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Developing Framework to Optimize the Preparation of (EOT) Claims Using Integration of (LPS) and (BIM) Techniques in Construction Projects

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ABSTRACT

Construction projects face delays and disturbances that could be caused by one of the contracting parties, both of them, or beyond their control. Proving the delay needs a significant effort to introduce all details, documents, and records which explain the causes of the delays. The contractor needs to submit a claim, whether it is extension of time (EOT) claim or any claim with an adequate definition, causation, liabilities, analysis of delays to get an extension of time-related to the risk event. Claims preparation processes need to be collected and documented daily throughout the project phases, especially during construction phases. Lean Construction, with its common technique, the last planner system (LPS), and building information modeling (BIM) have significant synergies and can bring benefits when implemented together to support the preparation of the extension of time (EOT) claim. Building information modeling used as a digital platform to facilitate communication between the project team, improve project performance, and implement the last planner system (LPS) phases effectively. (LPS) is enhancing the coordination within the project team.

The primary purpose of the research is to develop Framework to Optimize the preparation of extension of time (EOT) Claims Using Integration of the last planner system (LPS) and building information modeling (BIM) Techniques in Construction Projects. The integration will represent in implementation of the appropriate (BIM) functionalities along with the five phases of the last planner system (LPS). As a result of the integration, the inputs and outputs well documented, which considered as the primary support to the processes preparation of the extension of time (EOT) claim. Also, The framework supported by process flowchart to clarify outputs, inputs, and the project team's responsibility, Which will contribute to optimizing the preparation of the extension of time (EOT) claims.

KEYWORDS: Lean, Building Information Modeling (BIM), Last Planner System (LPS), Extension of Time (EOT), Delay, Integration, Benefits, Weekly Work Planning (WWP), Percent Plan Complete (PPC), Daily Huddle Meeting, KanBim, Kanban, 4D-Modeling, 3D-Modeling.

1. INTRODUCTION

Delays are the main problem which faces the construction projects. Delays have many negative impacts on the project objectives such as increase project completion date, project costs overruns, contract termination, loss of productivity and effect on the relationship between owner and contractor as disputes, litigations, and liabilities [1]. Delays lead to the emergence of claims and disputes [2]. Construction delays classified into four major categories [3]; one of them is an excusable delay. An excusable delay is a delay that cannot be controlled by the contractor. The contractor needs to submit the extension of time (EOT) claim into the owner to rectify the delay. (EOT) the application involved, completed relevant facts, records, documents with the appropriate analysis method of the delay event [4], and identifying analyzing the causes of the delay [5].

Construction projects in recent years are becoming more extensive than before and more complicated. So the main concern is the need to develop and optimize the project management process. One of the recent approaches that developed to overcome the challenges faced by traditional project management techniques, Lean construction, and building information modeling (BIM). Lean construction focusing on understanding the construction as a production and planning process. The last planner system (LPS) is the most common lean construction techniques. The last planner system (LPS) aims to reduce variability and

to enhance the reliability and predictability of the workflow for production planning and controlling and manage the construction process. Building information modeling (BIM) is one of the significant techniques which evolved to use in the construction project and facilitates the collection of the project information digitally, which leads to reduce project cost and duration, enhances communication between the project team. The integration between BIM and LPS in construction leads to improve productivity and performance overall the project [6]. Also, the integration helps construction companies to reduce lead time, delays, and improve project sustainability [7].

1.1.Problem Statement

Project delay has to become a common problem in construction projects. Contractors subjected to facing risk events, which led to delays in the work. Therefore, the contractor should submit a claim to prove his problem. Otherwise, he will find himself subjected to Liquidated damages for reasons within the client's control, not within his control.
In construction projects, the preparation of extension of time (EOT) claim of the excusable delay events needs significant efforts to identify activities and liabilities, applying delay analysis, specify causes and effects of each event, and substantiate evidence. Achieving the steps of (EOT) claim preparation needs to collecting and organizing the documents throughout the project life cycle. BIM supports and enhances the communication between the project team and receives the information digitally. (LPS) supports the planning and control of the workflow. Integration between BIM functionalities, at the five phases of the last planner system, "collaborative programming, make ready-lookahead planning, weekly work planning, daily huddle meeting, measurement, and learning" will help to collect and organize the documents and enable the contractor to prepare (EOT) claim.

1.2.Research Objective

The usability of BIM has provided a means for increasing total project quality, providing accurate scheduling timetables, yielding quantity take-offs, and diminishing total project costs. The Last Planner System (LPS) provided a well-defined process for planning, scheduling, and controlling a construction project. Integration between building information modeling and the last planner system has a positive effect

on the implementation time of the construction projects, and support the construction practitioners to improve project planning and control.
This research aims to develop a framework to optimize preparation (EOT) claims using the integration between BIM functionalities and the last planner system at the five phases of (LPS) in construction projects. The framework developed to ensure that a claim submission contains all the relevant and necessary information to prove the event, and the documents placed in an easily understood manner, which leads the reviewer to a logical conclusion to demonstrate the claimant's entitlement.

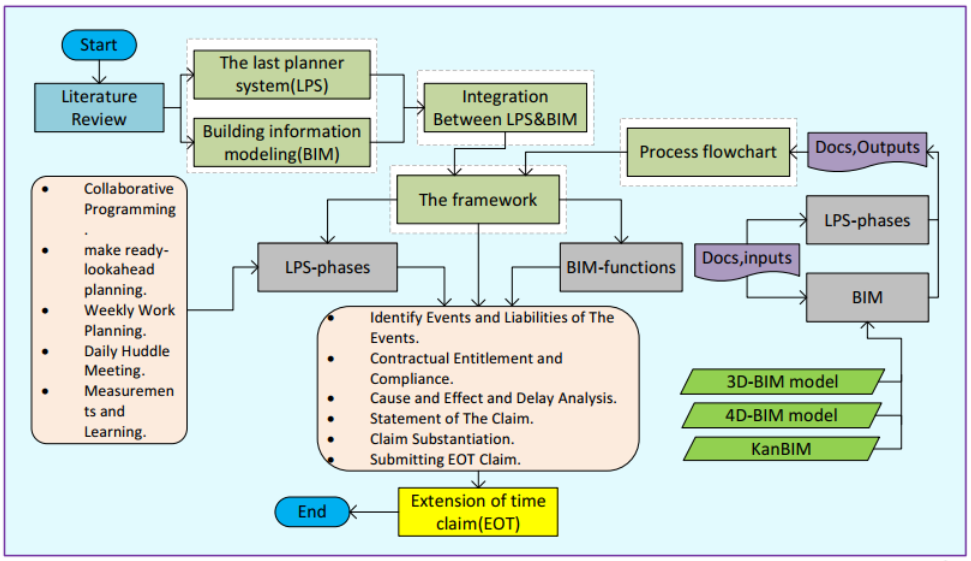

Figure 1: Sequence of Research Methodology

1.3.Research Methodology

The first part is a literature review about the last planner system (LPS) and a literature review
of the building modeling (BIM). The research methodology is divided into four parts, as described below, figure (1).
The second part is the integration between the last planner system and building information modeling throughout the project phases, the integration in the construction management system, and the benefits of the interaction.
The third part is developing a framework of using the integration between the last planner system and building information modeling at

the five phases of the last planner system, and description of the preparation steps of the extension of time claim (EOT).

The fourth part is supporting the framework by using process flowchart to describe the integration between LPS and BIM, the documents that generated during inputs and outputs at each phase, the responsibility, and the relation between the documents that support the preparation steps of extension of time (EOT) claim.

