ENHANCING THE PROJECT PERFORMANCE & EFFICIENCY THROUGH KANBAN VISUAL PLANNING

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Abstract - In the rapidly evolving and innovative construction sector, project management plays a vital role in the development of the project. Efficient project management, adherence to deadlines, and cost control are essential in construction industries. This case study explores the implementation of the Kanban lean construction tool to effectively manage the two projects consisting of nine activities Shuttering work, steel work, casting work, Block work, Plaster work, Plumbing work, M.S. grill work, Waterproofing work, Dado work. Using Kanban project was monitored and analyzed based on time, cost, and percentage plan completion. The study evaluates the progress of each activity based on percentage plan completion and identifies the area of delays, labour cost impact. The result demonstrated the Kanban is improving the work efficiency and coordination among stack holders. The strategies such as using a coup lock system for shuttering work, optimizing the steel work with cutting and bending platforms, and streamlining material transportation for finishing activities reducing the labor costs. This case study emphasizes the significance of kanban as a value able tool in the construction industry's needs for seamless collaboration among all stakeholders.

Index Terms - **Kanban, Lean construction, Percentage Plan Completion, Project management, Project Efficiency.**

I. INTRODUCTION

The construction industry is an essential part of a country and essential infrastructure and industrial development growth but the chronological problems of construction are well-known as waste generation low productivity, poor safety, and inferior working condition and in adequate quality there for many solutions are offered to relieve this problem in construction. Currently, new techniques are adopted in construction industries for appropriate management of the construction project lean construction is way to design the production system to minimize the waste of materials, time and effort, in order to generate the maximum possible value of the end product. These lean construction techniques originated from production system.

New technologies and procedures are continually being introduced in the construction sector to enhance project performance and efficiency. Lean construction is one such approach that has attracted a lot of attention recently. It entails finding and decreasing waste and non-value-added activities from construction processes in order to boost productivity and profitability. Lean tools offer a framework for analyzing and optimizing building processes to decrease waste, lower costs, and improve project outcomes, making their identification and evaluation in construction projects an important area of research. In order to improve project performance, this topic will examine the most favorable lean tools used in construction projects, their advantages, and effective implementation strategies. Additionally, we will look at ways to overcome these difficulties so that lean tools can be successfully utilized in the construction industry. Project teams can increase their productivity and profitability through a full understanding of lean technologies used in construction projects, thereby fostering the expansion and prosperity of the construction sector as a whole.

II. KANBAN TOOL

For visualizing the activities and tasks by adopting lean construction, kanban tool is emerging as a potent tool for construction management. kanban method gives an organized approach to managing the workflow by visualizing methods and improve the project outcomes. In traditional construction practices delays, and poor allocation of resources, which increased cost and decrease the quality. By applying kanban method improve communications, minimize the waste, and simplify the work process. Kanban revolve around visualizing the task using kanban board. The board contains the construction process and activity and move activities to cloud to do to doing and done mention in Fig. 1 by this movement of activities in the kanban board we can easily track the project, gain the real time visibility of project progress and promotes work flows. It is a pull approach to the project not push approach with continuous improvement.
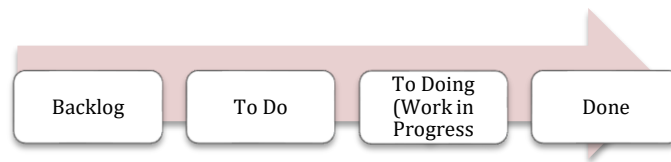
Fig.1. Kanban Process

III. OBJECTIVE

- To study the lean construction tools and techniques in detail.
- To understanding the implementation of kanban in construction project.
- To manage the progress of the project and identify the delay, project efficiency, percentage plan completion and cost impact on project by using kanban.

