SUSTAINABLE DELAY MITIGATION: DATA-DRIVEN ANALYSIS OF ONGOING INFRASTRUCTURE PROJECTS AT KLC CONSTRUCTIONS

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Abstract- **Delays in infrastructure projects are a persistent challenge in the construction industry, often leading to cost overruns, resource inefficiencies, and reduced stakeholder confidence. This study presents a data-driven approach to identifying, classifying, and mitigating delays in ongoing infrastructure works undertaken by KLC Constructions. Real-time data was collected through site visits, stakeholder interviews, and project documentation, and analyzed using project management tools such as Microsoft Excel and Gantt charts. The types of delays were categorized into excusable, non-excusable, critical, and non-critical delays, allowing for a structured assessment of their impact on project timelines and resources. The study also included AutoCAD-based construction layout analysis and quantity take-offs for key materials to quantify resource requirements and identify material-related delays. While advanced delay simulations using Primavera were suggested, Excel-based delay tracking and Gantt chart analysis were performed to visualize slippages and critical activities.**

Index Terms- **Infrastructure Projects, Construction Delays, Delay Analysis, Gantt Chart, Project Management, Quantity Take-Off, AutoCAD, Sustainable Construction, Delay Mitigation, SDG 9, SDG 11**

I. INTRODUCTION

In the construction industry, time is one of the most critical assets. Yet, project delays remain a persistent challenge, affecting not only the timely completion of works but also escalating costs, disrupting resource management, and undermining the confidence of clients and stakeholders. In the construction industry, how even seemingly minor setbacks—such as late material deliveries, poor coordination between subcontractors, or unexpected site conditions—can cascade into significant disruptions across the entire project lifecycle. This project aims to provide a comprehensive exploration of the multifaceted legal issues that modern construction projects encounter.

II. OBJECTIVES

- To identify and categorize the types of delays (excusable, non-excusable, critical, and non-critical) affecting the progress of ongoing infrastructure projects managed by KLC Constructions.
- To analyze the root causes of these delays using real-time data collected from project sites, stakeholder interviews, and construction documentation
- To quantify the time and resource impacts of identified delays through project management tools such as Microsoft Excel and Gantt charts.
- To propose practical, data-driven mitigation strategies aimed at improving project scheduling, resource allocation, and stakeholder coordination.
- To align delay mitigation practices with the principles of sustainable construction, contributing to the achievement of UN SDG 9 (Industry, Innovation & Infrastructure) and SDG 11 (Sustainable Cities & Communities).

III. LITERATURE REVIEW

Balouch, Sheu, and Abdul-Samad (2024) explores how digital technologies can support sustainability in project management. The authors emphasize that tools like project management software, cloud-based platforms, and data analytics improve stakeholder engagement, streamline processes, and enhance

decision-making—all of which contribute to better environmental and operational outcomes. However, the paper also highlights several challenges that organizations face when adopting these technologies, including high implementation costs, lack of skilled personnel, resistance to change, and concerns about data privacy. Through a structured review of real-world case studies, the authors conclude that while technology offers significant potential to drive sustainable practices in project management, successful implementation requires strategic planning, training, and change management to overcome barriers and ensure long-term impact.

Kamangdang and Casita (2019): classified construction delays into excusable, non-excusable, and compensable categories. Their study underlined the importance of understanding these classifications for accurate liability assignment and claims resolution. They also emphasized the challenges posed by concurrent delays, which often involve multiple responsible parties and require more advanced analytical tools.

Braimah (2013): focused on the methodological issues in delay analysis, reviewing various Delay Analysis Techniques (DATs) used in practice. He highlighted significant discrepancies in delay outcomes when different techniques were applied to the same case, due to varying assumptions and data inputs. The study called for improved standardization in delay analysis, greater consideration of software limitations, and better integration of factors like resource leveling, pacing, and concurrent delays.

