SHIPPING CONTAINER: COMPARATIVE ANALYSIS OF IMPLEMENTING SHIPPING CONTAINERS CONSTRUCTION AND CONVENTIONAL METHOD CONSTRUCTION IN TERMS OF COST, TIME IN WARM AND HUMID CLIMATE ZONES.

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ABSTRACT - *The report delves into the innovative realm of shipping container architecture, blending sustainability, cost-effectiveness, and adaptability. It explores material usage, planning, design, and execution of maritime infrastructure, highlighting intersections with civil engineering, architecture, urban planning, and transportation logistics. Objectives include understanding sustainability and cost-time dynamics, analyzing challenges like globalization, climate change, and technological innovation, and exploring best practices in project management, stakeholder engagement, and regulatory compliance. Emphasis is on environmental sustainability, eco-friendly design strategies, and recent technological advancements. The study aims to propose recommendations for advancing shipping architecture knowledge, fostering resilient, environmentally responsible, and economically viable maritime infrastructure. By integrating recent advancements and industry insights, it seeks to inform future development and promote sustainable maritime infrastructure worldwide.*

Key Words: **container, cost, time, comparison, rapid construction, shipping architecture…**

1.INTRODUCTION

Malcom McLean, born in 1914 on a North Carolina farm, started his transportation company in 1934 after saving up for a used truck post-graduation. By expanding his fleet to five vehicles, he encountered road transportation limitations and fines. Recalling a 1937 incident in New Jersey, McLean envisioned a standard-sized trailer for efficient cargo shipping. Collaborating with engineer Keith Tantlinger, they refined the container concept, resulting in a theft-resistant, stackable, and lockable design.

1.1 TIMELINE EVOLUTION OF CONTAINER HOUSING

1950s Development of standardized containers 1960s

Early experiments of containers 1970s

Concept development in containers 1980s

Growth interest of containers 1990s

Early container construction projects 2000s

Early container home construction present

Environmentally friendly and sustainable construction.

Abandoned containers have found new life as low-income and student housing in Amsterdam, addressing the pressing need for affordable living spaces in densely populated areas. This adaptation underscores the truth of the saying "necessity is the mother of invention." Container architecture has proven invaluable in meeting various demands, from providing emergency shelters for military purposes to offering sustainable housing solutions for urban environments facing housing shortages.

2. LITERATURE STUDY

A shipping container comprises several key structural components that collaborate to create a sturdy rectangular framework. These components include the roof, side walls, floor, cross members, top and bottom rails, and corner posts. Each of these elements plays a crucial role in maintaining the container's structural integrity and ensuring its durability during transportation and storage.

2.1 STANDARDS OF SHIPPING CONTAINER SIZE AND WEIGHTS

10-Foot Container: 9'9.75" x 8' x 8'6", 9' 3 " x 7 '8" x 7' 10",7 '8" x 7'5", 75 square-feet, 2,850 lb.

20-Foot Container:19 '10.5 " x 8' x 8 '6",19'3" x 7 '8" x 7' 10",7 '8" x 7'5",150 square feet,5,050 lb.

20-Ft-High Cube:19 '10.5 " x 8' x 9 '6",19'3" x 7 '8" x 8' 10",7 '8" x 8'5.5",150 sq ft,5,181 lb.

40-Foot Container:40' x 8' x 8'6",39' 5" x 7'8"x 7' 10",7'8" x 7'5",300 square-feet,8,000 lb.

40-Foot-High Cube:40' x 8' x 9'6",39' 5" x 7'8"x 8'10",7'8" x 8'5.5",300 square-feet,8,775 lb.

2.1.1 BUILDING STANDARDS OF SHIPPING CONTAINER

Shipping container building standards encompass adherence to local construction laws and regulations, including fire safety, electrical safety, insulation, and structural integrity. Strengthening containers to withstand loads and structural changes involves welding and adding reinforcements. Effective insulation, ventilation systems, and proper window and door installation maintain energy efficiency and air quality. Electrical and plumbing systems must meet code standards, while roofing and exterior finishes protect against weather. Containers require a strong foundation and consideration of environmental concerns, such as sustainability and accessibility. Compliance with fire safety regulations, obtaining necessary permissions, consulting structural engineers, and planning utility connections are essential steps in container construction.

2.1.2 COMPONENTS OF SHIPPING CONTAINER

Shipping container components include corner posts, corner castings, header and sill, top and bottom rails, cross-members, and bows. Corner posts are vertical frame components with corner castings used for lifting, handling, and securing. Header and sill form the door entrance path. Top and bottom rails provide structural support, while cross-members support the floor frame. Bows, spaced apart, form the roof structure, often covered with aluminum sheathing or corrugated steel panels. Aluminum containers have sheathing welded to top rails, while GRP containers use fiberglass-reinforced plywood panels. Doors, made from various materials, feature door gaskets for waterproofing. Security seals and locking mechanisms ensure container security, with assigned numbers and colors for identification.