IV. SCOPE OF WORK

- Details study the lean construction tools and techniques which is used in construction management and which helps to reduce waste and cost of construction project.
- To ensure that lean construction technique is actually applicable to the field, some famous tools are tested for the construction field such as last planner system but other tools kanban for construction project and site are not studied.
- The kanban method is from the production system kanban which means visual map card for Planning, actual work, and completed work and tracking the project progress, time cost and productivity of labour
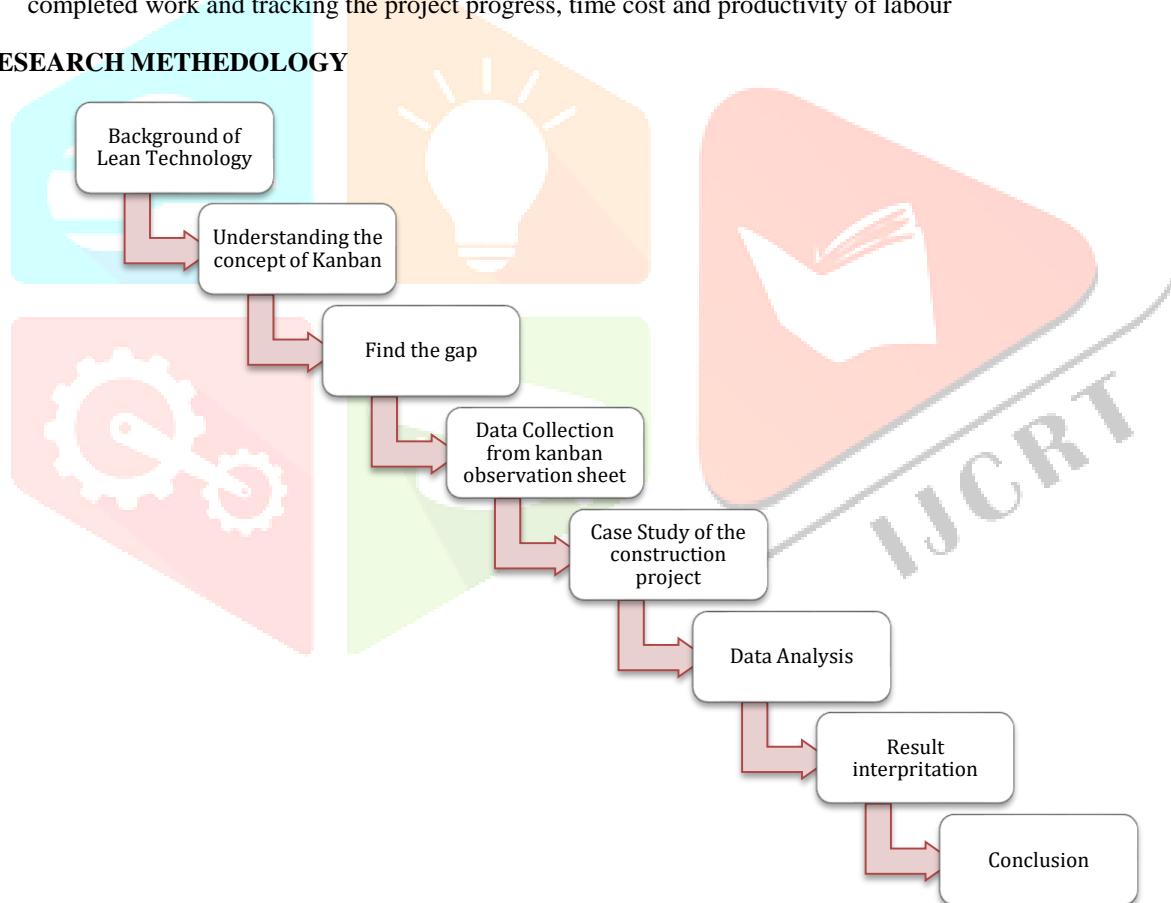
V. RESEARCH METHEDOLOGY

Fig.2. Research Methodology

Problem Statement

In the construction project the planned and actual work has major causes of delay and overrun cost of project. Now in recent advancement of adoption of new techniques and tools of lean construction are generate the value to the project. The kanban tools used for case study of construction project.

Literature review

Detail study of literature review of background of lean construction, lean construction tools and techniques, most utilized lean construction practice in field of construction, eight waste of construction, kanban method in construction case studied lean construction in Construction management, and planning of a project.

Data Collection

Case study of the two construction project and studied regarding planning actual work or completed work and remaining work. Details collected regarding actual quantity, manpower and cost. Data collection form Construction project case study approach of two project. In this construction project suggested that plan the project by using kanban method and data collection. The first project is Aarambh Vistara Residential cum commercial ten storey project case study carried for Slab Work and the second project is Stellar Residential cum commercial thirteen floor project for the work of Block work and plaster work, plumbing work, M.S. grill work, water proofing & Dado work. For kanban case study on a construction project for project performance, efficiency, productivity and cost. The kanban has three stages Plan the work or Activity (Do), Work in progress (Doing), Work completion (Done). The case study under taken for one month the study of two project situated in Ahmedabad for project.

Data Analysis

Data interpretation for case study of kanban method on construction project by observation and evaluation and Sheet prepared for data interpretation. There are nine activities taken in to consideration. Three activities of Project one is Shuttering work, steel work, casting work of Aarambh vistara. And four activities of Block work, Plasterwork, Plumbing work, waterproofing work, M.S. grill work and Dado work second project Stellar. In kanban move the activities from cloud to do to doing and done stages. Data collection and interpretation sheet is prepared in excel sheet. From kanban tool manage the sequence.

