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Developing prediction system for lean construction projects performance in Iraq

Omer Tareq Abed 1, Sepanta Naimi2

[1] Altinbas University, Civil Engineering Department Istanbul Turkey
[2] Altinbas University, Civil Engineering Department Istanbul Turkey

* Corresponding author email: otariq154@gmail.com

ABSTRACT
Lean construction concept is concern with the design production processes and maximizing the amount of value generated with the least amount of waste in terms of the amount of time, effort, and resources used. it is used recently to improve construction project performance. The present thesis improves the accessible data of cost estimating approaches by investigating the factors for the construction project in Iraq. Then, developed a prediction system for lean construction projects performance to specify the success rules in the implementation lean construction cost process. The method applied on private residence project, condominium, and apartment to measure the differences in construction projects. The results observed a significant prediction system, which developed, based on lean concept to evaluate the waste in building construction. Finally, the system underwent testing, with excellent outcomes that specialists predicted would result in high levels of efficiency.

Keywords: *Prediction System, Lean Process, Cost, Private Residence, Condominium Project.*

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INTRODUCTION

Performance is defined as the level of efficiency and effectiveness in the completion of all project goals. The use of key performance indicators, or KPIs, is an industry standard method for evaluating the success of a project. Measurement of the success of a project while it is still in the process of being carried out is referred to as "dynamic project performance measurement." Predicting how a construction project will turn out is essential in the construction business for the purposes of monitoring and regulating construction jobs. Egan first introduced the KPI approach for monitoring performance in his paper titled Rethinking Construction, which was published in 1998 by Egan. After that, time and cost were the only KPIs that were employed for a couple of years; however, in today's world, additional KPIs are required to be recognized for the purpose of knowing the real state of a project [1]. The Key Performance Indicators (KPIs) are developed, measured, and reported on with the assistance of Defense Construction Canada (DCC). KPIs are the metrics of choice for DCC when it comes to gauging the success of Canadian initiatives. In addition, the Construction Industry Institute (CII) has recently implemented a performance evaluation program that makes use of KPIs in order to evaluate the success of construction projects in the United States (US). In the research that has been published, key performance indicators for construction projects have been assessed and projected in both a quantitative and qualitative manner [2] [3].

1.1 Cost Estimation Methods

Assessing construction expenses requires considering both immediate and indirect expenses, as well as revenue margin. Contractors use unit pricing to compute project expenses, but it requires expertise and proficiency. Direct cost estimation is a conventional approach with high accuracy but time-consuming calculations. Alternative methodologies are being investigated to improve computational efficiency[4]. Artificial neural networks, linear regression, fuzzy sets, and support vector machines are essential subjects for evaluating project effectiveness. Performance measures help determine the order and effectiveness of activities within a process, ensuring output meets objectives. They help gather, compute, and analyze data on performance, client satisfaction, and potential modifications[5]. Performance measures are crucial for organizations to assess their progress and identify areas for improvement. [6][7].

1.2 problem statement

The majority of literature on project performance prediction focuses on quantitative techniques, with few qualitative KPIs like customer satisfaction, quality, and safety being unquantifiable. Most studies assess performance during the project, allowing stakeholders to propose remedial actions and anticipate remaining performance[8]. Neuro-fuzzy models, artificial neural networks, and multiple regression models have been compared for their predictive abilities. Managers should research lean project management, risk management, and project management techniques to evaluate project complexity. Accessible data and cost estimating approaches are limiting factors for construction projects in Iraq, but most processes still fall short of conventional methods.

1.3 Research Aim and Objectives

The difficulty that was described in the preceding part makes it clear that this thesis covers a wide-ranging subject matter of interest. The purpose of this thesis may be broken down into two parts. The following are some of the goals of the current research:

a) To develop a prediction system for lean construction projects performance in Iraq

b) To identify the success rules in the implementation lean construction cost process.