2.1.3 PROS AND CONS OF CONTAINER CONSTRUCTION

Shipping container construction offers several advantages, including its economical nature when sourced at a fair price, structural strength derived from their durability in harsh sea conditions, and inherent modularity facilitating versatile room designs. Additionally, construction time can be significantly reduced, and eco-responsibility is promoted through the reuse of existing resources. However, challenges arise from poor insulation requiring additional insulation for temperature regulation, design restrictions due to costly modifications and container size limitations, and navigating complex regulatory requirements. Concerns also exist regarding potential toxins from previous use, necessitating testing and treatment, while maintenance is essential to prevent rust and corrosion over time. Furthermore, standard container sizes may pose limitations on available space without combining multiple units for certain applications.

2.1.4 COST OF CONTAINER CONSTRUCTION

The cost of shipping containers varies depending on factors such as size, material, and special features. Domestic shipping containers typically range from ₹80,000 to ₹1,20,000 for a 20-foot container and ₹1,50,000 to ₹2,50,000 for a 40-foot container. Refrigerated containers, or reefers, are pricier, with 20-foot units costing between ₹2,50,000 to ₹3,50,000 and 40-foot units ranging from ₹3,50,000 to ₹4,50,000. Open-top containers and flat rack containers follow similar pricing patterns, with 20-foot units priced between ₹1,20,000 to ₹2,00,000 and 40-foot units ranging from ₹2,50,000 to ₹3,50,000. High cube containers, which are taller than standard containers, are priced between ₹90,000 to ₹1,30,000 for 20-foot units and ₹1,60,000 to ₹2,60,000 for 40-foot units. Additionally, specific materials such as stainless steel or galvanized steel can impact pricing, with costs varying accordingly.

2.2 JOURNAL STUDY

[1] TITLE: USE OF SHIPPING CONTAINER HOUSING CONCEPT AS A LOW-COST HOUSING SOLUTION FOR RESETTLEMENT PROJECTS IN URBAN AREAS, AUTHOR: J.R.P. Ishan1, Nayantara De Silva2 and K.T. Withanage3.

The research highlights the significant cost savings offered by shipping container housing (SCH), with potential for constructing thousands of units at over 60% cost reduction compared to conventional housing solutions. However, despite its financial advantages, SCH encounters resistance among low-income communities in Sri Lanka. Alternative applications, such as post-disaster housing and self-employed shops, show promise for broader utilization beyond traditional housing contexts, suggesting avenues for further exploration and implementation.

[2] TITLE: SUSTAINABILITY AND THE RECYCLE OF THE PORTABLE SHIPPING CONTAINERS IN OFFERING HEALTH CARE SERVICES IN COVID 19 CIRCUMSTANCES, AUTHOR: Islam El Ghonaimy As'har Habbab dept. of Architecture and Interior Design University of Bahrain

The research underscores the importance of repurposing shipping containers into field hospitals to address infectious disease outbreaks in MENA cities. Through eco-friendly assembling processes and innovative data collection methods, container-based facilities offer sustainable solutions for providing essential healthcare services during epidemics. However, successful implementation requires careful planning, considering factors such as site suitability, budget constraints, and regulatory requirements. A comprehensive checklist covering site assessment, budgeting, and design is essential for effectively creating functional healthcare facilities to meet the needs of patients and medical professionals during emergencies.

2.2.1 JOURNAL STUDY INFERENCE

The diverse aspects of shipping container projects underscore the need for nuanced project management approaches. From addressing resistance among low-income groups to exploring alternative applications like post-disaster housing, project managers must navigate various challenges while maximizing cost-effectiveness and environmental sustainability. Prefabrication, community engagement, and climate-specific considerations emerge as critical factors in ensuring project success and long-term viability. Ultimately, effective project management hinges on adaptability, awareness, and integration of sustainable practices to meet diverse needs and contexts globally.

2.3 CASE STUDY

A case study was conducted to explore project management principles, design concepts, and operational aspects. The study aimed to understand how these elements interact within the context of real-world projects, providing valuable insights into effective project execution and decision-making processes.

2.3.1 NEW PARK STATION, NEW JERSEY, USA

Case study has been done New Park Station exemplifies innovative and community-centric architecture by repurposing shipping containers to create a vertically integrated, diverse, and environmentally conscious urban space. The design incorporates three distinct building typologies and promotes architectural diversity, catering to various occupant types and fostering a dynamic living environment. Emphasizing environmental sustainability, the project implements green rooftops, natural ventilation, and urban farming plots. Moreover, New Park Station serves as a community hub, encouraging social interaction through communal spaces, a farmers' market, and a co-op model for reduced grocery costs. Overall, the project demonstrates a holistic approach to urban development, prioritizing connectivity, social engagement, and environmental responsibility.