VI. LITERATURE REVIEW

Lean construction concept from Toyota production system to improve and decrease the waste of construction and deliver the project within time limit and create the optimum value of the project. In lean construction last planner system for construction lean supply and lean design and in that major action design, control and improvement in production system and give also broad view to operation research and management science. Lean construction has two direction management of one construction site operation and other direction is design management, supply chain management, cost management to deliver the project. kanban tools from production system to construction system, for material management strategy with list waste generation and decrease the waiting time and physical waste. Kanban is used for inventory management from supplier to site and generates the value of product or project to the customers and by implementing the supplier kanban and value stream mapping collaborate the organization and people. kanban for production process and control, divided into two kanban one is ordering kanban and the second is receipt kanban and also use kanban for safety control, work performance, information transparency, and proper communication, decrease the rate of accidents. Kanban is a valuable system to check the project performance. Kanban in earthwork management. Digital kanban used for reduce waiting time for and decrease the lead time for construction activity and enhance the performance of the excavator. Principle jidoka "Intelligence is used to control the activity of earthwork. In this literature, they considered the pull system for a process one line with a series of activities with their start and finish time with proper delivered material within the construction site under case study of PCC Slab construction and avoid the overstocking of inventory and products or item by using kanban methods

VII. DATA COLLECTION

Data collection form Construction project case study approach of two projects. This construction project suggested that plan the project by using kanban method and data collection. The first project is Aarambh Vistara Residential cum commercial ten storey project case study carried out for Shuttering Work, Reinforcement work, Casting work, and the second project is Stellar Residential cum commercial thirteen-floor project for the work of Block work and plaster work, plumbing work, M.S. grill work, waterproofing & Dado work. For a kanban case study on a construction project for project performance, efficiency, and cost. The kanban has three stages Plan the work or Activity (Do), Work in progress (Doing), and Work completion (Done). The case study undertaken for one month the study of two projects situated in Ahmedabad for a project.

Fig. 3. Aarambh Vistara Project Kanban

7.1. SHUTTERING WORK

For Project Aarambh vistara planning for Shuttering work of block D & E is based on available resources material, Manpower, machinery and past project productivity. Total 14 days for Block D & E, Quantity of 1103 Square Meter. Shuttering material use in this project is ply formwork for beam bottom and sides and M.S. Formwork for Slab shuttering. Nilgiri wood used for centering work.

7.2. REINFORCEMENT WORK

For Project- 1 Planning for Steel work after shuttering work of block D & E is based on available resources material, Manpower, machinery and past project productivity. Total 10 days for Block D & E, Quantity of steel for beam & slab is 33.182 tonne. Tower crane is used for transfer the material for Steel yard to cutting place to binding place.

7.3. CASTING WORK

For Project- 1 Planning for casting work after Reinforcement work of block D & E is based on available resources material, Manpower, machinery and past project productivity. Total 1(17-05-2023) days for Block D & E, Quantity of Concrete casting work for beam & slab is 153 Cubic Meter, M 25 grade is used for basement block E & D slab and beam casting. Tower crane is used for casting work.

Fig. 4. Shuttering Work

Fig. 5. Steel work

Fig. 6. Casting Work

7.4. BLOCK WORK

For Project- 2 Stellar Planning for block work after RCC work of slab, beam, column , For Block work of Block C of Stellar project is planned based on available resources material, Manpower, machinery and according to this plan the. Total 4 (01-05-2023 to 4-5-2023) days for Block C, Quantity of Block work for 13th floor is 836 Square Meter, some material are lifted by material lift but some are manually transport ground floor to 13th floor.

7.5. PLASTER WORK

For Project- 2 Stellar Planning for inside plaster after completion of inside Block work of , For Block work of Block C of Stellar project is planned based on available resources material, Manpower, machinery and according to this plan the. Total 4 (04-05-2023 to 08-05-2023) days for Block C, Quantity of Block work for 13th floor is 1800 Square Meter, some material are lifted by material lift but some are manually transport ground floor to 13th floor.

Fig. 7. Block Work

Fig. 8. Plaster Work

7.6. PLUMBING WORK OBSERVATION SHEET

Plumbing work for Common Bathroom, attached bathroom, Wash area, and kitchen started after completion plaster work. For Plumbing work of Block C of Stellar project is planned based on available resources plumbing material, Manpower, machinery and according to this plan the. Total 4 Days (03-05-2023 to 06-05-2023) for Block C. In Plumbing material CPVC, PVC are used. In this activity only focus on labour work. Quantity of Block work for 9th floor is 4628.74 Square Meter area, by material are manually transport ground floor to 9th floor, not use material lift.