2. LITERATURE SURVEY

This is not able to control trying to cut rapid construction strategies through conservative methods. As just a result, applied ideas as well as methods must be used in renovation to assist working groups in dealing with building spendings through the use of optimal resources, which can be accomplished through the use of sustainable building concepts and procedures[9]. As a result, the purpose of this paper is to provide an overall view and discussion of the potential application of slender principles and techniques. Sift in building project that also helps to reduce material waste in building and gives the performance of exertion in product starting to emerge process with electromagnets a profit equal and which variables contribute to adopt lean institution in building works has been debated with the existing building really does prior educations. He saw many times how quality management is decreasing, resulting in rework and many wastes such as overproduction, stock, unneeded mass transit, employee separations, placed above a white, deficiency, resource going to wait, unutilized worker creative thinking, and effort accidents[10] [11].

This research proposes an initial version of rules for implementing lean building project attributes in construction projects. It calls for innovative project processes and a "lean thinking architecture" for factory competence advancement in construction firms. Key themes about lean production are discussed from design and manufacturing perspectives, and the best managerial relationships between building design and production plans. The conceptual design exercise involves intricacies in ancient management team arrangements, project planning, and co-investment. The incorporation of construction and control happenings into house building has revealed existing architectural procedures' shortcomings in terms of severe standards and interpretation of construction [12] [13].

This obvious limitations in the Worldwide Gathering for Lean Constructing in the bright of the IDs again for 12th annual meeting. It aims to provide a brief insight into the evolution over the last twelve years as well as the national of the painting. Its primary objective is to expose a conversation of the future effort wilean the Lean Construction industry. The study states that a shift in the foundational paradigm is fashionable, and that a recent research program should be identified with a start in the slender knowledge of both the building project by manner of man has been known just after construction locations and with a complex adaptive compassionate of the countryside of such a procedure.. Components in this initiative are underlined, and areas of research are identified to maximize value for customers, minimize waste in having to deliver this value, and manage project allocation. [15] [14].

3. RESEARCH METHODOLOGY

This study focuses on improving cost efficiency in Iraqi families by identifying and evaluating critical elements influencing cost

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efficiency. The research techniques include identifying cost performance factors, questionnaires, expert interviews, and correlations between project component elements. Survey respondents with prior experience in building projects were contacted to determine the significance of cost success variables. Data was collected through questionnaires and in-depth conversations, allowing for more detailed conversations and understanding of the interviewee's reasons and preferences. The researcher's ability to gather, analyze, and draw conclusions from data is essential, as well as ensuring the interviewee feels at ease and genuine interest in the topic matter.
The researcher used non-threatening body language and open-ended questions to ensure accurate responses. The study requires dependable and trustworthy participants for effective communication.

3.1 select the effective factors case waste in projects

Polls are an effective method for collecting data for analysis and optimal results. However, researchers often misuse this method by using questionnaires for field surveys. Researchers should establish a connection between research goals and specific queries, using open-ended and closed-ended questions, and using open queries for data evaluation. Excel, a spreadsheet application, is used to organize data and estimate forecasts, with each column representing a unique variable.
In this section, a list of independent study factors' assumptions regarding how various performance factors perceive the significance of project management is presented, along with justifications for each factor. The following categories were used by Luangcharoenrat et al. to illustrate the most prevalent factors in 2019:

Table 3.1: Design and Documentation (DEDO) factors

Unclear drawing specification
Design errors.
Change to design.
Construction drawing errors.
Delays in design work
Complicated design.

Table 3.2: Material and Procurement (MAPR) factors

upraise material prices
Material transporting problems.
Defective materials.
Material quality problems.
Improper material handling.
Improper material storage.
Material ordering problems.
Damaged materials.

Table 3.3: Management related factors factors

Poor construction planning
weakness in decision making
Low management skills
Too much owner interference
Additional business change of owner
delay in payment
bureaucracy
Not enough management information
low Percentage of supervisors in the project
Poor distribution of tasks

Table 3.4: Human Resources (HUMA) factors

Ineffective planning and scheduling.
Lack of suppliers involvement
Incompetent workers
Designers' inexperience Inattentive working attitudes and behaviors
Frequent exposure of workers to accidents
Poor use of resources
Poor use of technology
Poor understanding of working methods
Low labor productivity
unskilled labor

Table 3.5: Equipment related factors

Lack of equipment on site
Delay in the delivery of equipment
Poor equipment productivity
Poor ability to operate equipment
Frequent equipment malfunctions
Poor maintenance of equipment