Fig -1: New Park station, new jersey, USA.

2.3.2 PUMA CITY, SHIPPING CONTAINER STORE / LOT-EK

LOT-EK's PUMA City project for the Volvo Ocean Race embodies architectural efficiency, modularity, and sustainability through its innovative use of shipping containers. The design's adaptability to various locations, spatial innovation within container constraints, and transportability for events highlight a forward-thinking approach in contemporary architecture and event design. Overall, PUMA City serves as a sustainable and visually impactful branding statement, showcasing a commitment to eco-friendly practices and innovative design solutions.

Fig -2: PUMA city.

2.3.3 KEETWONEN, AMSTERDAM

The Keetwonen project in Amsterdam showcases the potential of container architecture in providing innovative, adaptable, and sustainable housing solutions. Its success, demonstrated by the world's largest container city for students, highlights the efficiency, rapid construction, and cost-effectiveness of container-based developments. By addressing urgent housing needs while fostering community living through communal spaces, Keetwonen sets a precedent for similar large-scale projects globally. Its proven success suggests that container architecture could play a significant role in addressing Nigeria's housing deficit, offering practical and scalable solutions tailored to local socio-economic conditions.

Fig -3: keetwonen, Amsterdam.

2.3.4OVER ALL INFERENCE

Both New Park Station and LOT-EK's container-based project for the Volvo Ocean Race showcase innovative design and sustainability, suggesting a strong emphasis on integrating eco-friendly practices into project management strategies. New Park Station's community-centric approach likely involved extensive stakeholder engagement to ensure alignment with local needs, while LOT-EK's efficient and modular design reflects careful planning and coordination to optimize resources. Both projects demonstrate spatial innovation and adaptability, underscoring the importance of flexibility in project management. Moreover, their scalability and alignment with contemporary trends highlight their potential to address broader sustainable development goals and contribute to positive social, economic, and environmental impacts.

2.4 LIVE STUDY

A proposal has been developed for residential accommodation in Kotturpuram, Chennai, Tamil Nadu, India. With a focus on comparing conventional construction methods to the utilization of shipping container architecture. Kotturpuram, known for one of Chennai's 1131 slums, is located along the Adyar riverfront, with a site area covering 41026.9 sq.m. The objective of the comparison is to evaluate the cost and time implications of both approaches, taking into account factors like construction efficiency, material procurement, and project management requirements.

Fig -4: kotturpuram, Chennai, Tamil Nadu, India

2.4.1 LIVE STUDY ANALYSIS

Kotturpuram, Chennai, experiences a tropical climate marked by high temperatures, humidity, and seasonal rainfall, with occasional cyclonic disturbances. Summer temperatures often exceed 35°C, while winter temperatures range from 20°C to 25°C. High humidity levels, especially during the monsoon season, contribute to discomfort. Heavy rainfall occurs mainly during the northeast monsoon, leading to flooding and waterlogging. Understanding these climatic factors is crucial for effective urban planning, infrastructure development, and ensuring the well-being of residents in the area.

2.4.2 MATERIAL STUDY

Polyurethane foam and polystyrene foam, like EPS and XPS, offer exceptional thermal insulation when applied inside shipping containers. They regulate temperatures, prevent condensation, and improve energy efficiency, creating comfortable living or working spaces. Polyurethane foam exhibits superior fire resistance compared to polystyrene, withstanding higher temperatures without damage. While polyurethane remains intact up to 700 degrees Fahrenheit, polystyrene melts at lower temperatures of 200 to 300 degrees Fahrenheit. Additionally, polyurethane provides excellent electrical insulation. Both foams are lightweight, space-efficient, and practical for container conversions, with polyurethane offering flexibility even in extreme cold, ensuring durability in various climate conditions.

Fig -5: kotturpuram site, Chennai, Tamil Nadu, India

2.4.3 SITE STUDY

The site plan, sourced from the Tamil Nadu Urban Habitat Planning and Development Board in Chennai, Tamil Nadu, India, serves as the basis for a study comparing proposed plans for estimation of cost and time. The analysis focuses on comparing conventional construction methods with container construction. Through this study, the aim is to understand the differences in cost, time, and feasibility between the two approaches, offering insights into the potential benefits and challenges associated with each method.