2. REVIEW OF LITERATURE

2.1.The Last Planner System (LPS)

Lean production principles developed in Japan by the production engineering leadership of Taiichi Ohno [8]. Lean production principles resulted from the Toyota Production System (TPS) [9]. [10], introduced a new production theory that includes a combination of lean production and other production theories, this new production theory applicable to construction and constitutes the basis of lean construction.

Lean construction is a way to design production systems to minimize waste of materials, time, and effort to generate the maximum possible amount of value [11]. The last planner system (LPS) is the most application in Lean construction techniques [12]. (LPS) developed for managing construction projects, minimizing the negative impact of variability, enhancing the reliability, predictability of workflow for production planning and control [13]. the last planner system is a collaborative planning process that seeks to engage all team members of the project to gets closer to doing the work. It focuses on improving relations and collaboration between project parties, measuring the stability of work plans [14]. (LPS) helping the project team to overcome the problem that exists from the contract. (LPS) specifies the reasons for the project variances, achieving continuous improvement through PPC measurements. Also, the project can be completed successfully by project team participants in WWP and eliminating and mitigating the problems that exist from the project structure [15].

Steps of the Last Planner System

[16]stated that the steps of the LPS composed of collaborative programming, which helps the project team to know each other, identify, and collect the problems to solve it. Make–Ready Plan that is ensuring the assignments are ready for installation, identifying constraints, and

participation in new operations [17]. Weekly work Plan for monitoring the current activities at the site, planning the work in the next week, strengthen the relations between project parties to get reliable promises, commitments, and executions, increase experiences, improvements, and learning. Then Daily Huddle Meeting for monitoring and controlling the production to keep tasks on track as planned. Measurement, Learning, And Continual Improvement are the basis of evaluation that takes place within the WWP meeting. Learning to reduce repeated failures. PPC measures the predictability of task delivery, the percentage, and reliability of promises. Figure (2) shows the last planner system steps.

2.2.Building Information Modeling (BIM)

Building information modeling (BIM) has enjoyed rapid growth in its use in the architecture, engineering, and construction (AEC) projects [18]. Figure (3) shows the cycle of building information modeling. BIM described the geometry, spatial relationships, geographic information, quantities, properties of building elements, cost estimates, material inventories, and project schedule [19]. BIM using effectively at many parts of construction project design verification, estimation, and preconstruction, digital information [20,21]. (BIM) visualizes the production in the form of 3D-Models [22]. 3D-Model can understand and communicate together [23]. BIM provides a platform for improving project efficiency [24]. (BIM) has essential characteristics as coordination, simulation, optimization, visualization information [25]. also, preparing alternative sequences of tasks [26], predicting of logistics problems [27], discovering spatial conflicts between activities [28], monitoring the status of discrepancies [29], enhancing site layouts [30], and analysis of workspace overstock [31]. BIM can address the process of planning and controlling logistics operations for prefabricated building systems [32].

BIM Benefits

Building information modeling in continuous development and became as a suitable technology for representing building in semantic and geometric description [33]. The benefits of BIM classified according to three different applications in the construction industry. The first is Building Design, BIM, provides a comprehensive approach for evaluating design options [34], utilizing BIM in the early stages of the project life cycle for understanding the scope of work [35]. The second

is building construction, BIM, allows all parties from different disciplines to updating and tracking the project documentation by utilizing a traceable and effective methodology [36]. The third is uilding operation and maintenance management, BIM, visualizes any potential failures for buildings due to natural hazardous or malicious events, which facilitate the implementation of forensic analysis [37].

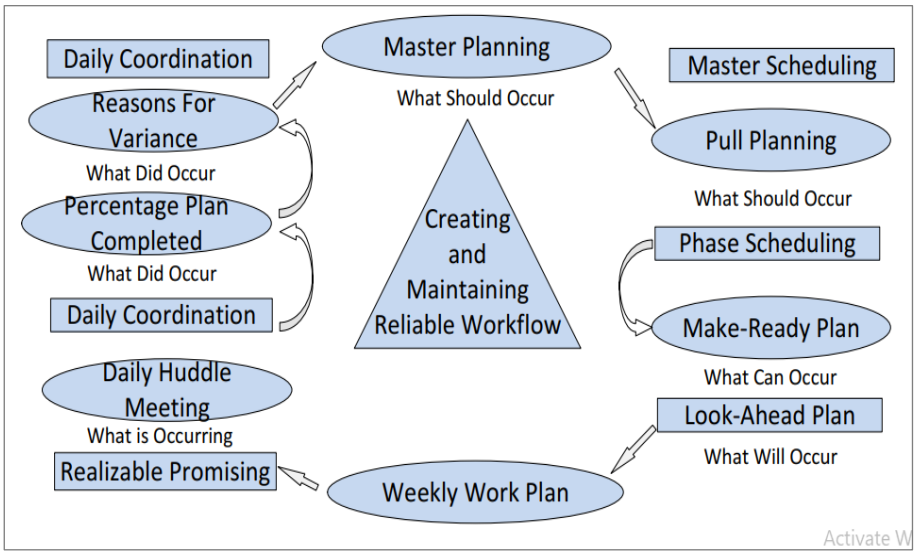

Figure (2) Steps of the Last Planner System-[16]

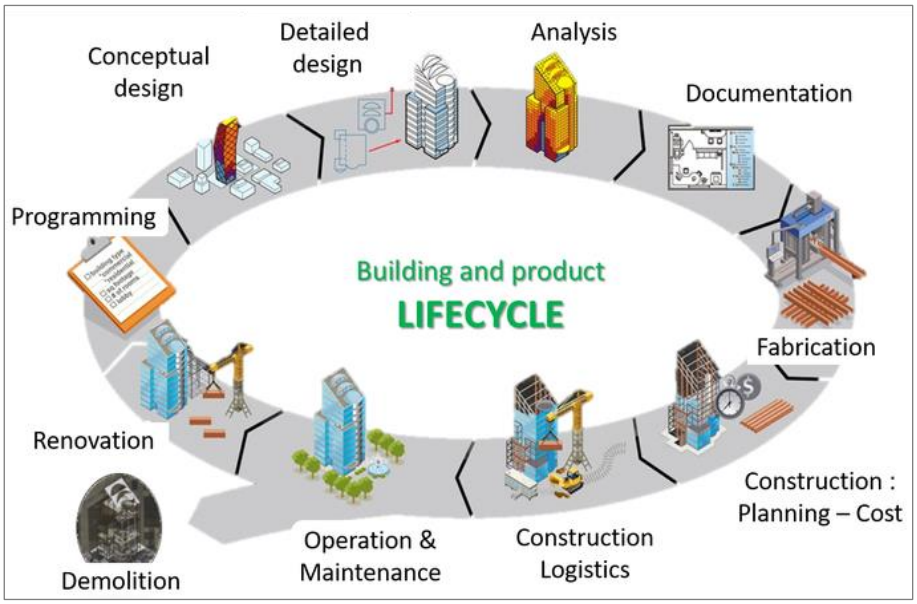

Figure (3) the cycle of building information modeling.
(https://prodbim.wordpress.com/what-is-bim/)