Table 3.6: The types of used building in this research

	building type
1	Private residential
2	Condominium and Apartment

Table 3.7: The types of building heights used in this research

building height (m)	
1	less than 15 m
2	(15-23) m
3	more than 23m

3.2 Revit drawing model

a) create the model

The four facades, namely Rear, Left, Front, and Right, are representative of the four distinct interfaces of the building. The graphical user interface will display cameras arranged in four different configurations for each of the specified orientations. To modify levels, floors, or roles with Elevations, one should open a location red selection and double-click on one of the four sides of the green selection, as illustrated in Figure 3.1. It is advisable to opt for one of the four available ports and exclusively utilize it for all operations. The anterior position is considered to be the optimal placement.

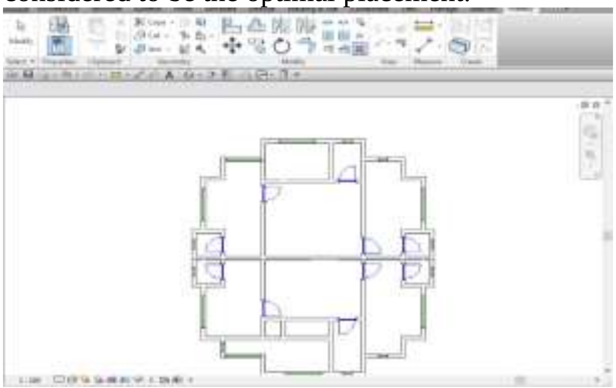

Figure 3.1: Revit foundation drawing

As part of the project, make more cams or make plans for their placement. The camera will show location and click the camera when you choose the Elevation icon from the View selection in the Elevation FRAMING & ELEVATION options. This will demonstrate the camera. Additionally, this chooses the first height option.

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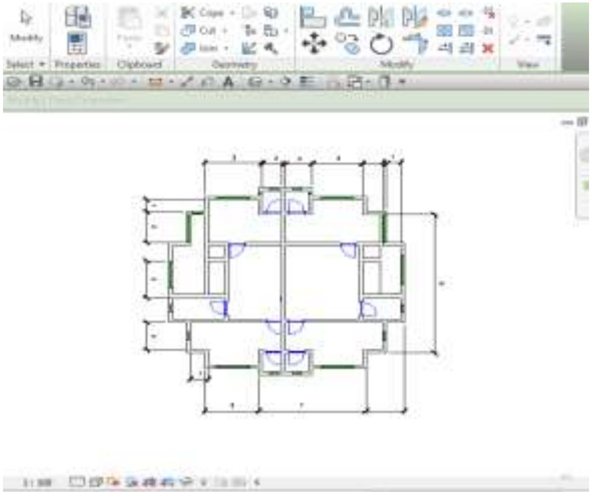

Figure 3.2: Insert dimensions

b) drawing the building walls

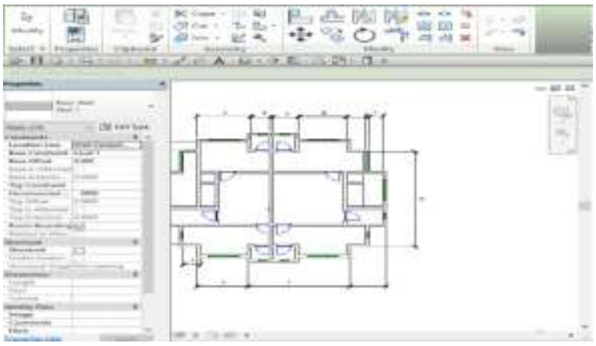

Figure 3.3: Wall drawing process

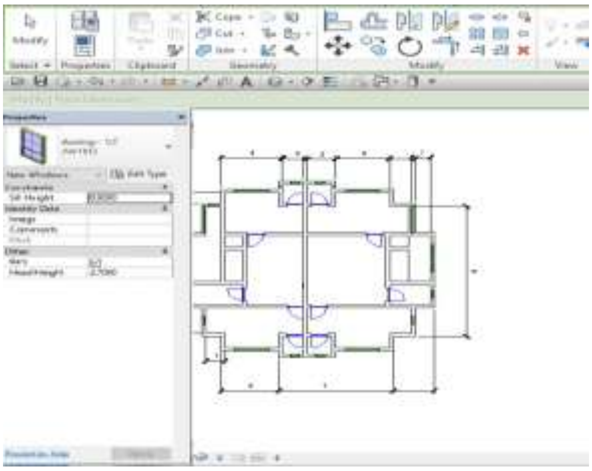

Figure 3.4: Insert windows

Any potential alternate places should be thought of before the markers are permanently placed. Our initial starting point will be at the bottom, which will be decorated right away.