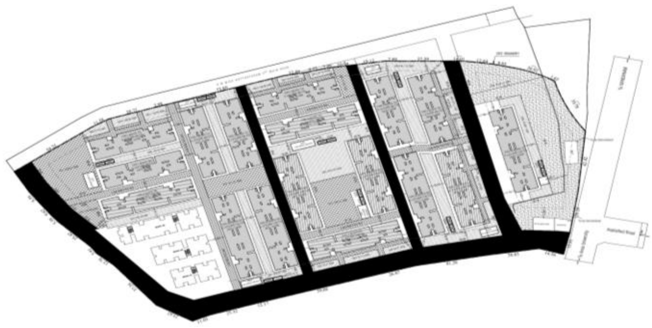

Fig -5: kotturpuram proposed existing site plan, Chennai, Tamil Nadu, India

The site plan obtained from the Tamil Nadu Urban Habitat Planning and Development Board remains largely unchanged, with minor adjustments made to accommodate newly proposed container units. These adjustments involve integrating the container units into the existing layout while ensuring compatibility with the surrounding infrastructure. The study aims to compare the cost, time, and feasibility of implementing these container units compared to conventional construction methods, offering insights into their potential as alternative housing solutions.

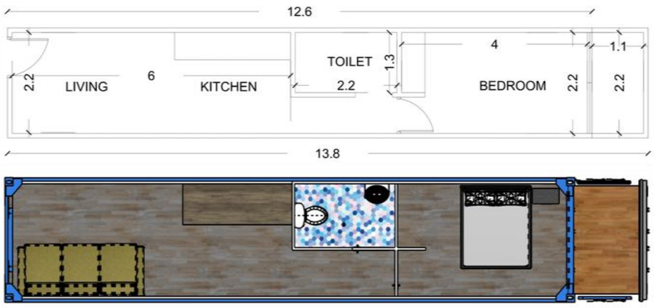

Fig -6: proposed container unit

The proposal suggests utilizing containers as single units, with each container having an area of 33.4 square meters. This approach emphasizes the modular nature of containers, allowing for standalone units that can be easily transported, assembled, and adapted for various purposes. By standardizing the unit size, the proposal aims to streamline construction processes and ensure consistency across the project while offering flexibility in design and utilization.

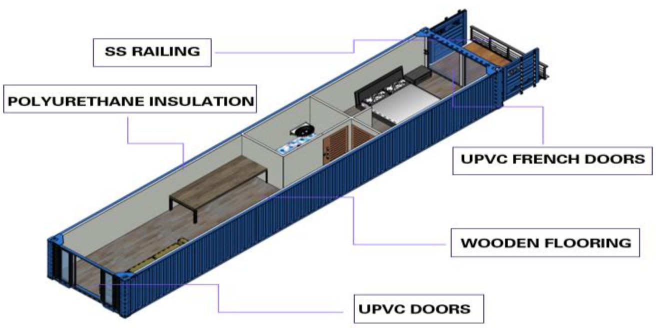

Fig -7: proposed container unit isometric view

Fig 8: proposed new site plan using container units

2.4.3.1. COST ESTIMATION FOR CONVENTIONAL METHOD CONSTRUCTION AND CONTAINER CONSTRUCTION METHOD

2.4.3.1.a COST ESTIMATION FOR CONVENTIONAL METHOD CONSTRUCTION

ESTIMATION FOR TYPE 1 BLOCK

Sl. No.	Building Area (Sft)		39029.90	@	2,550.00	Per Sft
	Total Estimated Building Cost		Rs		9,95,26,248.57	
1	Cost of labour and material				Cost	
a	Cost on accounts of labour	30-35% of the total cost		35%	3,48,34,187.00	
b	Cost on account for material	65-70% of the total cost		65%	6,46,92,061.57	
						9,95,26,248.57
2a	Cost on account of foundation and plinth	10-15% of total cost		15%	1,49,28,937.29	
2b	Cost on account of Superstructure	90-85% of the total cost		85%	8,45,97,311.28	
						9,95,26,248.57
3	Cost of second storey	85-90% of the total cost		85%	8,45,97,311.28	
4	Cost of different parts of percentage breakup of building (excluding sanitary and electrical installations)					
a	earth work in excavation and filling	1/2% of the total cost		0.5%	4,97,631.24	
b	concreting of foundation	5% of the total cost		5%	49,76,312.43	
c	damp proof course	1% of the total cost		1%	9,95,262.49	
d	brick work	34% of the total cost		34%	3,38,38,924.51	
e	roofing	20% of the total cost		20%	1,99,05,249.71	
f	flooring	6% of the total cost		6%	59,71,574.91	
g	plastering and painting	10% of the total cost		10%	99,52,624.86	
h	white washing and color washing, etc.	2% of the total cost		2%	19,90,524.97	
I	miscellaneous	5 1/2 % of the total cost		5.5%	54,73,943.67	
						8,36,02,048.80
5	Cost of sanitary and electrical works					
a	sanitary and water supply installation	8% of the total cost		8%	79,62,099.89	
b	electrical installation excluding fans	8% of the total cost		8%	79,62,099.89	
						1,59,24,199.77

