., 2024).

Economies of Scale: Prefabrication typically necessitates large-scale production to be economically viable. The main source of cost savings in prefabrication comes from economies of scale, which require substantial investment in manufacturing infrastructure and the optimization of production processes (Gunawardena & Mendis, 2022).

III. METHODOLOGY

A. Research Design

This study adopted a mixed-methods case study approach to assess the cost related impact in the adoption of prefabricated construction technologies. The methodology integrated quantitative data from surveys and qualitative insights from site visits and interviews, enabling a robust analysis through triangulation (Creswell & Creswell, 2018).

B. Scoping & Preliminary Survey

A preliminary scoping exercise was conducted to establish the feasibility of the study. Manufacturers of EPS panels, precast elements, and converted shipping containers were contacted to map the prevalence and distribution of these technologies. This helped refine the study's scope and confirmed the adequacy of the project population for research (Kumar, 2011).

C. Research Tools

The study employed a multi-method data collection strategy to ensure a comprehensive understanding of the adoption of prefabricated construction technologies. Semi-structured interviews were conducted with key stakeholders; developers, consultants, contractors, construction workers, and residents, to capture diverse insights on implementation experiences, perceived benefits, and challenges (Svend & Steinar, 2015). Structured surveys were distributed to a broad range of respondents to quantitatively assess awareness, perceptions, and willingness to adopt prefabrication(Fellows & Liu, 2021). Document analysis supplemented primary data by examining relevant policy documents, technical standards, and project records such as bills of quantities, offering contextual insights into regulatory and market dynamics (Bowen, 2009). Additionally, site visits and direct observations were carried out across multiple prefabricated housing sites in the Nairobi Metropolitan Area to examine the actual construction processes and evaluate their efficiency and integration in real-time (Yin, 2014). The tools used to support these methods included interview guides, survey questionnaires, documentary sources, and structured observation checklists, which facilitated systematic data gathering across all approaches.

D. Sampling Strategy

To obtain relevant and insightful data, the study employed a purposive sampling strategy to select participants and cases with direct experience in prefabricated construction technologies. Stratified purposive sampling ensured diversity across project types, professional backgrounds, and geographical locations within the Nairobi Metropolitan Area (Etikan, 2016). Snowball sampling further extended the reach, especially during questionnaire distribution, by encouraging initial respondents to share the survey within their professional networks.

A target of at least 30 case studies was set (Mugenda & Mugenda, 2003), selected based on: use of prefabricated systems (e.g., precast components, EPS panels, or converted containers), project scale (from individual units to multi-unit developments), and geographic spread across urban and peri-urban areas (Creswell & Creswell, 2018).

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For interviews and surveys, stakeholders such as project managers, architects, engineers, contractors, and end-users were purposively selected based on their involvement in prefabricated housing. Snowball sampling helped identify additional key informants (Parker et al., 2019).

In total, the study achieved 105 valid survey responses and conducted 54 interviews and site visits, well above the 12–25 interviews typically required for thematic saturation (Guest et al., 2006), enhancing the study's validity and comprehensiveness.

D. Data Analysis Procedures

To address the objective on cost efficiency, both qualitative and quantitative data were analyzed.

Qualitative Analysis: Using thematic analysis, cost-related insights from interviews and site observations were identified and categorized. This included stakeholders' experiences with cost savings, cost drivers, and comparative affordability of prefabricated systems. Microsoft Excel aided in organizing and visualizing these themes for easier interpretation (Virginia & Victoria, 2021).

Quantitative Analysis: Survey responses on cost-related aspects; such as perceived cost savings, cost overruns, and affordability, were analyzed using descriptive statistics. Frequencies, percentages, means, and standard deviations were calculated to understand stakeholder perceptions on cost effectiveness across different prefabricated technologies and project types.