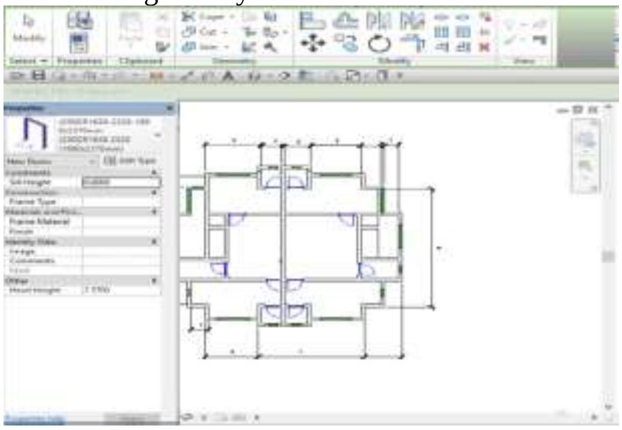

Figure 3.5: Insert doors

3.3 specify the project quantities

By selecting QUANTITIES / SCHEDULES while researching the job, you can define restrictions, quantities, and costs. By choosing the QUANTITIES / SCHEDULES choice from the menu that displays, you can get to this button. We can indicate whether the table is for doorways, windows, columns, plinths, etc. by describing the table layout using Schedules New Quantities.

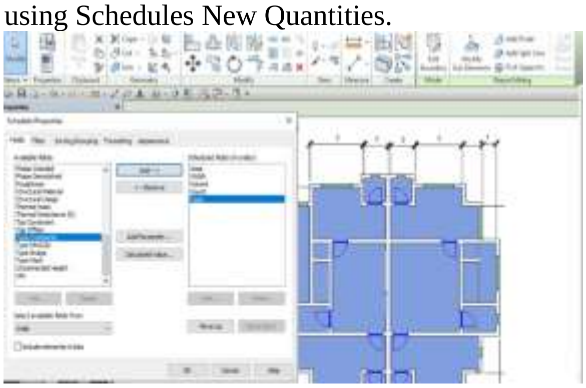

Figure 3.7: Specify the quantities

4. RESULTS AND DISCUSSION

The lean approach involves understanding the interaction between iterators and hands during three stages to achieve the desired outcome. Researchers must recognize customer concepts and pay attention to their needs to optimize efficiency and reduce waste. Efficiency is determined by the ratio of value produced to resources squandered, so reducing unnecessary resources and improving client relations are crucial. This study aimed to find the best engineering lean approach for building projects, focusing on the cooperation of components in determining cost situations. The project involved Iraqi residential buildings under development and involved two main planning phases. The researcher organized and categorized data to indicate the current approach.

4.1 prediction system

For prediction system based on lean concept, the evaluation of waste in building construction shown in the tables below. The survey was done based on the effective factors only. The percentage of waste will be use to eliminate the waste cause in construction processes. The new method that used in this research is the polynomial prediction line for evaluating the waste in the construction building based on the building height and type.

Table 4.1: Waste percentage of Condominium and Apartment construction processes

Condominium and Apartment factors	(3-15) m	(15-23) m	(23-45) m
Change to design.	0.18		
Construction drawing errors.		0.10	
Delays in design work			0.09
Defective materials.	0.18		
Improper material storage.		0.14	
Damaged materials.			0.08
weakness in decision making			0.08
Low management skills			0.08
Too much owner interference			0.08
Additional business change of owner			0.08
bureaucracy	0.15		
low Percentage of supervisors in the project	0.15		
Poor distribution of tasks		0.16	
Ineffective planning and scheduling.	0.10	0.14	
Frequent exposure of workers to accidents		0.14	
Poor use of technology			0.11
Low labor productivity			0.11
unskilled labour	0.10		0.11
Lack of equipment on site			0.09
Delay in the delivery of equipment		0.10	
Poor ability to operate equipment		0.10	0.09
Frequent equipment malfunctions	0.15		
Poor maintenance of equipment		0.10	