2.3. Integration Between The Last Planner System and Building Information Modeling

In recent years construction companies utilized the integration between lean construction and BIM to get the benefit from their implementation. [38] stated that building information modeling (BIM) and the last planner system (LPS) using to reduce construction delay by enabling the construction practitioners to control construction processes, reduce project duration, and overhead cost. [39] studies that there are synergies between lean construction and building information modeling that results in useful improvement the productivity. [40] establishing a framework for incorporating building information modeling functionalities 3D-Visualisation, 4D-Scheduling, and MEP (Mechanical Electrical Plumbing) clash detection into the last planner system to improve the workflow during the construction project phase. due to this integration increase collaboration between all project participants, Request For Information decreased, and change orders reduced, adding value and increase customer satisfaction. [41] focusing on the implementation of LPS weekly work plans (WWP) in two BIM-Based building design projects to improve workflow, based on the perspective of [22] interaction matrix. [42], investigating the role of lean practices that enabling BIM adaption by using a case study of two projects in India, one of them only using BIM technology for enhancing decision making, and the other project implements the last planner system after using BIM for improving coordination. [43] represents the potential participation of BIM to visualize the product and the process of construction projects in terms of lean construction principles. they discussed some examples of utilizing BIM and related technology to reduce the variability of the construction process. [22] presented a study that mentioned a comparison between 24 principles of lean with 18 BIM functionalities and providing the interaction between lean principles and BIM functionalities. Due to these interactions, the results consist of 52 positive interactions from 56 total interactions. The interactions occurred in different project phases, such as predesign, design, fabrication, preconstruction, and construction. [44] utilized the interaction between the Lean construction principles and BIM functionalities and developed the interaction matrix of BIM and lean the construction principles in the construction phase and explained the several interactions through each BIM functionalities. Figure (4) shows the number of interactions of Lean

Construction principles. Figure (5) shows the interaction of BIM functionalities with Lean principles.

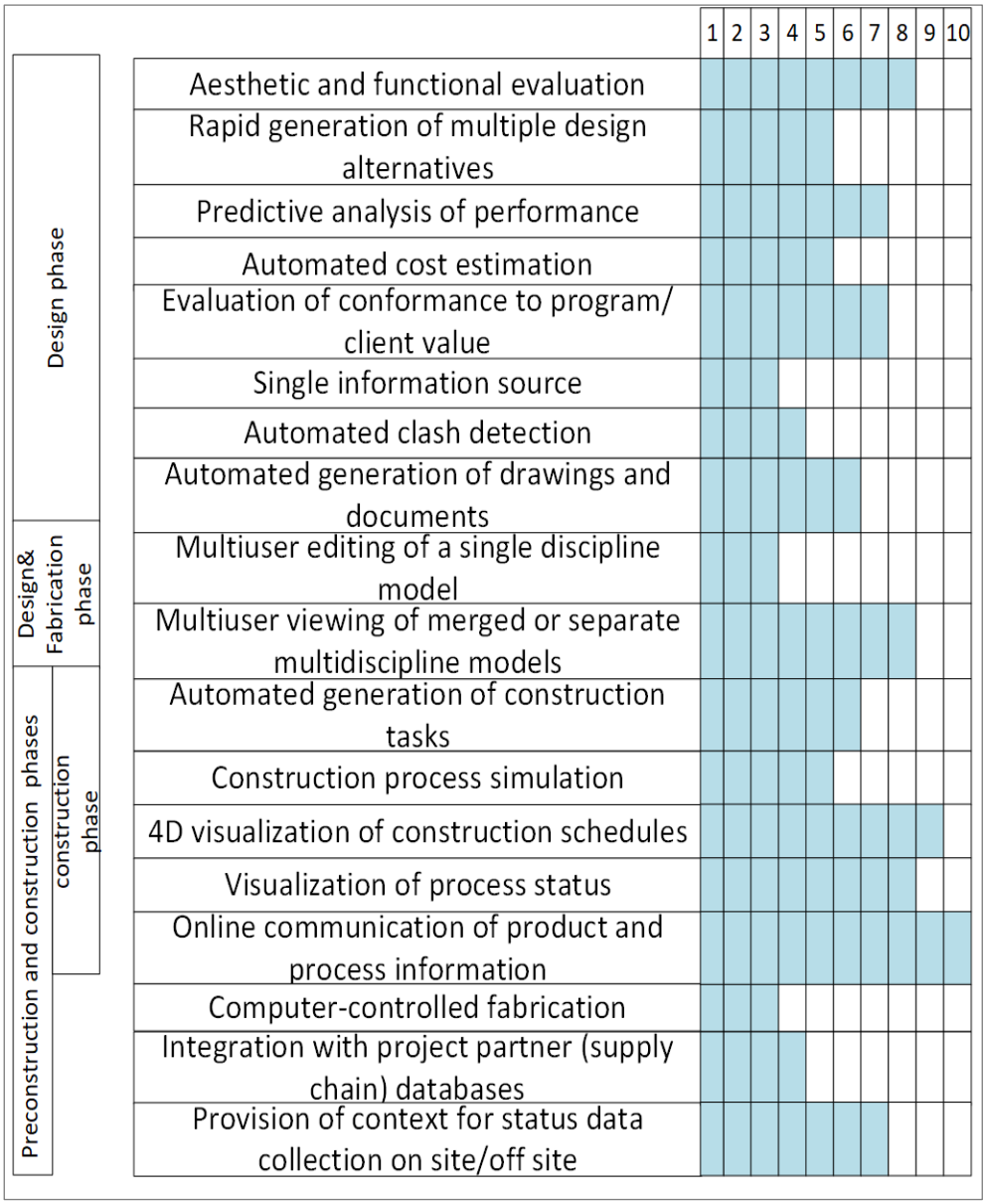

Figure (4) the number of interactions of Lean principles with BIM functions [44]. (Amended by ((Burguete, M. G, 2018)).