IV. RESULTS AND DISCUSSION

A. Partial Analysis of Cost, Duration, and Area Data of Housing Projects

The survey gathered cost and floor area data from housing projects that employed various prefabricated technologies. However, many respondents had worked with more than one system, such as precast concrete, EPS panels, and shipping containers, making it difficult to attribute specific cost or size data to a single technology. In some cases, responses were incomplete, with either cost or area details missing. To maintain analytical integrity and draw meaningful insights, a structured approach was adopted to manage these ambiguities and ensure reliable comparisons.

Technology-Specific Analysis (Group A)

Responses where participants interacted with only one type of prefabricated construction technology and provided complete data will be analyzed in detail. This includes project-level averages for cost, and area, as well as derived metrics such as cost per square meter. These responses will provide the most reliable insights into the performance of each prefabrication method.

General Trend Analysis (Group B)

For responses that indicated multiple technologies or had incomplete attribution of cost to a specific system, the data will be analyzed in aggregate to identify general patterns and tendencies in prefabricated housing projects. These responses will not be used for direct comparisons across technologies but will help illustrate the broader adoption context.

Therefore, the analysis presented herein is partial, as it focuses primarily on the subset of responses with clearly attributable project-level information. The findings from this analysis are valid within that scope and should be interpreted with an understanding of this limitation.

A.1. Technology-Specific Analysis (Group A)

i. Expanded Polystyrene Panels (EPS):

The cost data available from respondents whose responses were strictly associated with only EPS is shown in Table 4.6.

Table 1: Area, and Cost/m² in EPS Projects

No.	Project ID	Area (m2)	Cost (KES)	Cost/m2
1	12:38:34	120	2,000,000.00	16,666.67
2	4:41:06	3500	250,000,000.00	71,428.57
3	8:39:48	110	4,000,000.00	36,363.64
4	11:06:43	108	6,500,000.00	60,185.19
5	8:47:00	48	1,800,000.00	37,500.00
	Average	777.2	52860000	44,428.81

Source**:** Field survey (2025)

Cost/m² ranged between KES 16,667 and KES 71,429, with an average of KES 44,429. One project had significantly higher cost and size (KES 250M; 3,500m²), which may skew the average. However, the large sample variation reflects the diversity of EPS project applications—from small housing units to large developments.

The data for EPS projects was further analyzed by categorizing them according to housing typologies. The categorization was based on area thresholds commonly used in the Kenyan context: a standard bungalow was assumed to be up to 150 square meters, a maisonette up to 300 square meters, and anything above 300 square meters was considered an apartment. Among the bungalow projects, the average cost per square meter was approximately KES 37,679, while the apartment project, recorded the highest cost per square meter at KES 71,429.

ii. Precast concrete wall and floor systems

Out of the 31 respondents who indicated prior engagement with precast concrete walls and floor systems, only 21 provided complete information on the two variables – area, and cost.

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Table 2: Area, and Cost/m² in Precast Concrete Projects

No.	Project ID	Area (m2)	Cost (KES)	Cost/m2
1	10:31:31	9,000.00	250,000,000.00	27,777.78
2	7:53:03	600.00	7,000,000.00	11,666.67
3	10:55:34	100.00	1,200,000.00	12,000.00
4	2:33:23	5,300.00	127,200,000.00	24,000.00
5	3:34:00	540.00	17,000,000.00	31,481.48
6	3:56:42	94.00	1,000,000.00	10,638.30
7	10:08:43	215.50	6,000,000.00	27,842.23
8	10:27:48	200.00	3,500,000.00	17,500.00
9	8:29:22	240.00	5,000,000.00	20,833.33
10	5:35:39	450.00	7,000,000.00	15,555.56
11	6:17:45	300.00	12,000,000.00	40,000.00
12	9:26:16	45.00	1,500,000.00	33,333.33
13	3:22:58	120.00	4,000,000.00	33,333.33
14	4:20:09	1,800.00	40,000,000.00	22,222.22
15	5:11:58	145.00	3,500,000.00	24,137.93
16	1:42:32	652.00	22,000,000.00	33,742.33
17	2:58:38	440.00	14,900,000.00	33,863.64
18	4:35:34	2,000.00	40,000,000.00	20,000.00
19	11:24:03	800.00	22,000,000.00	27,500.00
20	10:40:07	100.00	3,500,000.00	35,000.00
21	2:29:36	80.00	2,500,000.00	31,250.00
	Average	1,105.79	28,133,333.33	25,413.24

Source**:** Field survey (2025)

This analysis presents data from 21 housing projects that utilized precast floor and wall systems and provided complete information on area, cost, and duration. Project sizes ranged from 45 m² to 9,000 m², with construction costs between KES 1.2 million and KES 250 million, with an average cost of KES 25,413.24/m².