7.7. M.S. GRILL WORK OBSERVATION SHEET

Fabrication work for Balcony railing, window side railing started after completion of plaster work. For M.S. grill work of Block C of Stellar project is planned based on available resources material, Manpower, machinery and according to this plan the. Total 6 Days (05-05-2023 to 10-05-2023) for Block C. Grill material, Welding machine and rode are used. Quantity of M.S. grill work for 1st floor is 164 KG material are used, material are manually transport ground floor to 1st floor, not use material lift.
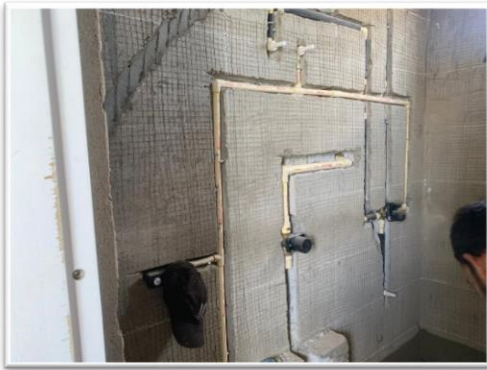
Fig. 9. Plumbing Work

Fig.10. Fabrication Work

7.8. WATER PROOFING WORK OBSERVATION SHEET

Water proofing work for Common Bathroom, attached bathroom, Balcony, wash area started after completion plaster work. Water proofing work of Block C of Stellar project is planned based on available resources material, Manpower, machinery and according to this plan the. In water proofing material PD chemical used for coating and brick used for BBCC waterproofing work. Total 10 (28-04-2023 to 07-05-2023) days for Block C, Quantity of Block work for 7th floor is 1800 Square Meter, some material are lifted by material lift but some are manually transport ground floor to 7th floor.

7.9. DADO WORK OBSERVATION SHEET

Dado work for Kitchen, Common Bathroom, attached bathroom started after completion plaster work. For Block work of Block C of Stellar project is planned based on available resources material, Manpower, machinery and according to this plan the activity. Total 4 (02-05-2023 to 05-05-2023) days for Block C. 1200 x 2400 mm Tiles, cement, sand materials are used for dado work. Quantity of Block work for 13th floor is 1800 Square Meter, some material are lifted by material lift but some are manually transport ground floor to 7th floor.

Data collection is carried out by visual inspection, Daily progress report, and daily labour report and by communicating with senior engineer, Project manager of Vistara and stellar Project.

Fig. 11. Waterproofing Work

Fig. 12. Dado Work

VIII. DATA INTERPRETATION

In shuttering work of basement floor block D & E for To do planning the work at the date of 15 days, activities start as per planned date by the activities from to do to work in progress section, and monitor till the completion of shuttering work and finish date is 17/5/2023. From the data observation sheet measures the total quantity of work actual cost and delay of that particular activities. By visualizing this shuttering activities for further work of other Slab shuttering work progress manage properly. Daily manage the kanban visual board Maintain activity work flow easily by managing all resources. The planned cost is 4,96,931/- Rs and actual cost of shuttering work is 5,20,884/- Rs. Overall slab Shuttering work of D & E block is increased and project also delay 28 % and complete 72% as per planned date.
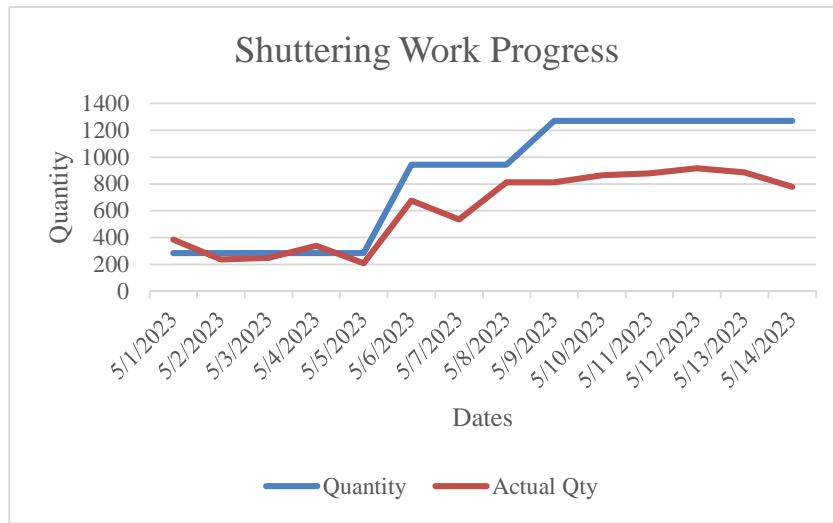
Fig. 13. Shuttering work Progress

In Steel work of basement floor block D & E for To do planning the work for 10 days, activities start as per planned date by the activities from to do to work in progress section, and monitor till the completion of steel work and finish date is 19/5/2023. From the data observation sheet measures the total quantity of work actual cost and delay of that particular activities. By visualizing this reinforcement work activities For further work of other Slab steel work progress manage properly. Daily manage the kanban visual board Maintain activity work flow easily by managing all resources. The planned cost is 23,08,030/- Rs and actual cost of steel work is 23,17,765/- Rs. Overall slab steel work of D & E block is increased and project also delay 57 % and complete 43% as per planned date.