Causes of construction delays

Here is a comprehensive list of **common causes of construction delays**, organized into major categories to help clarify their sources and effects:

Contractor-Related Causes

- Poor project planning and scheduling
- Inadequate site management and supervision

Client/Owner-Related Causes

- Delay in providing site access or possession
- Frequent design changes or scope modifications

Consultant/Designer-Related Causes

- Delay in approval of drawings or materials
- Incomplete or unclear design documents

Material and Equipment-Related Causes

- Late delivery of materials or equipment
- Shortage of materials in the market

External Factors

- Bad weather (e.g., heavy rain, storms, extreme temperatures)
- Regulatory or permit delays

Project Management-Related Causes

- Inadequate risk management
- Inefficient resource allocation

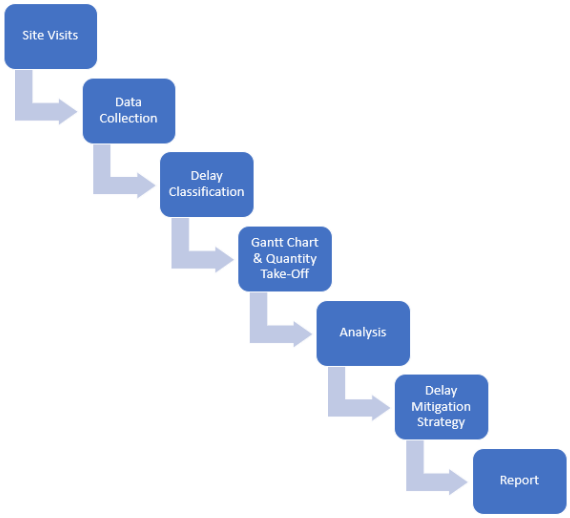
Research Gap

While extensive studies have been conducted on the causes and classifications of delays in construction projects, most existing literature focuses on either theoretical frameworks or retrospective analysis of completed projects. Limited research applies real-time, site-specific data to actively monitor and analyze delays in ongoing infrastructure projects, particularly in the Indian context.

Moreover, there is a lack of integration between technical tools like AutoCAD, Excel-based Gantt charts, and sustainable project management practices in current delay analysis studies. Very few works connect delay mitigation strategies with sustainability principles or align them with global development frameworks such as the United Nations Sustainable Development Goals (SDGs). This project aims to bridge these gaps by conducting a data-driven, real-time delay analysis on a live project and proposing practical, sustainability-aligned mitigation strategies.

IV. METHODOLOGY

Fig: 01FLOW CHART OF METHODOLOGY



Tools Used:

1. Auto CAD: To prepare the site layout and typical floor plan, which helped link physical work zones to the observed delays.

2. Microsoft Excel: To prepare quantities for estimation

3. Gantt chart: To analyze the delay through visualization.

CASE STUDY

Project Overview

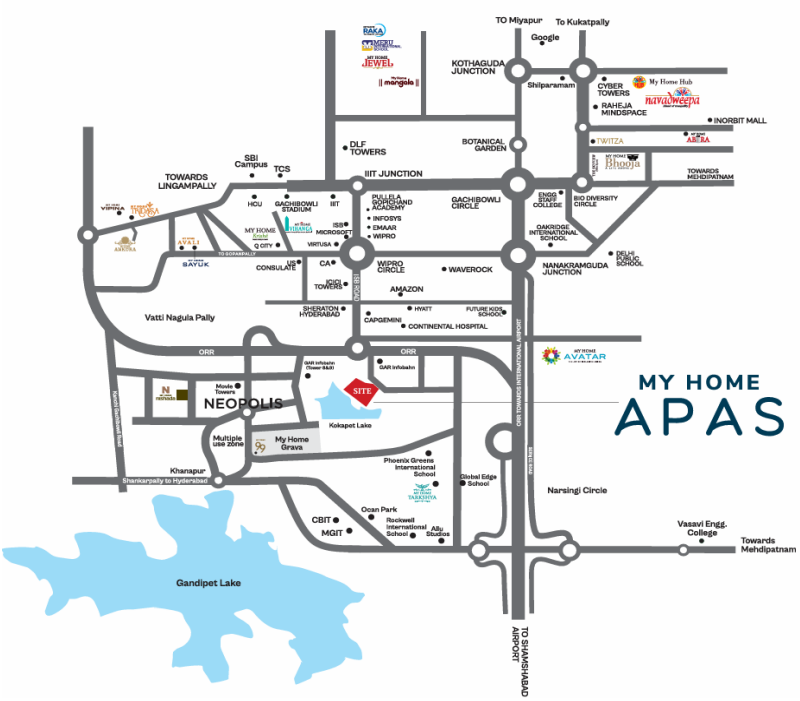


Fig: 02 LOCATION MAP

Location Highlights:
Corporate Offices: Wipro - 5 mins, Microsoft - 7 mins, Infosys - 7 mins
Shopping and Entertainment: IKEA - 17 mins, Inorbit Mall - 22 mins
Hospitals: Continental Hospitals - 5 mins, AIG Hospitals, Gachibowli - 15 mins