Table -1: estimation for per block 1 type

Construction cost per block is Rs. 9,95,26,248.00

ESTIMATION FOR TYPE 2 BLOCK

Sl. No.	Building Area (Sft)		43809.07	@	2,550.00	Per Sft
	Total Estimated Building Cost		Rs		11,17,13,136.15	
1	Cost of labour and material				Cost	
a	Cost on accounts of labour	30-35% of the total cost		35%	3,90,99,597.65	
b	Cost on account for material	65-70% of the total cost		65%	7,26,13,538.50	
						11,17,13,136.15
2a	Cost on account of foundation and plinth	10-15% of total cost		15%	1,67,56,970.42	
2b	Cost on account of Superstructure	90-85% of the total cost		85%	9,49,56,165.73	
						11,17,13,136.15
3	Cost of second storey	85-90% of the total cost		85%	9,49,56,165.73	
4	Cost of different parts of percentage breakup of building (excluding sanitary and electrical installations)					
a	earth work in excavation and filling	1/2% of the total cost		0.5%	5,58,565.68	
b	concreting of foundation	5% of the total cost		5%	55,85,656.81	
c	damp proof course	1% of the total cost		1%	11,17,131.36	
d	brick work	34% of the total cost		34%	3,79,82,466.29	
e	roofing	20% of the total cost		20%	2,23,42,627.23	
f	flooring	6% of the total cost		6%	67,02,788.17	
g	plastering and painting	10% of the total cost		10%	1,11,71,313.62	
h	white washing and color washing, etc.	2% of the total cost		2%	22,34,262.72	
I	miscellaneous	5 1/2 % of the total cost		5.5%	61,44,222.49	
						9,38,39,034.37
5	Cost of sanitary and electrical works					
a	sanitary and water supply installation	8% of the total cost		8%	89,37,050.89	
b	electrical installation excluding fans	8% of the total cost		8%	89,37,050.89	
						1,78,74,101.78

Table -2: estimation for per block 2 type

Construction cost per block is Rs. 11,17,13,136.00

ESTIMATION FOR TYPE 3 BLOCK

Sl. No.	Building Area (Sft)		47684.08	@	2,550.00	Per Sft
	Total Estimated Building Cost		Rs		12,15,94,396.35	
1	Cost of labour and material				Cost	
a	Cost on accounts of labour	30-35% of the total cost		35%	4,25,58,038.72	
b	Cost on account for material	65-70% of the total cost		65%	7,90,36,357.63	
						12,15,94,396.35
2a	Cost on account of foundation and plinth	10-15% of total cost		15%	1,82,39,159.45	
2b	Cost on account of Superstructure	90-85% of the total cost		85%	############	
						12,15,94,396.35
3	Cost of second storey	85-90% of the total cost		85%	############	
4	Cost of different parts of percentage breakup of building (excluding sanitary and electrical installations)					
a	earth work in excavation and filling	1/2% of the total cost		0.5%	6,07,971.98	
b	concreting of foundation	5% of the total cost		5%	60,79,719.82	
c	damp proof course	1% of the total cost		1%	12,15,943.96	
d	brick work	34% of the total cost		34%	4,13,42,094.76	
e	roofing	20% of the total cost		20%	2,43,18,879.27	
f	flooring	6% of the total cost		6%	72,95,663.78	
g	plastering and painting	10% of the total cost		10%	1,21,59,439.64	
h	white washing and color washing, etc.	2% of the total cost		2%	24,31,887.93	
I	miscellaneous	5 1/2 % of the total cost		5.5%	66,87,691.80	
						10,21,39,292.93
5	Cost of sanitary and electrical works					
a	sanitary and water supply installation	8% of the total cost		8%	97,27,551.71	
b	electrical installation excluding fans	8% of the total cost		8%	97,27,551.71	
						1,94,55,103.42

Table -3: estimation for per block 3 type

Construction cost per block is Rs. 12,15,94,396.00

OVER ALL CONSTRUCTION ESTIMATION COST FOR CONVENTIONAL METHOD

MATERIAL COST:

Brick (per 1000) Rs.5,000 – 7,000

Cement (per bag, 50kg) Rs. 350 – 400

Steel (per ton) Rs. 45,000 – 50,000

Wood (per cubic foot) Rs. 1,500 – 2,500

Roofing Material (per sq. ft) Rs. 100 – 300

LABOUR COST:

Skilled Labor (per day) Rs. 900 – 1,200 Rs. 900 – 1,200

Unskilled Labor (per day) Rs. 700 – 900 Rs. 700 – 900

Machineries cost Rs. 1,000 – 5,000 Rs. 8,000 and above

Electrical and Plumbing 15% - 20% of total project cost 15% - 20% of total project cost