Table 4.2: Waste percentage of Private residential construction processes

Private residential factors	(3- 15) m	(15-23) m	(23-45) m
Change to design.	0.18		
Construction drawing errors.		0.18	
Complicated design.			0.10
			0.11
Material quality problems.	0.15		
Improper material handling.	0.15		
Improper material storage.		0.18	
weakness in decision making			0.14
Additional business change of owner	0.17		
bureaucracy		0.18	
Not enough management information			0.14

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Lack of suppliers involvement	0.19		
Designers' inexperience Inattentive working attitudes and behaviors		0.15	
Poor use of resources		0.15	
Poor use of technology			0.14
Low labor productivity			0.14
Lack of equipment on site			0.12
Delay in the delivery of equipment	0.16		
Poor equipment productivity		0.18	
Poor ability to operate equipment			0.12

The results evaluated by the plot and using Microsoft Exile function process

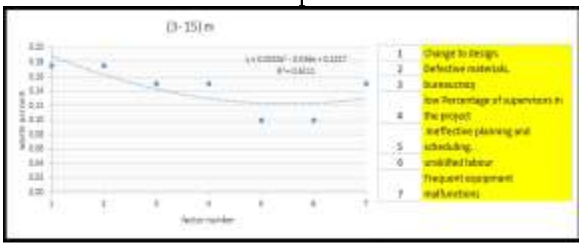

Figure 4.20: Private residential factors (3-15)m

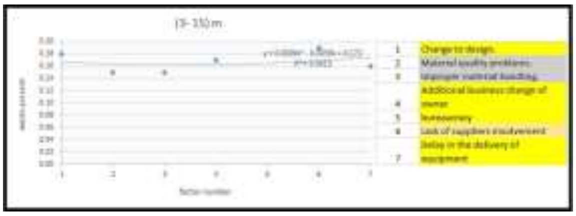

Figure 4.21: Condominium and Apartment factors (3-15)m

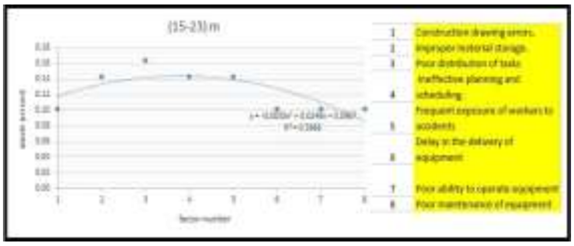

Figure 4.22: Private residential factors (15-23)m

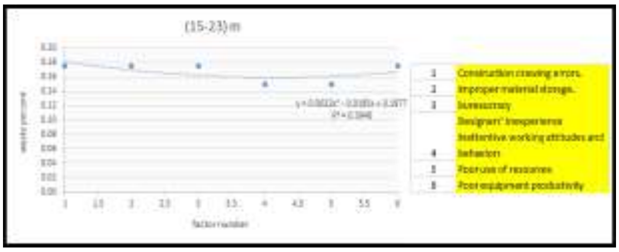

Figure 4.23: Condominium and Apartment factors (15-23)m

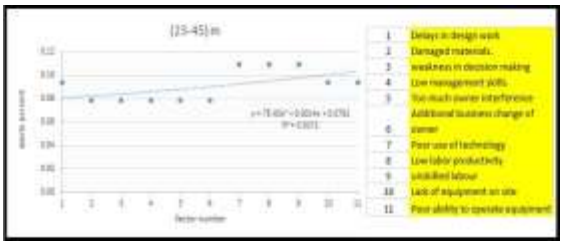

Figure 4.24: Private residential factors(23-45)m

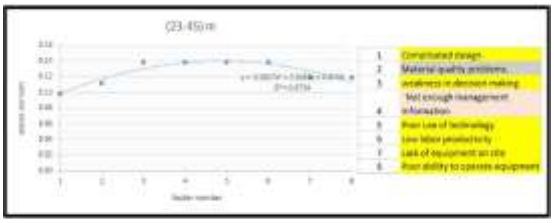

Figure 4.25: Condominium and Apartment factors (23-45)m

$y1 = 0.0033x_1^2 - 0.036x_1 + 0.2217$
$y2 = 0.0009x_2^2 - 0.0059x_2 + 0.172$
$y3 = -0.0033x_3^2 + 0.0249x_3 + 0.0967$
$y4 = 0.0022x_4^2 - 0.0185x_4 + 0.1977$
$y5 = 7e\text{-}05x_5^2 + 0.0014x_5 + 0.0792$
$y6 = -0.0027x_6^2 + 0.0267x_6 + 0.0748$
Total waste $y_t = y1+y2+y3+y4+y5+y6$

Figure 4.26: The Rivet quantities results

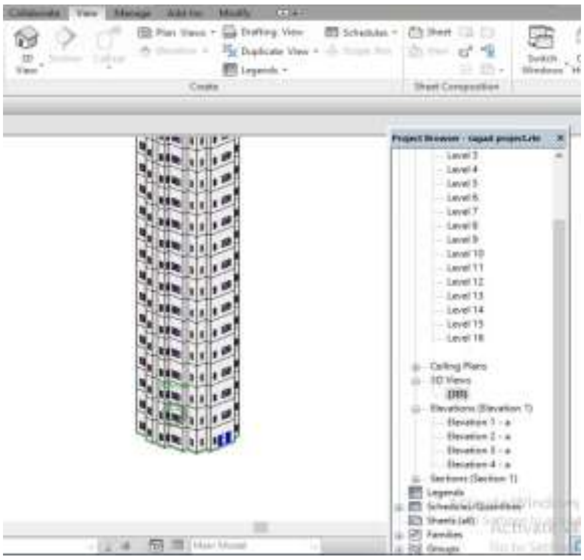

Figure 4.27: The Rivet building results

When applying the set of prediction function in Revit quantities, the results can be shown in the table 4.3.

Table 4.3: The Results of prediction system

code	effective factors	Type of Construction Waste	waste factor results
f1	Change to design.	Concrete	f1, f4