In Casting work of basement floor block D & E for To do planning the work at the date of 17/5/2023 , activities start as per planned date, the activities moves from to do to work in progress section, and monitor till the completion of casting work and finish date is 21/5/2023. From the data observation sheet measures the total quantity of work actual cost and delay of that particular activities. By visualizing this Casting activities for further work of other Slab casting work progress manage properly. Daily manage the kanban visual board maintain activity work flow easily by managing all resources. The planned cost is 6,22,155/- Rs and actual cost of steel work is 6,56,235/- Rs. Overall slab Casting work of D & E block is increased and project also delayed by 3 days.
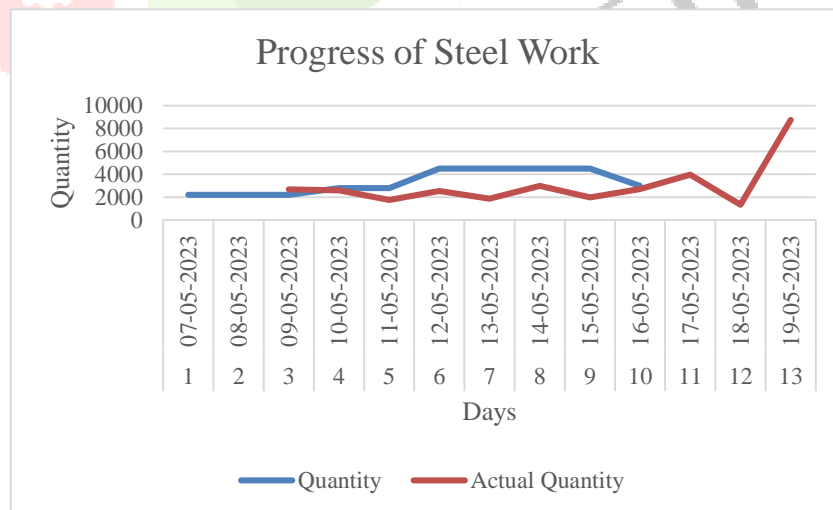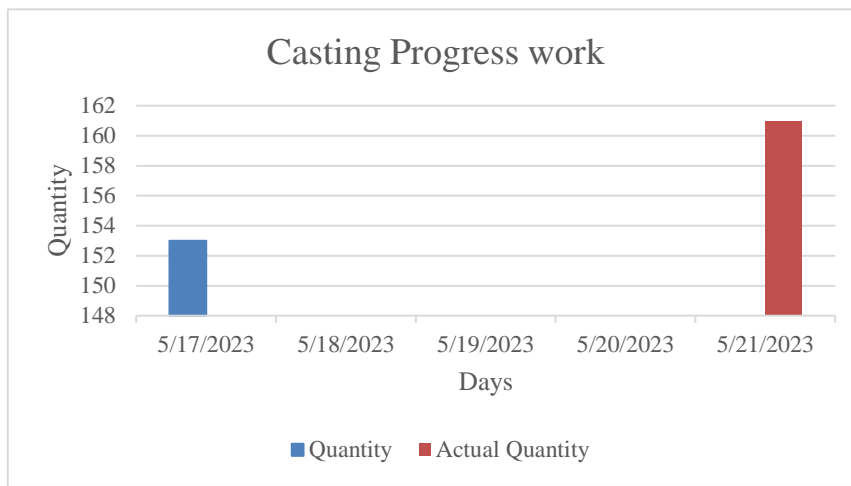

Fig. 14. Steel work progress

Fig. 15. Casting work progress

Block work in block-C at 13th floor activity is considered for planning date is 1/5/23 & the start activity on planning date but delay two day from ending date of 4/5/2023 , activities start as per planned date, the activities moves from to do to work in progress section, and monitor till the completion of Block work and finish date is 6/5/2023. From the data observation sheet measures the total quantity of work, actual cost and delay of that particular activities. By visualizing this block work activities for further work of other floor and block casting work progress manage properly. Daily manage the kanban visual board maintain activity work flow easily by managing all resources. The planned cost is 6,32,920/- Rs and actual cost of steel work is 6,72,970/- Rs. Overall Project progress of Block work of C block percentage plan completion is 63.27% remaining work percentage is 36.73% which is completed after 3 days.