CONSTRUCTION COST FOR TYPES OF BLOCKS			
BLOCK TYPE	NO OF BLOCKS	CONSTRUCTIONCOST PER BLOCK	TOTAL CONSTRUCTION COST
TYPE 1	7	₹ 9,95,26,248.00	₹ 69,66,83,736.00
TYPE 2	5	₹ 11,17,13,136.00	₹ 55,85,65,680.00
TYPE 3	4	₹ 12,15,94,396.00	₹ 48,63,77,584.00
TOTAL CONSTRUCTION COST USING CONVENTIONAL METHOD			₹ 1,74,16,27,000.00

Table -4: OVERALL ESTIMATION COST FOR CONSTRUCTION USING CONVENTIONAL METHOD

THE TOTAL COST FOR CONSTRUCTION USING CONVENTIONAL METHOD CONSTRUCTION IS AROUND Rs,1,74,16,27,000.00

2.4.3.1.b COST ESTIMATION FOR CONTAINER CONSTRUCTION METHOD CONSTRUCTION

ESTIMATION FOR PER CONTAINER

ESTIMATE COST PER CONTAINER CONSTRUCTION					
COST OF CONTAINER					
UNIT	CONTAINER PER UNIT				COST OF CONTAINER
1	₹ 1,50,000.00				₹ 1,50,000.00
COST OF CONTAINER					₹ 1,50,000.00
COST OF CONTAINER INSULATION PER SQ.FT 250 Rs					
S.NO	DESCRIPTION	UNITS	AREA	COST/ SQ.FT	TOTAL COST
1	40'X8'6" SIDE PANEL	2	344	250	₹ 1,72,000.00
2	8'X8'6" FRONT PANEL	1	68.8	250	₹ 17,200.00
3	8'X40' ROOF INSULATION	1	320	250	₹ 80,000.00
TOTAL COST FOR INSULATION					₹ 2,69,200.00
COST OF JOINERY PER SQ.FT 350 Rs					
S.NO	DESCRIPTION	UNITS	AREA	COST/ SQ.FT	TOTAL COST
1	MAIN DOOR	1	18	350	₹ 6,300.00
2		1	68.8	350	₹ 24,080.00
TOTAL COST FOR INSULATION					₹ 30,380.00
COST OF FLOORING PER SQ.FT 50Rs					
S.NO	DESCRIPTION	UNITS	AREA	COST/ SQ.FT	TOTAL COST
1	COMMON FLOORING	1	270	50	₹ 13,500.00
2	TOILET	1	32	50	₹ 1,600.00
3	BALCONY	1	26.9	50	₹ 1,345.00
TOTAL COST FOR FLOORING					₹ 16,445.00
TOTAL COST FOR PER CONTAINER FULLY INSULATED					₹ 4,66,025.00

Table -5: estimation cost for per container

Cost of common area (lift, corridor spaces, staircases.)

Lift 2 nos 10 passenger with six stops (22 lakhs per lift)- 44,00,000 Rs.

Construction cost for lift machine room & staircase head room – (rs.23,000 per sqm) 104. 8sq.m- 24,10, 400.rs

Cost of foundation: 18,000 per sq.m

Cost of welding fabrication labor cost: 1250rs / day.

ESTIMATION FOR BUILDING BLOCKS USING CONTAINER CONSTRUCTION

BLOCK TYPE 1 (7 BLOCKS)

No of units: (14 units per floor x 6 floors)-84 units x per unit container cost= rs.3,91,46,100

Overhead tank: overhead tank 20,000 lit x Rs 25 /lit (2 tanks considered)- rs.10,00,000

Construction cost for lift machine room & staircase head room – (rs.23,000 per sqm)) {104. 77 sq.m per floor x 6=628.62 sq.m}- rs.1,44,58,260

Cost of foundation (475.82 sq.m): rs.85,64,760

Lift 2 nos 10 passenger with six stops (22 lakhs per lift)- rs.44,00,000

Total cost of per block type 1: rs.6,75,69,120/-

Total blocks cost-(no of blocks 7 x cost per block) rs.47,29,83,840

BLOCK TYPE 2 (5 BLOCKS):

No of units: (16 units per floor x 6 floors)- 96 units x per unit container cost= rs.4,47,38,400

Overhead tank: overhead tank 20,000 lit x Rs 25 /lit (2 tanks considered)- rs.10,00,000

Construction cost for lift machine room & staircase head room – (rs.23,000 per sqm) {110. 58sq.m per floor x 6=663.48 sq.m}- rs.1,52,60,040