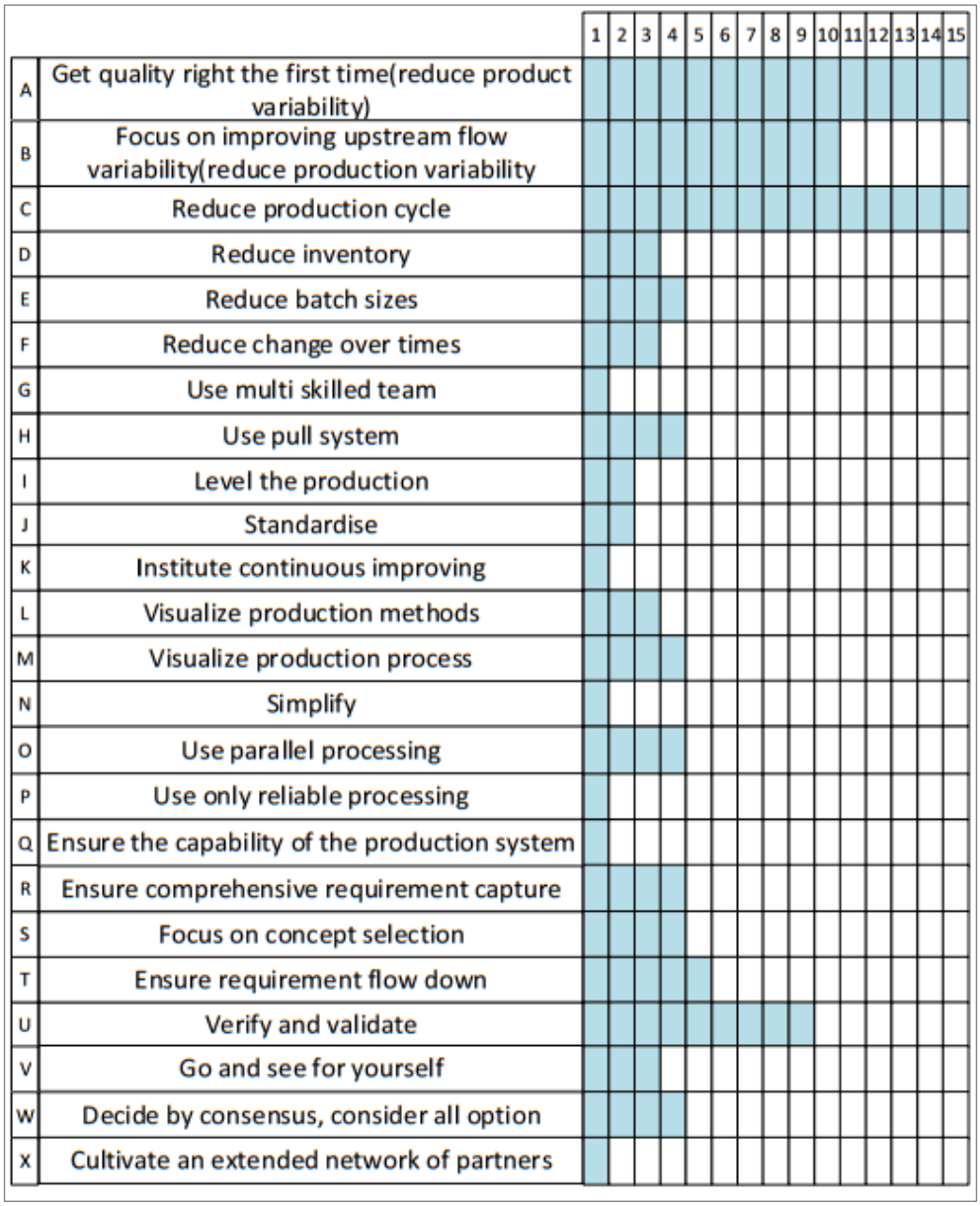

Figure (5) Amount of interactions of BIM functionalities with lean principles [44].

Integration of BIM and LEAN in Construction Management Systems

Communication problems exist in construction projects due to some factors as weak in preparation of the status reports, the reliance of paper documents rather than soft copy in production information, and site conditions [22]. Due to the dynamic production in construction projects,

the control needed, so to overcome this problem, there are some construction management systems such as VisiLean [39], BeaM! [45], and KanBIM; KanBIM approach generated to support the pull system in LPS by using the information technology. The term of KanBIM comes from Kanban, which is a system that provides flow signal to the workers and allows them to adjust the workflow by visualizing the process, also provide the labor with process status, managing the flow of construction operation day-to-day. Figure (6) shows crew leader reporting work status in Kanbim.

The Benefits of The Integration Between LEAN and BIM

Lean construction and BIM have the same orientation to improve productivity, efficiency, quality, as well as monitoring of cost. Therefore, that synergy and mutual added-values expected from applying them [45], the potential features that developed from the interaction between lean construction and BIM approach as follow: Visualization, Scheduling. Site layout, Safety management, Clash Detection, Constructability, Monitoring.

Figure (6) crew leader reporting work status in Kanbim(Sacks 2010)

3. THE FRAMEWORK TO OPTIMIZE THE PREPARATION OF (EOT) CLAIMS USING INTEGRATION OF LPS AND BIM TECHNIQUES IN CONSTRUCTION PROJECTS

Integration between Last Planner System and Building Information Modeling, this approach enables the contractor to prove the delays and create proper support of the claim for extension of time to avoid liquidated damages or penalties. The following tables (1,2,3,4,5,6) shows an explanation of the integration between LPS and BIM at the five phases of the LPS, the preparation steps of the extension of the claim,

and the optimization (EOT) claim preparation throughout the integration. The framework will be addressing two stages; the first stage developed to explain the integration between the last planner system and building information modeling. The second stage described the steps of creation and submission of (EOT) claims through the integration.

In the first stage, The integration depicted the process of the last planner system and the functions of the building information modeling. BIM functions organized under three groups, (3D-Modeling,4D-Modeling, KanBim), used as inputs throughout the integration with the last planner system, and arranged as per the phases of the last planner system. To exploit all documents and records that generated during each stage and using these outputs that resulted from the integration to optimize (EOT) claims preparation. Figure (7) shows the flowchart of the correlation between LPS and the functions of the BIM at the five (LPS) phases with three groups (3D, 4D, and KanBim). Figures (8,9,10,11) display some documents used in recording information on the work status, issues, and risk events.

In the second stage, The steps of creation and submission of the claims through the integration to prepare an extension of time claim, this will be based on the inputs and outputs of the interaction of the last planner system and building information modeling. These results and information will be collect and organize to get a proper claim (EOT). Figure (12) shows the framework of the integration between LPS and BIM to optimize the (EOT) claim preparation.

The process flowchart developed to support the framework. The process flowchart contains the integration between the last planner system with its five phases, the documents that used among (LPS) phases, the documents which resulted from the integration, responsibilities, and the Building Information Modeling. The integration at each (LPS) phase will generate reports, whether arising from the inputs or the outputs of the integration. These documents will be organized and discussed in the weekly work plan for (EOT) claim preparation. Figure (13) shows a process flowchart of the integration between LPS and BIM with the documents for the development of the (EOT) claim.

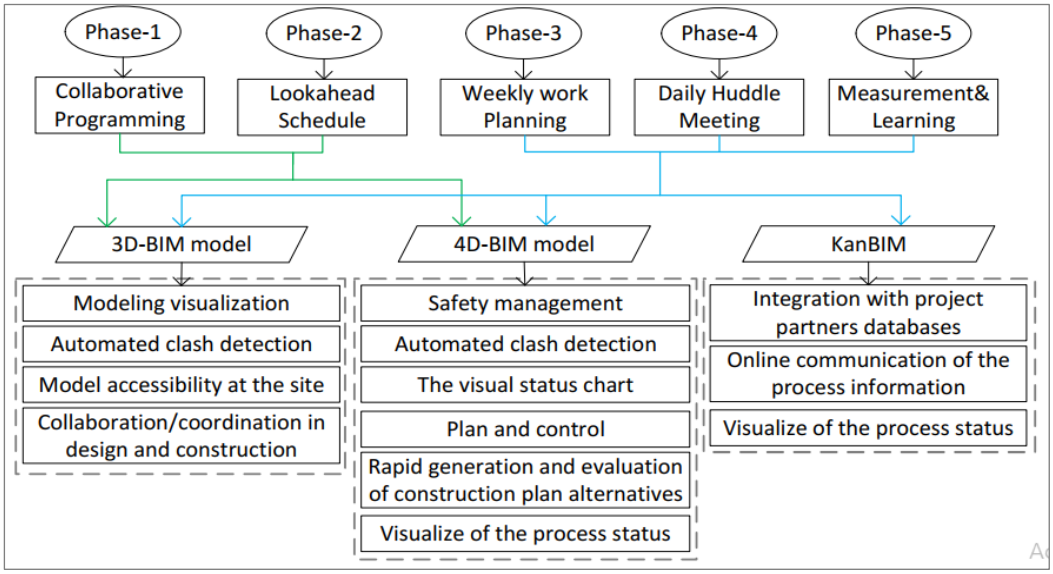

Figure (7) the flowchart of the correlation between BIM functions and LPS at the five phases of the LPS on three groups (3D,4D, and KanBim)