Nearby Locations: Metro Station - 20 mins, Airport - 25 mins, Railway Station - 35 min

Fig: 03 SITE LAYOUT PLAN PREPARED IN AUTOCAD

Project Details

- **Project Name: MY HOME APAS**
- **Developer**: My Home Constructions Pvt. Ltd., part of the respected My Home Group headed by Jupally Rameswar Rao
- **Project Type:** High-rise luxury residential apartment
- **Size (area in sqm):** 54,632 sqm (13.5 acres across six towers)
- **Location:** Kokapet, Hyderabad, Telangana
- **RERA Reg No**: P02400006812
- **Towers**: Six high-rise buildings, rising to G+44 floors (approx. 150 m / 492 ft)

Quantity Take-off

PROJECT : MY HOME APAS Residential Towers
DRG.REF /REV NO : ma-Aps-T2-STR-FF-01 To 04/R0
AREA/BUILDING : Tower-2,3,5,&6
DESCRIPTION OF WORK : BEAMS OF 1st Floor

S.No	Beam Type	Bark Mark	Description of Elements	Length	breadth	ø of Bars	Spacing	NO of Elements	Nos of Bars	Total no of bars	Cutting Length in Mtr	Shape	Net Length	Weight of different dia (ø) in KGs							Remark
														8mm	10mm	12mm	16mm	20mm	25mm	32mm	
								Beams													
1	B1 _230 X 1800																				
	B1	BB1	Bottom Bar			T20		1	2		4.000	4.000									
	B1	BX1	Bottom Bar			T20		1	2	2	4.000	4.000	8.000					19.760			
	B1	TB1	Top Bar			T20		1	2	2	4.000	4.000	8.000					19.760			
	B1	TX1	Top Extra Bar			T20		1	2	2	4.000	4.000	8.000					19.760			
	B1	SFR1	SFR on Both Sides of Beam			T8	175	2	9	18	2.700	2.700	48.600	19.197							
												STIRRUPS									
	B1	MST1	Main Stirrup			T8	175	1	14	14	3.900	0.170 / 1.740 / 0.170	54.600	21.567							
			TOTAL WEIGHT IN KGS											40.67				59.28			

Table: 01 STEEL WEIGHT CALCULATION

Tower-02										
1st TO 2nd FLOOR										
S.NO	DESCRIPTION	Grid no.	NOS	LENGTH	BREATH	HEIGHT	CONC-QTY	UNIT	RATE	AMOUNT (RUPEES)
	SLAB									
1	A6a	125 THICK SLAB	1	8.53		0.125	1.07	m3	450.00	481.5
2	A6 &A6b	150 THICK SLAB	1	31.68		0.150	4.75	m1	450.00	2137.5
3	A2b	125 THICK SLAB	1	17.83		0.125	2.23	m2	450.00	1003.5
4	A5	125 THICK SLAB	1	7.46		0.125	0.93	m3	450.00	418.5
	OPENING	125 THICK SLAB	-1	0.60	0.25	0.125	-0.02	m3	450.00	-9
5	A4	125 THICK SLAB	1	14.29		0.125	1.79	m3	450.00	805.5
6	A9b	125 THICK SLAB	1	2.15		0.125	0.27	m3	450.00	121.5
	OPENING	125 THICK SLAB	-1	1.24	0.25	0.125	-0.04	m3	450.00	-18
7	A4a	125 THICK SLAB	1	3.55		0.125	0.44	m3	450.00	198
8	A9a	125 THICK SLAB	1	5.04		0.125	0.63	m3	450.00	283.5
9	A10	125 THICK SLAB	1	2.62		0.125	0.33	m3	450.00	148.5
10	A3	125 THICK SLAB	1	2.49		0.125	0.31	m3	450.00	139.5
11	A2 & A2a	180 THICK SLAB	1	48.89		0.180	8.80	m3	450.00	3960
12	A6C	125 THICK SLAB	1	5.45		0.125	0.68	m3	450.00	306
13	A6d	125 THICK SLAB	1	1.69		0.125	0.21	m3	450.00	94.5
	OPENING	125 THICK SLAB	-1	0.98	0.25	0.125	-0.03	m3	450.00	-13.5
14	A7	125 THICK SLAB	1	18.02		0.125	2.25	m3	450.00	1012.5
15	A7a	125 THICK SLAB	1	2.94		0.125	0.37	m3	450.00	166.5
16	A7b	125 THICK SLAB	1	5.03		0.125	0.63	m3	450.00	283.5
17	A7c	125 THICK SLAB	1	4.01		0.125	0.50	m3	450.00	225
		FLAT -01 QUANTITY					26.10			11745

