Optimized method for the Implementation of Lean Construction

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Abstract

Optimization is important for any kind of process which can only be accomplished following a structured approach. A lean approach guides towards the maximization of payback as well as minimization of the misuse. A lean construction management emphasizes on monitoring and continuous quality improvement for the best possible output. In our study, we have identified the key components for the lean construction management to examine how these could be used to achieve optimized output.

KeyWords: Lean, Optimization, Management, Construction, Output

I. Introduction

Lean Construction is an immediate measureable output-based production system. In this process, there are number of key areas which may include but not limited to certain activities or functions like: (A) Appropriate approach for Project Delivery on Schedule and Process Flow (B) Collaboration/Relationship Management with respects (C) Generation and Preservation of the Values (D) Removal of Waste and Disposing the same maintaining the categories during the Project Life Cycle.

Lets us take Lean Construction Management Indicator (LCMI) as Y where Y=f(x), then we can write f(x) =$f(X_1)$ + $f(X_2)$ + $f(X_3)$ + $f(X_4)$ presuming X_1,X_2,X_3 and X_4 as some variables which can be presented as :

A	B	C	D
X_1	X_2	X_3	X_4

In this relationship model, function $f(X_2)$ to .. $f(X_4)$ all are dependent on $f(X_1)$ that means if approach to the project delivery and its flow is not defined, no matter whatsoever we do, any good output and/or optimization cannot be achieved.

In calculus, range represents set of all possible values of a function, the set of input values are the domain of a function. Let us define the ranges with respect to the secondary sources:

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Function Range	Description	Condition	Reference for the value
$0 \geq f(X_1) \leq 0.4$	A: Delivery planning and Project Flow	F(B,C,D)=F(A)	[1]
$0 \geq f(X_2) \leq 0.2$	B:Collaboration/Relationship Management	$F(A) > 0$ or $f(X1) > 0$	[2]
$0 \geq f(X_3) \leq 0.1$	C: Value Management	$F(A) > 0$ or $f(X1) > 0$	[3]
$0 \geq f(X_4) \leq 0.30$	D: Removal of Waste	$F(A) > 0$ or $f(X1) > 0$	[4]

Relationship Model: Entity (B),(C) and (D) is fully dependant on entity (A) that means if $f(X_1) > 0$ then only the other entities (B),(C) and (D) to be considered. That mathematically means,

(1) $f(X_2)$,$f(X_3)$ and $F(X_4)$ can have a finite value 0 or more if $f(X_1) > 0$

(2) $f(X_2) = 0$,$f(X_3) = 0$ and $F(X_4)=0$ when $f(X_1)=0$

II. Methodology

A quantitative method has been adopted for our study. Initially, the key components are defined which could be used as functions by tabulating their ranges and domains as well as the relationships. Range indicated the approximate values obtained from the secondary sources. Different use cases were then examined using elementary mathematics and calculus.

III . Result

arg max also represented as *argmax* returns the maximized values of the given functions, similarly, *arg min* also represented as *argmin* returns the minimized values of the given functions,

We know:

$$f\left(\arg\max_{x} f(x)\right) = \max_{x} f(x).$$

$$\text{So, } f(\underset{x}{\arg\max}\, f(x)) = \underset{x_1 \ldots x_n}{\max} f(x_1 + x_2 + ..x_n) \ldots\ldots\ldots\ldots (1)$$

Where n = 1 to 4

When, $f(x_1) > 0$, we get $$f(\underset{x_1 \ldots x_n}{\arg\max}\, f(x)) = 1 \ldots\ldots\ldots\ldots (2)$$

When $f(x1) < 0$, we get $$f(\underset{x_1 \ldots x_n}{\arg\max}\, f(x)) = 0 \ldots\ldots\ldots\ldots (3)$$

Now, let us consider arg min:

When f(x1) < 0 , we get $f(\arg\min_{x_1 \ldots x_n} f(x)) = 0$.. (4)

When f(x1) > 0 , we get $f(\arg\min_{x_1 \ldots x_n} f(x)) = 0$.. (5)

That means, 100% optimization is possible when the max values of the given functions are returned or in other words, the work is done under the ideal condition.

We can re-examine the same using calculus as below:

Let us calculate f(x) under different conditions.