Lookahead Plan Constraint Log		**Company:**						
Project	.....	**Contract Manager:**						
Phase	.....	**Prepared By:**						
Area	.....	**Date Prepared:**						
No	Name of Constraint	Explanation	Preventive Action	Responsible Person	Deadline	Comments	Fixed	Status

Figure (8) lookahead plan constraint log

Detected Problem Based on Meeting		**Company:**					
Project	.....	**Contract Manager:**					
Phase	.....	**Prepared By:**					
Area	.....	**Date Prepared:**					
No	Department	Name of Problem	Explanation	Responsible Person	Cause	Status	
						Internal	External

Figure (9) Detected problem based on meeting

Make Ready		**Company**														
Project	.....	**Contract Manager**														
Phase	.....	**Prepared By**														
Area	.....	**Date Prepared**														
ref	Task Description	Program start date	Responsible party	Information				Pre-req		Resources				Can Do	Notes
				Contract/ instr.	Deasign	RFIs	Mthd Stmt	Weather	Tasks	Plant	Labour	Space	Materials		

Figure (10) make Ready

Weekly Work Progress		**Company:**																												
Project	.....	**Contract Manager:**																												
Phase	.....	**Prepared By:**																												
Area	.....	**Date Prepared:**																												
No	Department	Items	W1							W2							W3							W4						
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28

Figure (11) Weekly Work Progrss

Table (1) shows explanation of the framework including stages of the integration, (LPS &BIM, EOT preparation, Optimization)-Phase (1)

Stage1	Phase	LPS	BIM-Functionalities	BIM-DOCs	Stage2	Preparation of EOT Claim	Optimizing the preparation of EOT Claim
The First Stage, Integration Between LPS and BIM	Phase-1-Collaborative Programming (Phase Planning)	**Work structuring:** consists of the work that allocated, sequencing, etc. and produce master and phase schedule. **Master schedule:** includes milestones, project dates, and phases. **Phase schedule:** includes work plans, task durations, resource loading, logistic plans, and organization chart, etc.	**Modeling Visualization:** Visualize the project at the object level, facilitating communication, understanding of the work efficiently.	3D-BIM	The Second Stage, Creation and Submission of The Claim	**This part consists of the steps of the creation and submission of the claims through the integration claims preparation. This based on the inputs and outputs of the integration of the last planner system and building information modeling. These results and information will be collected and organize to get a proper claim (EOT) in the following steps:** **<u>1- Identify events and liability of events:</u>** The contractor identifies the events by the circumstances that give rise to change, causing the delay, and identify the responsibility. Events collect from the site as "work status, reports, photos, daily meetings " or receiving official changes, also the documents, and the records that issuing by using BIM applications. The information will be discussed and analyzed in the weekly work plan to identify the events giving rise to the claim and identify the liability of the risk events.	**Due to the integration in phase-1 between LPS and BIM**: The preparation of the EOT claim optimized by preparing the master schedule and the detailed planned schedule, which considered the baseline schedule. The baseline schedule included cost, resources, sequencing, etc. The baseline schedule will be simulated and visualized by applying 4D-Modeling for detecting any clashes between different disciplines to get a clear Baseline schedule. Preparing a trustful baseline schedule considered as the main item in the process of the delay analysis to visualize and compare the variances and recording the activities that impacted by the risk events, the delays for each affected task, and specify the delays of the project completion date.
			Automated Clash Detection: Detect and resolve the clashes among discipline, and activity sequencing, reduce time wastes and decrease variability.	3D&4D-BIM			
			Safety Management: Detect any potential safety issues. Filtration of the tasks causes the risks, adjust the activity sequence.	4D-BIM			
			Rapid Generation and Evaluation of Construction plan: 4D-BIM enable the project controller to predict construction phase, task sequences, loading resources, simulation of construction plans, validation of construction sequences.	4D-BIM			

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Table (2) shows explanation of the framework including stages of the integration, (LPS &BIM, EOT preparation, Optimization)-Phase (2)

Stage1	Phase	LPS	BIM-Functionalities	BIM-DOCs	Stage2	Preparation of EOT Claim	Optimizing the preparation of EOT Claim
The First Stage, Integration Between LPS and BIM	Phase-2- Make Ready (Lookahed Planning)	**Look-ahead Planning:** details of the project budget and schedule, coordination map, and completion of the deliveries, controlling of workflow, pulling resources on the tasks. The tasks become ready for implementation by the schedule program. **Make a ready checklist:** including the constraints under the revision of the seven stream items in a construction project, to check the availability before moving the task into the execution. **The constraint log:** includes the constraint list and the action plan for how to deal with them and who is responsible for following and applying the action to solve the constraints.	**Modeling Visualization:** Visualize the project at the object level, facilitating communication, understanding of the work efficiently.	3D-BIM	The Second Stage, Creation and Submission of The Claim	**2- Contractual entitlement and compliance:** Contractual entitlement: the contractor identifies what the guidance does the contract give in the event of the risk event. The contractor defined clearly in a separate section of the claim documents, the contractual basis of the claim entitlement for extension of time by referring to the contract clauses in his request. Contractual compliance: what is the time frame stated in the contract for the contractor and the employer to comply with the claim.	**Due to the integration in phase-2 between LPS and BIM at this phase**: the integration between LPS and BIM will optimize the preparation of (EOT) claim by using the make-ready checklist, which helps to eliminate and resolving the constraints, enable the project team to execute the activities within the plan. Also, a constraint log containing more details about the constraints as an action plan, who does the action, the status of the constraints. This stage will have supported optimization by making the tasks in the look-ahead planning ready (constraint free). Therefore, the baseline schedule becomes free of the problems or constraints and supports the process of delay analysis in the steps of the EOT claim preparation. Also, this phase plays a vital role during the construction phase, which represented in all the work status that collected at the daily huddle meeting and discussed in the weekly work plan when including any constraint should be passing through the look-ahead planning phase. Therefore, these constraints will be recorded, documented, and support the preparation of the EOT claim by identifying the events and liabilities.
			Automated Clash Detection: Detect and resolve the clashes among discipline, and activity sequencing, reduce time wastes and decrease variability.	3D&4D-BIM			
			Model accessibility at the site: confirmation of the work can do, removing the constraints, preparation of the prerequisite work, improving the communication.	3D- BIM			
			Rapid Generation and Evaluation of Construction plan: visualization, simulation, adjustment of the plans by 4D-BIM, sequencing, and resource loading.	4D-BIM			
			Safety Management: Detect any potential safety issues, Filtration of the tasks causes the risks, adjustment of activity sequence.	4D-BIM			
			The visual status charts: provide the information on activity status and prerequisite items for each activity.	4D-BIM			

Table (3) shows explanation of the framework including stages of the integration, (LPS &BIM, EOT preparation, Optimization)-Phase (3-1)