The data for precast concrete projects was further analyzed by categorizing them according to housing typologies. A standard bungalow was defined as having a floor area up to 150 m², a maisonette between 151 and 300 m², and anything above 300 m² was classified as an apartment. The five projects falling under the bungalow category had an average cost of approximately KES 32,471 per square meter, while the four maisonette projects recorded an average cost of approximately KES 27,958/m². This suggests slightly improved cost efficiency compared to bungalows, likely due to better utilization of structural repetition and shared elements. The twelve apartment-scale projects showed the best cost performance, with an average cost of KES 23,163/m².

iii. Shipping Containers Conversion

Out of the 8 respondents who indicated prior engagement with shipping containers conversion, only 7 provided complete information of both area, and cost.

Table 3: Area, and Cost/m² in Conversion of Shipping Containers Projects

No.	Project ID	Area (m2)	Cost (KES)	Cost/m2
1	10:38:39	2,400.00	154,200,000.00	64,250.00
2	11:33:36	500.00	30,000,000.00	60,000.00
3	9:01:50	14.00	700,000.00	50,000.00
4	9:01:50	14.00	700,000.00	50,000.00
5	7:12:11	200.00	9,000,000.00	45,000.00
6	9:50:10	28.00	1,200,000.00	42,857.14
7	9:54:58	14.00	680,000.00	48,571.43
	Average	452.86	28,068,571.43	51,525.51

Source**:** Field survey (2025)

This table summarizes 7 projects that used conversion of shipping containers projects and reported complete data on area, and construction cost, and construction duration. Project sizes ranged from 14 m² to 2,400 m², with construction costs spanning from KES 680,000 to KES 154.2 million. The average construction cost was KES 51,525.51/m², while the average duration per square meter was 0.02574 months (approximately 0.77 days/m²). The data for shipping containers projects was further analyzed by categorizing them according to housing typologies, bungalows (≤150 m²), maisonettes (151–300 m²), and apartments (>300 m²). The five projects classified as bungalows had an average cost/m² of 47,086 KES/m. These projects, typically converted from 20ft or 40ft containers. The apartments had an average cost/m² of 62,125 KES/m².

A.2. General Trend Analysis (Group B)

Although these responses could not be directly tied to a specific technology, they still provide useful insight into the scale, and cost of projects using prefabrication more broadly.

Out of the 46 respondents who have interacted with multiple prefabricated technologies, only 32 provided complete information on area, and cost. The data available from respondents whose responses were strictly associated with the mixed projects is shown in Table below,

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Table 4: Area, and Cost/m² in Mixed Projects