Plaster work of block C 13th floor planning for four days , activities is not get started as per planned date, the activities moves from to do to work in progress section, and monitor till the completion of plaster work and finish date is 11/5/2023. From the data observation sheet measures the total quantity of work actual cost and delay of that particular activities. By visualizing this plaster work activities for further work of other Block & floor work progress manage properly. Daily manage the kanban visual board maintain activity work flow easily by managing all resources. The planned cost is 7,62,500/- Rs and actual cost of steel work is 7,84,200/- Rs. Percentage plan completion of this activities up to plan finish date 8/5/23 is 44.83% & delay by 3 days of percentage 55.17% completed at 11/5/23.
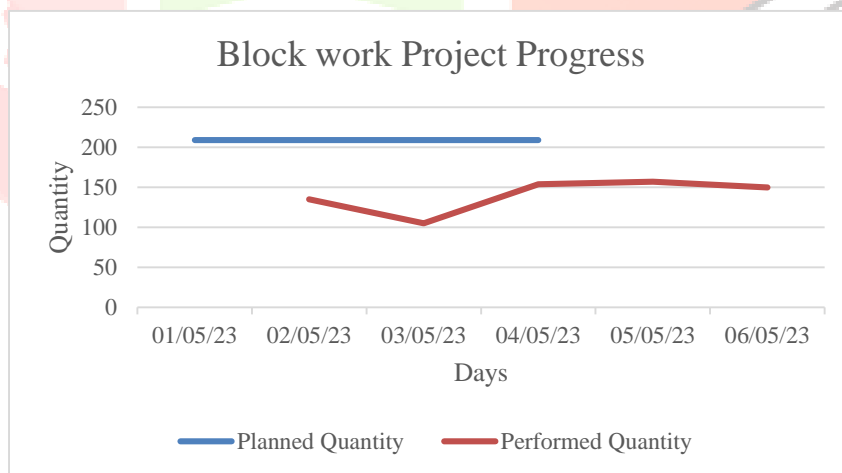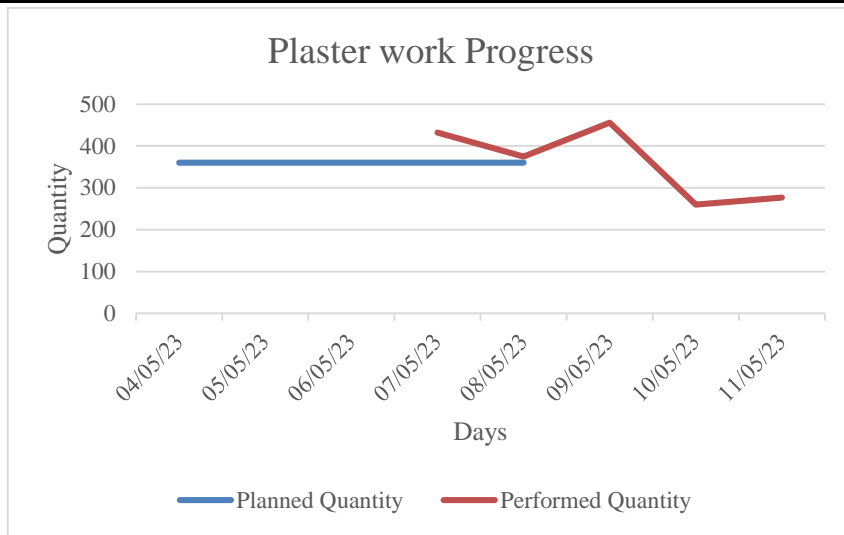

Fig. 16. Block work progress

Fig. 17. Plaster work progress

Plumbing work of block C first floor planning for five days, activities start on 5/5/2023 date, the activities moves from to do to work in progress section, and monitor till the completion of casting work and finish date is 6/5/2023. From the data observation sheet measures the total quantity of work completion incoured cost of work and delay of that particular activities. By visualizing this plumbing work activities. There are two part water supply system and drainage system in water supply both hot and cold water CPVC pipe are used and for drainage PVC pipe are used. Only labour cost calculation are taken in to consideration. Every day activities manage by the kanban visual board maintain activity progress and track the project easily by managing all resources. The planned cost is 99,517/- Rs and actual cost of steel work is 99,517/- Rs. In this activity given to contractor as per Toilet slab area rate. Plumbing work of C block start on 5/5/2023 and completed on 10- 5- 2023, activity delay by 2 days and extra 4 days are taken for completion of work.