Stage1	Phase	LPS	BIM-Functionalities	BIM-DOCs	Stage2	Preparation of EOT Claim	Optimizing the preparation of EOT Claim
The First Stage, Integration Between LPS and BIM	Phase-3- The Weekly Work Planning	**The weekly work plan:** The project team and sub-contractor committed by what will do of the work that specified before with what should do in the phase schedule and what can do in the make-ready plan. Preparing the plan for the next week and revise the plan of the previous week. Discussing and analyzing the data collected from the daily huddle meeting phase and the measurement and learning phase, updating the schedule. **The workable backlog:** is a log for recording the activities that received from the site by the team in the fourth phase (Daily huddle meeting) and assigns through the step (Make Ready) to analyze the constraints?	**Modeling Visualization:** improve communication during the meeting, understanding of the work by the stakeholders quickly	3D-BIM	The Second Stage, Creation and Submission of The Claim	**3-Cause and Effect and Delay Analysis:** The contractor arranges and explain the chronology of the events and describe the effect for each event. Cause and effect, covering the following items as details of the planned work affected. The relation between planned work. The duration for each task, the methodology used to prove the effect of the delay. And the status of the activities with the planned activities at the time of the event. Description of the changes to that plan because of the event. delay analysis, to get a proper result for delay analysis the contractor should be concerned with the following types of the schedule for introducing the program at different stages, Preparing the baseline program planning stage, Proper program updates execution stage, Revised plan due to updates execution & monitor and control stage.	**Due to the integration in phase-3 between LPS and BIM:** Weekly work planning optimizing the preparation of the EOT claim, the documents that collected from the daily huddle meeting as the work status, records, and plans will communicate in the weekly work plan meeting for discussion and analyzing. Also, the activities analyzed in the WWP will filter by applying the second phase to identify the events. Also, recording in the make-ready plan documents as look-ahead plan constraint log, make ready, workable backlog, and finally in the weekly work plan for preparing the events that caused the delays in the project. Also, WWP is the main phase for generating the steps of the EOT claim preparation, firstly collect the status, information, and documents from the daily huddle meeting then discussed analyzed and transferred into the make ready to identify the events and recorded into the documents. These events discussed in the WWP and identify the contractual entitlement.
			Automated Clash Detection: Detect and resolve the clashes among discipline, and activity sequencing, due to updating.	3D&4D-BIM			
			Model accessibility at the site: confirmation of the work can do, removing the constraints, preparation of the prerequisite work, improving the communication, and check the status of the work graphically.	3D-BIM			
			Collaboration/ coordination in design and construction: during the meeting, the model will be analyzed to rectify the problems that may found during execution, therefore, avoiding rework, continuous improvement, and coordination.	3D-BIM			
			Safety Management: Detect any potential safety issues, Filtration of the tasks causes the risks, adjust activity sequence.	4D-BIM			

Table (4) shows explanation of the framework including stages of the integration, (LPS &BIM, EOT preparation, Optimization)-Phase (3-2)

Stage1	Phase	LPS	BIM-Functionalities	BIM-DOCs	Stage2	Preparation of EOT Claim	Optimizing the preparation of EOT Claim
The First Stage, Integration Between LPS and BIM	Phase-3- The Weekly Work Planning	**Meeting agenda:** using for arranging, organizing, and managing the meeting and including the previous meeting activities, the current and the forecasting activities for each department, also involving decisions, commitments, and the name of the attendees. **Weekly work progress:** including the activities for each department, and the status of the tasks. The tasks should be revised daily and record status for each task for using and supporting the project team to know the work status, supporting the updating schedule, and helping the team on decision making	**Rapid Generation and Evaluation of Construction plan:** visualization, simulation, and adjustment of the plans by 4D-BIM, sequencing, resource loading.	4D-BIM	The Second Stage, Creation and Submission of The Claim	These stages of the program rectified in the last planner system phases as a collaborative program, make-ready, and weekly work plan. In the collaborative programming include the master schedule and phase schedule plan. The tasks in the phase schedule plan checked in the make-ready plan to remove the constraints to be ready after that, considering the activities in the weekly work plan as a baseline. When the contractor received owner changes or any changes at the site recorded and documented in the daily meeting, considering, and rectifying in the weekly work plan and making an update of the schedule by using visualization and simulation technique of the BIM to see the impact of the changes to the original plan.	Then the causes and effects of each event, the information, work status collected in the daily huddle meeting will be used for updating schedule and applying the delay analysis method by using baseline schedule, updated schedule, and the documents. In weekly work planning, after getting the updated schedule, the project team applying measurement to identify the percentage complete, the status of the project, and the forecasting measurement of the project plans due to the actual data. After that, in the WWP meeting, the project team has the documents, the events, liabilities, analysis, so the project team can be started in preparing the claim statement.
			Visualize the process status: BIM allows the team to receive the information or the process graphically, which allows the team to do the planning and assigning the work.	4D-BIM& KanBIM			
			Online communication of the product and process information: coordination of the work in case of conflict occurred at the construction phase, reduce time wastes, reduce variability, continuity of the workflow, facilitate decision making due to the availability of the information.	KanBIM			
			Integration with the Project Partner databases: support communication and coordination between the project team for transferring information of material submittal, ordering material delivery.	KanBIM			

Table (5) shows explanation of the framework including stages of the integration, (LPS&BIM, EOT preparation, Optimization)-Phase (4)

Stage1	Phase	LPS	BIM- Functionalities	BIM-DOCs	Stage2	Preparation of EOT Claim	Optimizing the preparation of EOT Claim
The First Stage, Integration Between LPS and BIM	Phas-4- Daily Huddle Meeting	**Daily Huddle Meeting:** managing and controlling the workflow, collaboration, keeping all parties on track, collecting work status regularly, improving communication. The documents and the records obtained will communicate in the weekly work plan. The documents as (material submittal, Document transmittal, Material Delivery inspection request, project daily resource report, daily failed to report, request for information, site operation inspection request, shop drawing submittal, site instruction, etc.).	**Modeling Visualization:** Visualize the project at the object level, improving communication, understanding of the work efficiently among the project team.	3D-BIM	The Second Stage, Creation and Submission of The Claim	Due to the changes in the project scope and the delays raised in the execution phase, the approved baseline program became ineffective. Therefore, the baseline program should be revised from time to time to rectify the changes. The revised schedule should be considered from the last update to reflect the changes in the scope and delays the proposed mitigation measures. The delay analysis method depends on the process that mentioned in the contract such as (As- planned vs. As-built, impacted as-planned, As-planned but for, collapsed as Built Method, Windows- Snapshot Technique). **4- Statement of the claim:** This stage based on the previous steps. The contractor will start to write and explain (EOT) claims. The contractor is beginning in the statement of the claim with a detailed narrative, and describing the facts caused extension of time claims.	**Due to the integration at phase-4 between LPS and BIM:** this phase is playing an essential role in the interaction of LPS and BIM, which considered a connection for collecting and communicating site information day-to-day. In the weekly work plan, the data gathering in the different documents. The documents including (material submittal, Document transmittal, Material Delivery inspection request, project daily resource report, daily failed to report, request for information, site operation inspection request, shop drawing submittal, site instruction, etc.). The documents are arranging, organizing, and analyzing in the WWP to identify the events, liabilities, and causes of the risk events. Also, the information using for updating the schedule to get the actual timetable, which considered as the second item plus baseline schedule for using in the delay analysis methods and estimate the days in which the project delays due to the events. The documents that collected optimizing the (EOT) claim by collecting and organizing to prove the delays and substantiation of the (EOT) claim.
			Plan and control: printing and communicating the activities with the status, durations, and resources for sharing precise knowledge and documents.	4D-BIM			
			Visualize the process status: using the graphic building model to transfer the information in the construction phase that enables the project team to plan and assign the work.	4D-BIM KanBIM			
			Integration with project partner databases: communication and coordination between the project team for transferring the information in advance as material submittal, ordering material delivery.	KanBIM			
			Status data collection at the site: data collection, task status, reports, and communication with the team.	KanBIM			
			Online communication of the product and process information: coordination of the work between the project team, also support and facilitate the decision making due to the availability of the data.	KanBIM			