f2	Construction drawing errors.	Brick	f5,f7,f8
f3	Complicated design.	concrete block	f2
f4	Material quality problems.	white block	f9,f19
f5	Improper material handling.	Wood	f11,f18
f6	Improper material storage.	gypsum	f10
f7	weakness in decision making	aluminum metal	f18,f6
f8	Additional business change of owner	iron Metal	f16
f9	bureaucracy	Rubber	f14
f10	Not enough management information	Stone	f19,f12
f11	Lack of suppliers involvement	Rebar	f11,f17
f12	Designers' inexperience Inattentive working attitudes and behaviors	bitumen	f5,f7,f8
f13	Poor use of resources	plastic sheets	f5,f7,f9
f14	Poor use of technology	Mortar	f5,f7,f10
f15	Low labor productivity	Untreated Wood	f5,f7,f11
f16	Lack of equipment on site	Misc. Waste	f5,f7,f12
f17	Delay in the delivery of equipment	eps foam sheets	f5,f7,f2
f18	Poor equipment productivity	Dirt/Earth	f5,f7,f11
f19	Poor ability to operate equipment	Tile/Ceramic	f5,f7,f19

5. CONCLUSION

The present thesis shows the evaluation of waste in building construction for the forecast system based on the lean concept. In completing the survey, only pertinent factors were taken into account. These actions will result in a reduction of construction waste by this percentage. In this research, construction detritus was rated in relation to building height and substance using a cutting-edge method known as the polynomial prediction line.

a) building project-specific surveys, expert assessments, interviews, and experimental research from prior studies were all used to evaluate successful performance variables and the extent of their influence. All five of the chosen performances have an impact on building projects.

b) Selecting the proper software to use as the foundation for the model's construction was the first of many aspects that needed careful thought when creating a model for building debris. The Microsoft Excel tool for basic performance assessment was chosen for the computation of the proportional effect of each performance area due to its usability and analytical strength.

Finally, the system underwent testing, with excellent outcomes that specialists predicted would result in high levels of efficiency.

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