M.S. grill work of Block C 1st floor planning for days , activities started on date of 7/5//2023, the activities moves from to do to work in progress section, and monitor till the completion of M.S. grill work and finish date is 13/5/2023. From the data observation sheet measures the total quantity of work actual cost and delay of that particular activities. By visualizing this M.S. grill work activities for further work of other M.S. grill work progress manage properly. Every day manage the kanban visual board maintain activity work flow easily by managing all resources. The planned cost is 24900/- Rs and actual cost of steel work is 29719/- Rs. Fabrication work percentage plan completion is 53.72 and remaining 46.28 up to date 13/5/2023 and project also delayed by 3 days
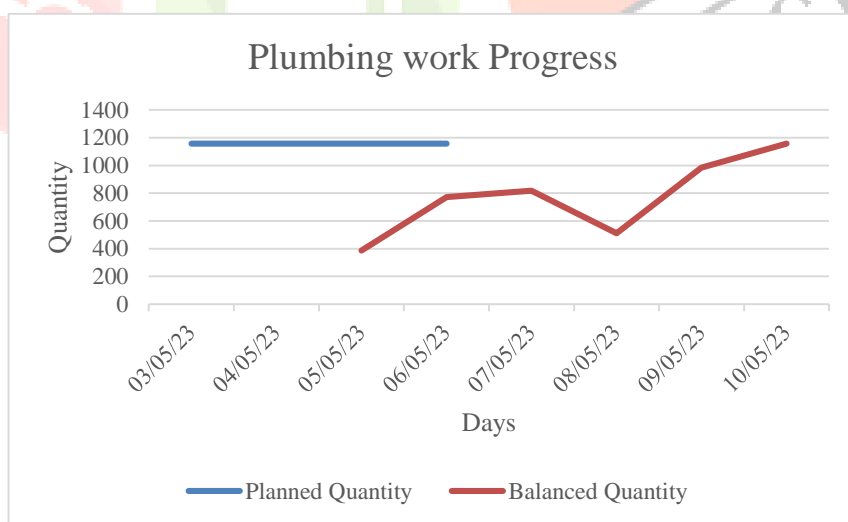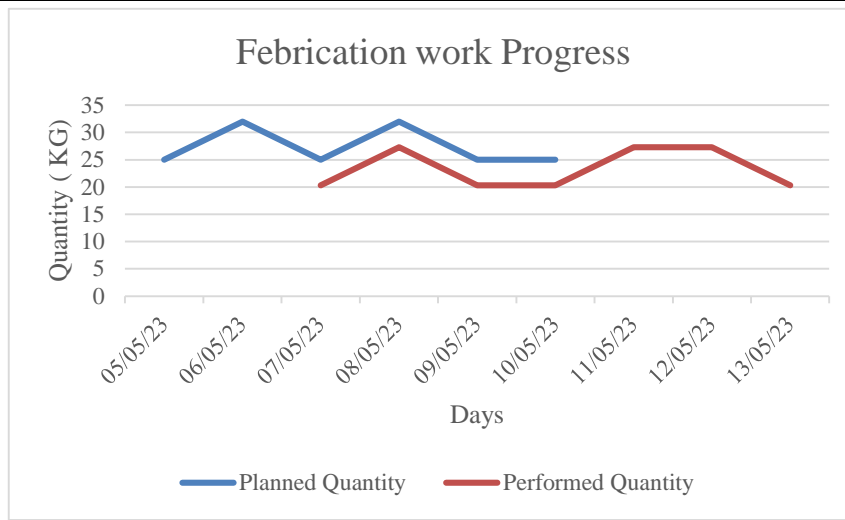

Fig. 18. Plumbing work progress

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Fig. 19. Fabrication work progress

Water proofing work of Block C 6th & 7th floor planned on date of 28/4/2023 , activities was not start as per planned date start on 1/5/2023, the activities moves from to do to work in progress section, and monitor till the completion of casting work and finish date is 10/5/2023. From the data observation sheet measures the total quantity of work actual cost and delay of that particular activities. By visualizing this waterproofing activities for further work of other block and floor progress of work manage properly. Daily manage the kanban visual board maintain activity work flow easily by managing all resources. The planned cost is 71,780/- Rs and actual cost of steel work is 94,530/- Rs. Percentage plan completion as per planned date is 66.66% and 33.34% completed on date of 10-5- 2023. Overall water proofing work and project also delayed by 3 days.
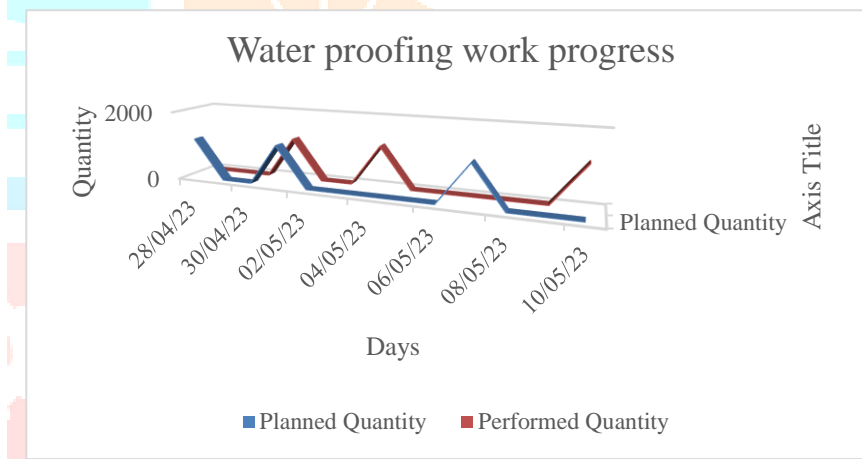