Table (6) shows explanation of the framework including stages of the integration, (LPS&BIM, EOT preparation, Optimization)-Phase (5)

Stage1	Phase	LPS	BIM- Functionalities	BIM-DOCs	Stage2	Preparation of EOT Claim	Optimizing the preparation of EOT Claim
The First Stage, Integration Between LPS and BIM	Phase-5- Measurement and Learning	**Measurement, learning and continual improvement:** are the basis of evaluation that takes place within the WWP meeting. The percent plan completes PPC measures the predictability of tasks delivery, the percentage and reliability of promises which completed within time. PPC calculated by the number of actual completed planned activities divided by the total planned activities and presented as a percentage. Uncompleted tasks after measuring PPC discussed to resolve the causes of incompletion and record it. PPC also helps the teams to decide for evaluation of their work, which presented at the next weekly work planning meeting.	**Collaboration/ coordination in design and construction:** the information collected from the daily meeting and communicated in WWP and measuring PPC and variances. When variances exist, this led to updating the model in some areas of the model.	3D-BIM	The Second Stage, Creation and Submission of The Claim	**5- Claim Substantiations:** The contractor collects the documents, whether soft copy or hard copy, to help him when he needs to support any delays once occurred. These substantiations collected along with the integration of LPS and BIM (baseline, updated schedule, Daily-Weekly-Monthly reports, work status, meetings, delay events log, notices for the delay, employer documents relevant to the delay, communications, records, BIM tools, and LPS templates, etc. **6- Submitting EOT Claim:** all the previous steps arranged and organized to introduce and submit the claim into the owner.	**Due to the integration in phase-5 between LPS and BIM**: in the weekly work plan meeting, all the work collected in the daily huddle meeting will be discussed weekly in the weekly work plan meeting for updating the schedule. After finishing the updated program, we can start measuring the variances by applying the percent plan thoroughly. The results and charts used to optimize the preparation of the EOT claim by supporting EOT substantiation with tables graphs and charts, variances results, and using as an indication for the productivity rate of the workforce and the project progress among occurring the events that cause the delays.
			Rapid Generation and Evaluation of Construction plan: measuring and calculating variances need updating schedule to get a new strategy for execution due to the delayed events.	4D-BIM			
			Plan and control: printing and communicating the activities with the status, duration, and resources for measuring PPC and identifying variances.	4D-BIM			
			Visualize the process status: transfer the information graphically in the construction phase to manage the percentage complete and compare with the planned to identify variances.	4D-BIM KanBIM			
			Integration with project partner databases: communication, improving relationships, direct ordering material.	KanBIM			
			Online communication of the product and process information: sharing the activity status. And decision making.	KanBIM			
			Status data collection at the site: collect the status from the site for measuring the percentage plan complete of the actual and planned work.	KanBIM			

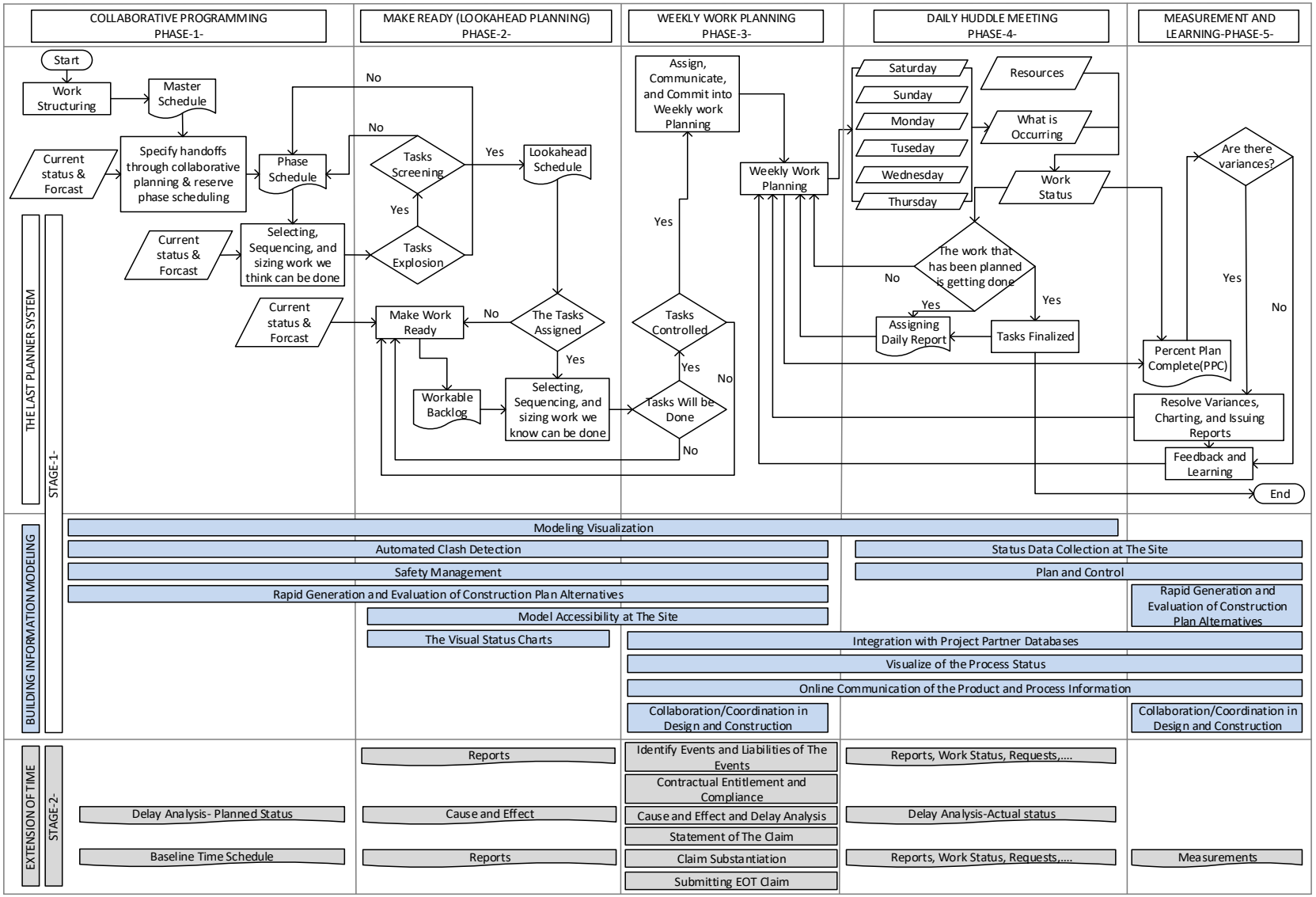

Figure (12) Framework to optimize preparation of (EOT) claims using integration of LPS and BIM techniques in construction projects