No.	Project ID	Area (m2)	Cost (KES)	Cost/m2
1	3:33:29	24,000.00	500,000,000.00	20,833.33
2	3:45:33	10,000.00	50,000,000.00	5,000.00
3	7:28:27	300.00	5,000,000.00	16,666.67
4	6:17:28	150,000.00	6,500,000,000.00	43,333.33
5	6:37:40	200.00	4,000,000.00	20,000.00
6	7:24:33	350.00	20,000,000.00	57,142.86
7	8:27:17	24,000.00	2,000,000,000.00	83,333.33
8	8:42:36	180.00	6,300,000.00	35,000.00
9	10:54:02	1,200.00	45,000,000.00	37,500.00
10	2:05:07	90.00	4,000,000.00	44,444.44
11	3:38:03	1,393.55	2,800,000.00	2,009.26
12	4:09:36	30.00	2,200,000.00	73,333.33
13	6:58:10	215.00	8,000,000.00	37,209.30
14	4:47:52	800.00	15,000,000.00	18,750.00
15	6:51:18	5,000.00	350,000,000.00	70,000.00
16	12:20:49	500.00	10,000,000.00	20,000.00
17	3:02:42	3,000.00	120,000,000.00	40,000.00
18	8:44:01	135.00	3,000,000.00	22,222.22
19	8:53:52	300.00	12,000,000.00	40,000.00
20	10:07:18	135.00	4,100,000.00	30,370.37
21	3:38:42	1,000.00	500,000,000.00	500,000.00
22	2:51:56	3,000.00	200,000,000.00	66,666.67
23	11:16:40	500.00	50,000,000.00	100,000.00
24	3:15:35	200.00	8,000,000.00	40,000.00
25	2:37:48	216.00	4,500,000.00	20,833.33
26	7:29:22	200.00	3,450,000.00	17,250.00
27	11:35:03	11,708.00	465,000,000.00	39,716.43
28	12:51:36	362.00	4,670,000.00	12,900.55
29	6:56:00	300.00	5,000,000.00	16,666.67
30	7:31:28	180.00	6,000,000.00	33,333.33
31	3:38:01	300.00	2,000,000.00	6,666.67
32	9:34:03	2,100.00	350,000,000.00	166,666.67
	Average	7,559.20	351,875,625.00	54,307.77

Source**:** Field survey (2025)

This table summarizes 32 projects of sizes ranging from 30 m² to 150,000 m², with construction costs spanning from KES 2,000,000 to KES 6.4 billion. The average construction cost was KES 54,307.77/m².

A.3. Comparative Summary Table

To enable a clearer understanding of the relative performance of each prefabricated construction technology, the table below presents a comparative summary of average project metrics. It

includes the average construction cost, and floor area, as well as the derived cost per square meter (KES/m²), for projects that exclusively used EPS panels, precast wall and floor systems, converted shipping containers, or a mix of these technologies. This comparison provides insight into the typical scale and cost-efficiency of each system

Table 5: Comparative Summary Table

Technology	Aver. Cost (KES)	Aver. Area (m2)	Aver. Cost/m2
EPS Only	52,860,000.00	777.2	44,428.81
Precast Concrete Wall and Floor Systems	28,133,333.33	1,105.79	25,413.24
Shipping Containers Conversion	28,068,571.43	452.86	51,525.51
Mixed Projects	351,875,625.00	7,559.20	54,307.77

Source: Field survey (2025)

The table compares average construction cost, floor area, and cost per square meter across four prefabrication types: EPS, precast systems, shipping containers, and mixed projects. Precast systems were the most cost-efficient at KES 25,413.24/m², followed by EPS (KES 44,428.81/m²), containers (KES 51,525.51/m²), and mixed projects (KES 54,307.77/m²). Mixed projects had the largest average floor area and highest total cost, while container projects were smallest in scale. Notably, "mixed projects" refer to responses where specific technologies weren't identified, reflecting general prefabrication experience rather than a defined system.

B. Industry Perceptions Regarding the Impact of Prefabrication on Construction Cost.

The survey question aimed to assess stakeholders' perceptions of how precast concrete, EPS panels, and shipping container conversions influence construction costs. Respondents indicated whether they viewed each technology as cost-saving, neutral, or increasing costs. The responses provide insight into industry attitudes and practical experiences regarding the economic viability of these technologies in housing delivery. Results are shown in Figure 1.