Fig. 20. Fabrication work progress

Dado work in Block-C at 7th floor in Kitchen and toilet area. This work planned four days, activities start on the date of 5/5/2023, the activities moves from to do to work in progress section, and monitor till the completion of Dado work and finish date is 9/5/2023. From the data observation sheet measures the total quantity of work incurred cost and delay of that particular activities. By visualizing this Dado work activities for further work of other floor and Block for this activities and manage the progress of activities and track the project task properly. Daily manage the kanban visual board maintain activity work flow easily by managing all resources. The planned cost is 15,74,020/- Rs and actual cost of steel work is 15,85,220/- Rs. Project percentage plan completion up to planned date is only 6 % and 93.81 % activity complete on date of 9/5/2023 this activities delay by 4 days.
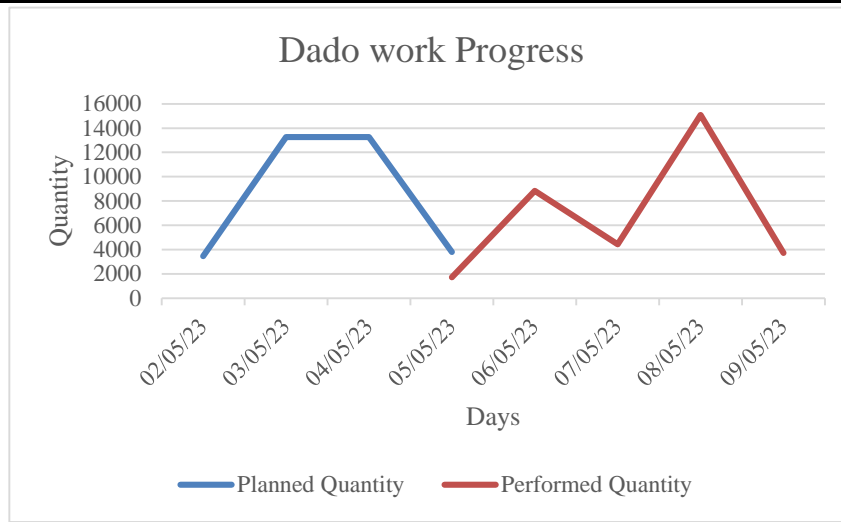
Fig. 21. Fabrication work progress

IX. CONCLUSION

In this innovative world construction sector play major role in the development sector. Project has different stack holder to manage the entire project deliver with the time limit with good quality. Cost, time, project progress and tracking of the project are major factor to focus on. Thus the lean construction tool kanban represented the visual chart and manage project by considering time, cost and percentage completion of the project as per planned time. Kanban reduce the delay of project and achieve productive work by communication with the team member and achieve project efficiency. In this case study two project are consider and total 9 no of activities were monitor and analysed. This activities are : 1) Shuttering work, 2) Steel work, 3) Casting work, 4) Block work, 5) Plaster Work, 6) Plumbing Work, 7) M.S. Grill work, 8) Water Proofing work, 9) Dado Work. Percentage plan completion for shuttering work is 72%, steelwork is 57%, casting work is 100%, Block work is 63%, plasterwork is 45%, plumbing work is 53.71%, M.S. grill work is 54%, water proofing work is 66%, dado work is only 6.13% as per schedule date. By this method found that delay in the work, Labour cost effect, and low percentage completion. In shuttering activities cup lock system is used instead of teka increase the speed of work, steel work cutting bending plat form provide near the location of the that achieve work as per schedule date, for finishing activity material, tools, equipment transportation from ground floor storage to the work location or floor reduce the work time and labour cost, start to start dependent activity don't get affected by each other and smoothly work as per planned time. By using kanban visual planning, tracking of the project and give better coordination between all stock holders.

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