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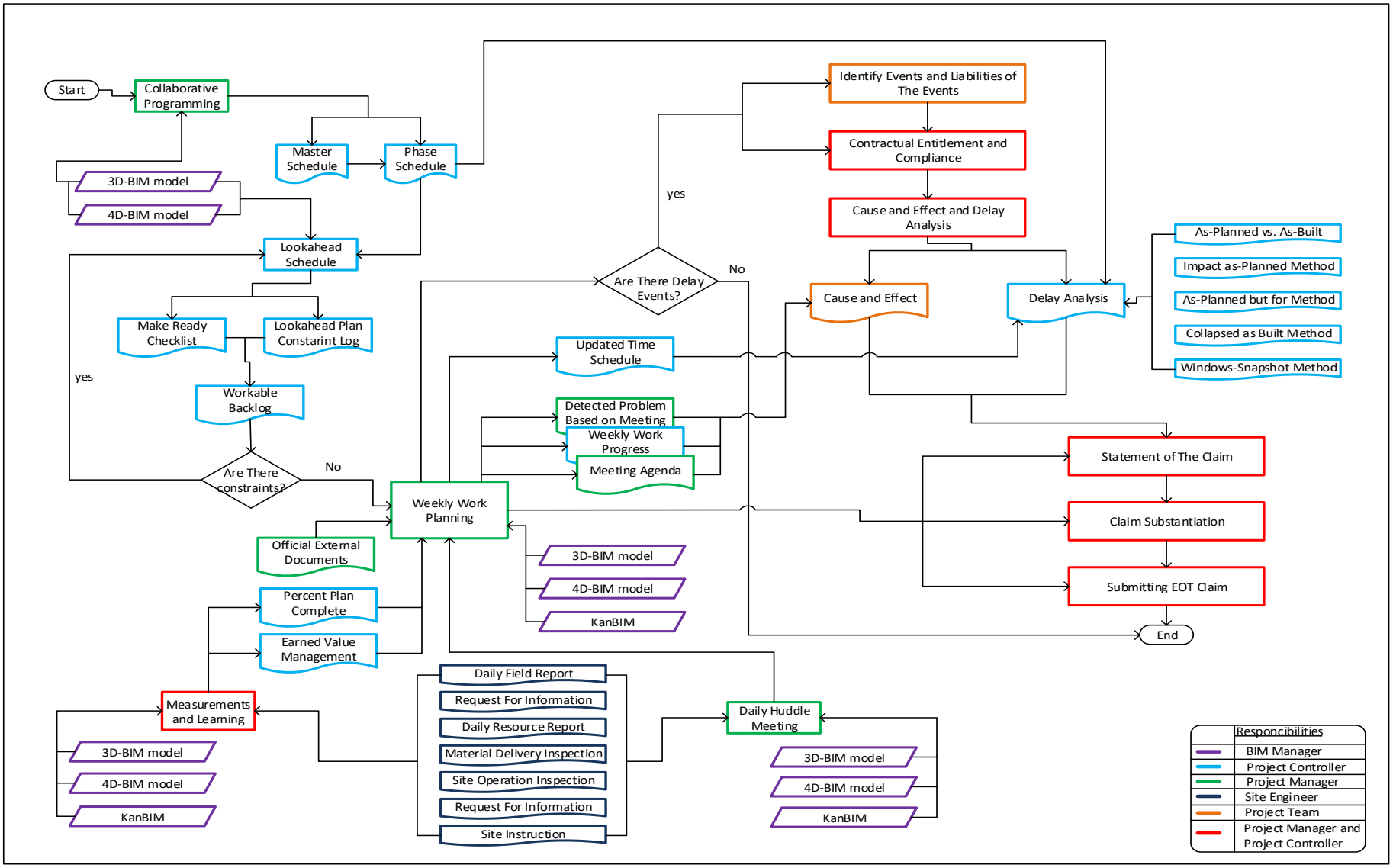

Figure (13) Process flowchart of the integration between LPS and BIM with the documents for the preparation of (EOT) claims

4. CONCLUSION

Delays are the main problem that faces the construction projects and have many negative impacts on the project objectives. Also, delays lead to the emergence of claims. Proving the delay needs a significant effort to introduce all details, documents and records that support (EOT) claims.

The primary purpose of this research was to determine the integration between the last planner system and building information modeling to optimize the (EOT) claim preparation. The outcome of this study enables the project team to know and apply the new technique for preparing the (EOT) claim.

This research shows that the different steps of the last planner system. The documents that will generate at each LPS phase, and the benefit of each document for supporting the (EOT) claim preparation. Also, the different functions of building information modeling and assigning the appropriate function at different last planner system phase. BIM functions categorized under three groups (3D-Modeling,4D-Modeling, and KanBim) for generating the documents to support the (EOT) preparation. The last planner system and building information modeling arranged and organized to develop a framework to get a proper extension of time claim.

Recommendations

This study focused on the integration of the last planner system and building information modeling in construction projects for optimizing the preparation of (EOT) claims.

In the framework, pointed out that using the delay analysis method is one of the available techniques. Therefore, further studies should focus on what is the appropriate delay analysis method during the integration process.

The framework was built on the LPS stages and BIM functions theoretically. Accordingly, further studies conducted to link the framework to reality.

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إطار عمل لتحسين إعداد مطالبات التمديد الزمنى (EOT) بإستخدام تكامل تقنيات نمذجة معلومات البناء (BIM) ونظام (LPS) فى مشاريع الإنشاء

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ملخص البحث
المشروعات الإنشائية تواجه تاخيرات واضطرابات والتى من الممكن ان يكون سبب فيها أحد طرفى التعاقد ، كلاهما، أو خارجه عن إرادتهما. يحتاج إثبات التأخير إلى جهد كبير لتقديم جميع التفاصيل والوثائق والسجلات التي تشرح أسباب التأخير. يحتاج المقاول الى تقديم مطالبة، سواء كانت مطالبة تمديد زمنى (EOT) أو أى مطالبة مع تعريف مناسب ، الأسباب، المسئوليات ، تحليل التأخيرات للحصول على تمديد الوقت المرتبط بالحدث. تحتاج عمليات إعداد المطالبات إلى جمعها وتوثيقها يومياً على مدارمراحل المشروع ، وخاصة خلال مراحل االإنشاء.
نظام Lean Construction بتقنيته الشائعة (LPS)، ونمذجة معلومات البناء (BIM) يتمتعان بأوجه تآزر كبيرة ويمكنهما تحقيق فوائد عند تنفيذهما معًا لدعم إعداد مطالبات التمديد الزمنى (EOT). نمذجة المعلومات البناء(BIM) تستخدم كمنصة رقمية لتسهيل التواصل بين فريق المشروع، تحسين أداء المشروع، وتنفيذ مراحل (LPS) بشكل فعال. (LPS) تعزز التنسيق داخل فريق المشروع.
الغرض الأساسى من البحث هو تطوير إطار لتحسين إعداد مطالبات التمديد الزمنى (EOT) باستخدام تكامل تقنيات نظام (LPS) و نمذجة معلومات البناء (BIM) في مشاريع الإنشاء. سيمثل التكامل فى إستخدام وظائف نمذجة معلومات البناء المناسبة (BIM) إلى جانب المراحل الخمس لنظام (LPS). نتيجة للتكامل، تم توثيق المدخلات والمخرجات بشكل جيد، والتي تعتبر الدعم الأساسى لعمليات إعداد مطالبات التمديد الزمنى (EOT). كما أن الإطار مدعوم بخريطة تدفق لتوضيح المخرجات والمدخلات ومسؤولية فريق المشروع، مما سيساهم في تحسين إعداد مطالبات التمديد الزمنى (EOT).

الكلمات المفتاحية: Lean، نمذجة معلومات البناء(BIM)، نظام التخطيط الأخر(LPS)، التمديد الزمنى(EOT)، التأخير، التكامل، الفوائد، تخطيط العمل الأسبوعى، النسبة المئوية للأعمال المخططة المكتملة، الإجتماع اليومى، KanBIM،Kanban،النمذجة رباعية الأبعاد،النمذجة ثلاثية الأبعاد.