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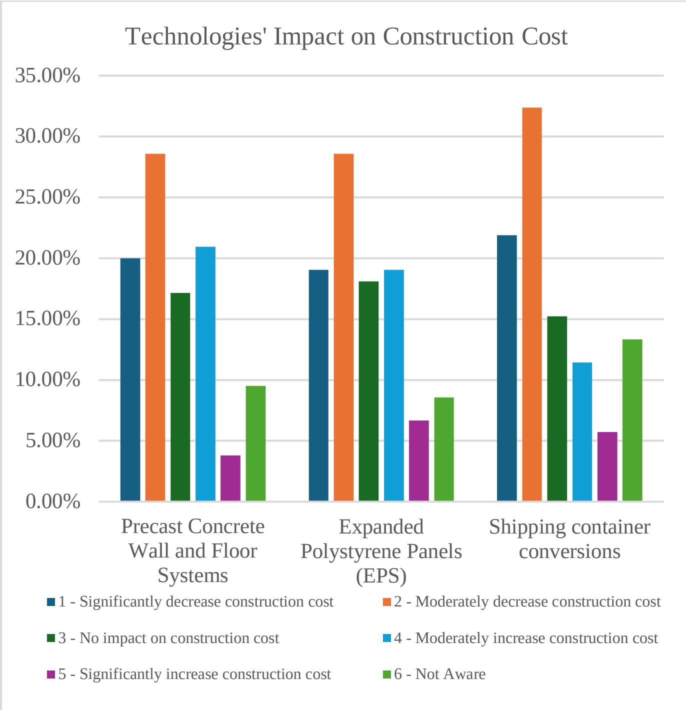

Figure 1: Industry Perception on Impact of Prefabrication on Construction Cost

Source: Field survey (2025)

The survey results revealed mixed perceptions on the cost impact of three prefabricated construction technologies. For Precast Concrete Systems, around 49% believe they reduce costs, but over 38% see no benefit or a potential increase. EPS Panels show similar views, with nearly half noting cost reductions, while others report neutral or increased costs. Shipping Container Conversions show stronger consensus on cost-saving potential, with over 54% perceiving cost reductions.

Interview insights supported the idea that prefabrication generally reduces costs; mainly through decreased labour needs and faster construction timelines. Specific savings were noted: 10% with wall panels, 30% with beam and block, and up to 50% with waffle slabs. However, high initial costs, especially for shipping containers and EPS panels, are a concern due to import duties and taxes. Additionally, all three technologies may incur added costs for specialized equipment.

Still, overall cost efficiency remains favourable, largely due to reduced labour, minimal material waste, and quicker project completion.

C. Construction Cost of Prefabrication Technologies as a Barrier to Adoption

To complement the quantitative data gathered from the online survey, follow-up interviews were conducted to obtain a more thorough understanding of the barriers affecting the uptake of prefabricated construction technologies. It was gathered that setting up prefabrication operations requires significant capital investment in machinery, production facilities, and transport equipment. High raw material costs, partly due to import duties and taxes on inputs such as EPS, raise the production costs, often resulting in prefabricated materials being more expensive per unit than conventional alternatives. This cost dynamic poses a particular challenge for small- and medium-sized developers and limits the scalability of production.

This was reinforced by the lack of financial support and affordable credit. This is because some banks reportedly do not offer credit facilities for developments utilizing precast systems, likely stemming from limited knowledge of the technology or concerns about potential risks. This limits uptake among developers who rely on external financing.

However, the Finance Bill 2025 has a potential turning point by expanding the scope of mortgage interest tax relief under the Income Tax Act (Cap. 470) to include loans used for the construction of owner-occupied residential housing, not just the purchase or improvement of property. This legislative shift could enhance the financial attractiveness of prefabricated construction projects by enabling developers and homeowners using such technologies to benefit from tax relief on construction-related borrowing, thereby improving credit access and reducing financing costs (Republic of Kenya, 2025).

D. Cost Related Recommendations to Enhance Adoption of Prefabricated Construction Technologies.

Tax Incentives and Import Duty Exemptions: Stakeholders highlighted that high costs of raw materials and setting up fabrication workshops remain key financial bottlenecks. Introducing tax reliefs and reducing import duties on essential inputs, including shipping containers and machinery, would lower production costs, making prefabricated solutions more affordable and attractive to both developers and clients.