Cost of foundation (536.99 sq.m): rs.96,65,820

Lift 2 nos 10 passenger with six stops (22 lakhs per lift)- rs.44,00,000

Total cost of per block type 2: rs.7,50,64,260

Total blocks cost-(no of blocks 5 x cost per block) rs.37,53,21,300

BLOCK TYPE 3 (4 BLOCKS):

No of units: (18 units per floor x 6 floors)- 108 units x per unit container cost = rs.5,03,30,700

overhead tank: overhead tank 20,000 lit x Rs 25 /lit (2 tanks considered)- rs.10,00,000

Construction cost for lift machine room & staircase head room – (rs.23,000 per sqm) {116. 27sq.m per floor x 6=697.62 sq.m} - rs.1,60,45,260

Cost of foundation (600.54 sq.m): rs.1,08,09,720

Lift 2 nos 10 passenger with six stops (22 lakhs per lift)- 44,00,000

Total cost of building per block: rs.8,25,85,680

Total blocks cost-(no of blocks 4 x cost per block) rs.33,03,42,720

CONSTRUCTION COST FOR TYPES OF CONTAINER BLOCKS			
BLOCK TYPE	NO OF BLOCK	CONSTRUCTION COST PER BLOCK	COST OF CONSTRUCTION
TYPE 1	7	₹ 6,75,69,120.00	₹ 47,29,83,840.00
TYPE 2	5	₹ 7,50,64,260.00	₹ 37,53,21,300.00
TYPE 3	4	₹ 8,25,85,680.00	₹ 33,03,42,720.00
TOTAL CONSTRUCTION COST USING SHIPPING CONTAINER			₹ 1,17,86,47,860.00

Table -6: OVERALL ESTIMATION COST FOR CONSTRUCTION USING CONTAINER CONSTRUCTION METHOD

2.4.3.3. COST COMPARISON OF BOTH CONVENTIONAL CONSTRUCTION METHOD

Cost comparison for conventional method with shipping container construction

Over all construction cost using conventional construction:

Total construction cost using conventional method-Rs 1,74,16,27,000

Over all construction cost using container construction:

Total cost of all container blocks building construction-1,17,86,47,860/-

THE COST DIFERENCE – RS.56,29,79,140 (38.5%).

2.4.3.2. TIME ESTIMATION FOR CONVENTIONAL METHOD CONSTRUCTION AND CONTAINER CONSTRUCTION METHOD

TIME ESTIMATION FOR CONTAINER METHOD CONSTRUCTION

The total number of container units proposed for the project is 1500, divided into three types: Type 1 blocks with 588 units, Type 2 blocks with 480 units, and Type 3 blocks with 432 units.

For offsite prefabrication of containers, the time required ranges from a minimum of 3 weeks to a maximum of 4 weeks per container, with a monthly fabrication capacity ranging from 15 to 20 units. Therefore, the total time for offsite container fabrication ranges from a minimum of 7 years to a maximum of 9 years.

Onsite fabrication involves a minimum of 5 weeks to a maximum of 8 weeks for common corridor and staircase fabrication per block, and assembling of container units ranging from 10 to 15 units per session. The foundation construction, including site preparation and excavation, takes a minimum of 8 months to a maximum of 14 months. Overall, the time for onsite container construction ranges from a minimum of 8 years to a maximum of 10 years, including parallel construction activities.

TIME ESTIMATION FOR CONVENTIONAL METHOD CONSTRUCTION

For the construction using conventional methods, each S+6 block takes a minimum of 18 months and a maximum of 22 months to complete. With a total of 16 blocks planned, the timeline for construction using conventional methods averages between a minimum of 12 years and a maximum of 15 years, considering parallel construction activities.

2.4.4. SITE ACCESS

The site has convenient access for containers, with a 30-foot-wide entry road on the east and south sides, facilitating easy entry. Containers will be sourced from Chennai port and transported via Adyar bridge to Kotturpuram. This setup ensures efficient transportation, smooth logistics, and effective progress in container construction.

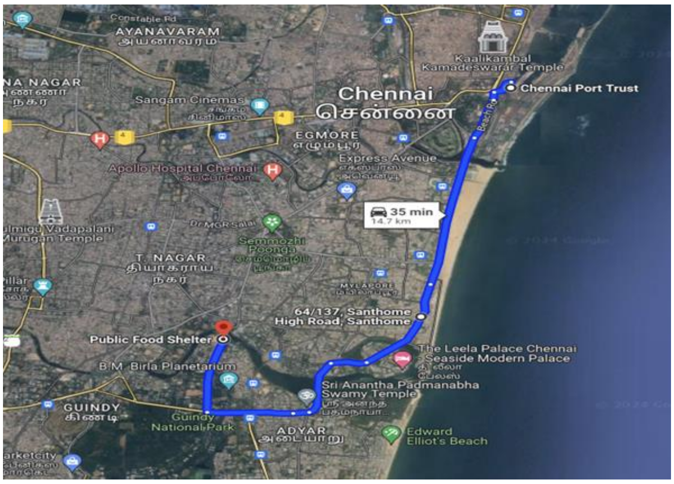

Fig 9: SITE ACCESS FROM HARBOR TO SITE ROADWAY PATH MAP

2.4.5. PROS AND CONS

2.4.5.1. PROS AND CONS OF SHIPPING CONSTRUCTION METHOD

PROS

Cost-effective: Containers are often cheaper to acquire than traditional building materials, especially in regions where there's a surplus of shipping containers.