Table: 02 CONCRETE QUANTITY

Gantt Chart and Delay Analysis:

GANTT CHART / TASK SCHEDULED

SL. NO	ACTIVITY	PLANNED START	PLANNED FINISH	ACTUAL START	ACTUAL FINISH	DELAYS(DAYS)
1	Surveyor Marking, Red oxide Marking And Theci Fixing	21-06-2025	22-06-2025	22-06-2025	23-06-2025	2
2	Wall And Beams Reinforcement	23-06-2025	24-06-2025	24-06-2025	25-06-2025	2
3	wall And Beams Reinforcement Checking	25-06-2025	25-06-2025	26-06-2025	26-06-2025	1
4	Walls Alignment , Mivan Shuttering And Checking	26-06-2025	27-06-2025	27-06-2025	28-06-2025	2
5	Mivan Accessories Fixing And Checking, Internal Plumb Checking	27-06-2025	27-06-2025	28-06-2025	28-06-2025	1
6	Exreranl Plumb Checking, Pin And Wedges Checking	28-06-2025	28-06-2025	29-06-2025	29-06-2025	1
7	Conceting	29-06-2025	30-06-2025	01-07-2025	02-07-2025	2

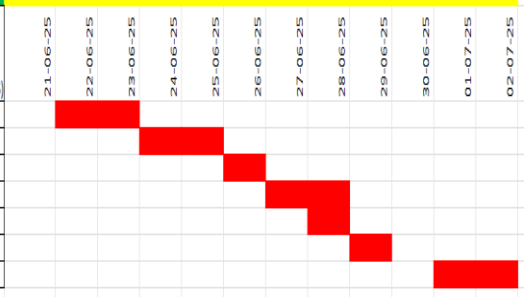


Table: 03 GANTT CHART SHOWING PLANNED VS ACTUAL DATES

Causes of Delays

1. Contractor-Related Causes

Fig: 04 DELAY DUE TO POOR SCHEDULING

2. Client-Related Causes

Fig: 05 DELAY DUE TO SLOW DECISION-MAKING

V. CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

Based on the data-driven analysis conducted on the ongoing infrastructure project at KLC Constructions, the following key conclusions are drawn:

- Delays were primarily caused by poor coordination, labor shortages, and material procurement issues, which disrupted critical construction activities.
- Excel-based Gantt charts effectively captured deviations in activity timelines, revealing slippages ranging from 2 to 7 days across key structural works like slab casting and column work.
- Quantity take-off analysis highlighted the material shortfalls (concrete, steel) that directly contributed to scheduling delays, enabling better forecasting of material needs.
- AutoCAD-based layout and section drawings helped visualize construction zones and relate delays to specific structural components (e.g., slab delay due to formwork congestion).

The study demonstrates that applying simple but structured digital tools like Excel and AutoCAD can significantly improve the tracking and mitigation of delays in real-time

Recommendations:

- Immediate Project-Level Recommendations:
- Establish a centralized material procurement and delivery tracking system to minimize procurement-related delays.
- Conduct weekly coordination meetings between site engineers, vendors, and project managers to reduce communication gaps.
- Long-Term Sustainable Practices:
- Train staff on using Primavera or equivalent project scheduling software for advanced delay forecasting and critical path analysis.
- Regularly update delay mitigation policies based on feedback from ongoing projects and stakeholder reviews.

SDG Alignment:

This study supports the advancement of the United Nations Sustainable Development Goals by promoting timely and sustainable project execution:

- SDG 9: Industry, Innovation, and Infrastructure

→ By enhancing infrastructure delivery through innovative and data-driven planning methods.

- SDG 11: Sustainable Cities and Communities

→ By contributing to the development of resilient urban infrastructure that avoids time and cost overruns.

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