Access to Low-Interest Loans: Financial support was cited as a crucial driver of adoption. Interviewees strongly recommended the establishment of low-interest loan products specifically tailored to prefabrication projects. For instance, NHC's financial backing for EPS-based housing was highlighted as a positive precedent that should be scaled. However, it was noted that many banks currently do not extend financing to projects using precast concrete systems, largely due to skepticism around their structural integrity and long-term performance. To bridge this gap, there is need for targeted engagement with financial institutions to build their confidence in these technologies. This could involve presenting successful case studies, offering technical guidance, and establishing regulatory assurances. Increasing access to affordable financing would significantly improve the feasibility and uptake of prefabricated construction in the mainstream market.

V. CONCLUSION AND RECOMMENDATIONS

A. Summary of Findings.

The survey and interview results indicated that prefabricated construction technologies substantially influence the cost of housing project delivery within the Nairobi Metropolitan Area. The comparative analysis of projects using various prefabricated systems, as summarized in Table 6, highlighted key differences in performance across technologies.

Projects utilizing Expanded Polystyrene (EPS) panels (n=5) had an average cost of KES 44,428.81 per square meter. Precast concrete wall and floor systems (n=21) recorded an average cost of KES 25,413.24/m², while converted shipping container projects (n=7) reported the highest average cost (KES 51,525.51/m²)

B. Influence of Prefabricated Technologies on Cost of Housing Projects.

Among the three technologies analyzed, precast concrete systems emerged as the most cost-efficient, followed by EPS panels, while shipping container conversions were the least cost-effective per square meter.

The typology-based assessment revealed that while EPS technology demonstrated clear cost efficiency and moderate speed in small-scale projects such as bungalows, its application in larger developments such as apartments may be more time-efficient but at a higher cost per unit area. It reaffirmed that precast construction technology becomes increasingly cost-efficient as project scale increases. While the unit cost tends to be higher for small-scale developments such as bungalows, apartment developments leverage the full benefits of prefabrication, particularly in terms of time and material efficiency. Container conversions exhibited high time efficiency across all typologies, particularly for small-scale units. However, costs remained higher, especially for larger projects, primarily due to the premium on imported containers and required modifications for habitability.

Interview data corroborated these views, with participants consistently noting that prefabricated construction systems result in overall cost savings compared to conventional methods. Key reasons cited included: reduced labor requirements, minimized material waste, reduced wet works, and improved site efficiency, which translates to lower overheads and faster turnover.

However, several respondents also highlighted cost-related limitations associated with prefabrication. For example, the initial procurement costs of prefabricated components are relatively high, particularly for EPS and shipping containers. The cost of importing containers is significantly increased by customs clearance charges and import duties, while EPS panels are similarly affected by high duties on raw materials. Additionally, all three systems often require specialized hoisting and handling equipment, which introduces additional project costs not typically encountered in conventional builds.

To contextualize these findings, the 2025/2026 IQSK Cost Handbook (Institute of Quantity Surveyors of Kenya, 2025) provides benchmark construction costs for conventional building in the Nairobi area. According to the handbook, the average construction cost per square meter is KES 45,400 for middle-income apartments, KES 52,400 for medium-standard townhouses, KES 45,200 for standard private dwelling houses, and KES 51,500 for middle-class private dwelling houses. Comparing these figures to the unit costs recorded in this study, where precast systems averaged KES 25,413/m², EPS KES 44,429/m², and shipping containers KES 51,526/m², supports the conclusion that prefabrication, particularly precast systems, can be cost-competitive or even superior when applied effectively and at scale.

C. Conclusion

Findings from both quantitative and qualitative data revealed that prefabricated technologies, including precast concrete systems, EPS panels, and shipping container conversions, have a significant positive influence on construction cost efficiency. Precast systems emerged as the most cost-effective.

D. Suggestions for Further Research

This study opens avenues for further research, particularly in two key areas:

Controlled Comparative Modelling: constructing identical units using EPS, precast, and container technologies in the same location to compare cost, time, and performance under similar conditions.

Lifecycle Costing and Long-Term Performance: evaluating long-term costs, maintenance, energy efficiency, and durability to better understand the full economic and structural value of prefabricated housing.

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