Speed of construction: Building with containers can be faster than traditional methods since much of the structure is pre-fabricated.

Eco-friendly: Repurposing shipping containers reduces waste and can be considered a form of recycling. Additionally, it can lessen the demand for new materials.

Modularity: Containers are inherently modular, making them easy to stack and arrange in various configurations to create unique architectural designs.

Durability: Shipping containers are designed to withstand harsh conditions at sea, so they offer a high level of durability and resistance to weather and pests.

CONS

Insulation challenges: Containers are made of metal, which conducts heat and cold, making insulation a critical concern. Proper insulation can add to the cost and complexity of the project.

Structural modifications: Cutting openings for windows and doors weakens the structural integrity of the container, requiring additional reinforcement.

Limited space: Containers have fixed dimensions, which may not always align with the desired layout or space requirements.

Permitting issues: Some areas have regulations that restrict or prohibit the use of shipping containers for residential or commercial purposes, making obtaining permits challenging.

Aesthetic limitations: While containers offer a unique look, some may find their appearance industrial or unattractive, limiting their appeal in certain contexts.

2.4.5.2. PROS AND CONS OF SHIPPING CONSTRUCTION METHOD

PROS

Design flexibility: Conventional construction allows for greater freedom in design, enabling architects and builders to create custom structures tailored to specific needs and preferences.

Proven methods: Traditional construction methods have been refined over centuries and are well-understood, reducing the risk of unexpected challenges during the building process.

High-quality finishes: Conventional construction methods often result in smoother finishes and greater attention to detail compared to container construction.

Resale value: Properties built using conventional construction methods typically have higher resale values and may be more attractive to buyers.

Wide acceptance: Conventional construction methods are widely accepted by building authorities and communities, making permitting and zoning processes more straightforward in many cases.

CONS

Higher cost: Traditional construction methods can be more expensive due to labor, materials, and longer construction timelines.

Environmental impact: Conventional construction often involves significant resource consumption and waste generation, contributing to environmental concerns.

Construction time: Building with traditional methods can take longer than container construction, especially for complex or large-scale projects.

Weather dependency: Conventional construction is more susceptible to weather delays, which can extend project timelines and increase costs.

Labor-intensive: Traditional construction methods require skilled labor and can be labor-intensive, adding to project expenses.

3. CONCLUSIONS

Container construction provides cost-effectiveness, speed, eco-friendliness, modularity, and durability advantages, showcasing significant cost savings and environmental benefits through material repurposing. However, challenges like insulation, structural modifications, limited space, permitting, and aesthetics must be addressed.

Conversely, conventional methods offer design flexibility, quality finishes, and potential resale value, albeit with higher costs and longer timelines. They may also have greater environmental impact.

Ultimately, the choice between container and conventional construction hinges on project-specific factors like budget, timeline, design preferences, and regulations, highlighting the need for careful consideration.

4. RESULTS

Container construction proves cost-effective, showing a significant cost advantage over conventional methods, saving approximately Rs. 56,29,79,140 (38.5%). Its shorter construction timeline of 3-4 years compared to 12 to 15 years for conventional methods highlights its speed advantage. Additionally, container construction positively impacts the environment through material reuse and reduced resource demand. However, challenges like insulation, structural modifications, space limitations, permitting hurdles, and aesthetic constraints require careful planning. While conventional methods offer design flexibility, quality finishes, and higher resale values, they come with higher costs, longer timelines, and greater environmental impact. Ultimately, the choice depends on factors like budget, timeline, design preferences, and regulations.

5. RECOMMENDATION

Container construction proves cost-effective, showing a significant cost advantage over conventional methods, saving approximately Rs. 56,29,79,140 (38.5%). Its shorter construction timeline of 3-4 years compared to 12 to 15 years for conventional methods highlights its speed advantage. Additionally, container construction positively impacts the environment through material reuse and reduced resource demand. However, challenges like insulation, structural modifications, space limitations, permitting hurdles, and aesthetic constraints require careful planning. While conventional methods offer design flexibility, quality finishes, and higher resale values, they come with higher costs, longer timelines, and greater environmental impact. Ultimately, the choice depends on factors like budget, timeline, design preferences, and regulations.

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