Case 1 :

$f(x) = \lim_{A \to 0} f(X_1) + f(X_2) + f(X_3) + f(X_4) = 0$... (6)

Case 1: *Observation*, No optimization can be reached without Proper Plan and Process Flow because B,C,D are dependent on A.

Case 2: $f(x) = \lim_{A \to 0.4} f(X_1) + \lim_{B \to 0} f(X_2) + \lim_{C \to 0} f(X_3) + \lim_{D \to 0} f(X_4) = 0.4$..(7)

Case 2: *Observation,* If Proper Plan and Process Flow exists even other functions remain non-existent, optimization at 40% level is achievable

Case 3: $f(x) = \lim_{A \to 0.4} f(X_1) + \lim_{B \to 0.2} f(X_2) + \lim_{C \to 0} f(X_3) + \lim_{D \to 0} f(X_4) = 0.6$..(8)

Case 3: *Observation,* If Proper Plan and Process Flow exists along with collaboration/Relationship management, optimization at 60% level could be achieved.

Case 4: $f(x) = \lim_{A \to 0.4} f(X_1) + \lim_{B \to 0.2} f(X_2) + \lim_{C \to 0.1} f(X_3) + \lim_{D \to 0} f(X_4) = 0.7$…(9)

Case 5: *Observation,* If Proper Plan and Process Flow exists along with collaboration/Relationship and value management optimization at 70% level could be achieved.

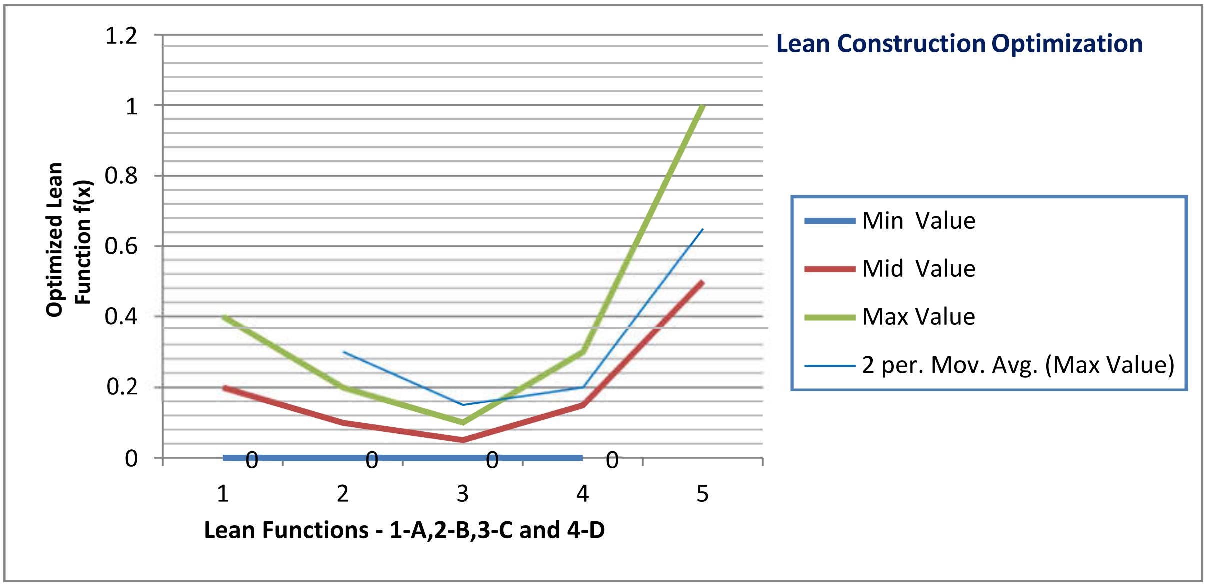
Case 5: f(x) = Limit $f(X_1)$ + Limit $f(X_2)$ + Limit $f(X_3)$ + Limit $f(X_4)$ = 1.00…(10)

A →0.4 B →0.2 C →0.1 D →0.3

Case 5: *Observation:*
If Proper Plan and Process Flow exists along with collaboration/Relationship, value management and Waste removal optimization at 100% level could be achieved.

Range	fun(X_1)	fun(X_2)	fun(X_3)	fun(X_4)	Y=fun(X)
Min	0	0	0	0	0
Mid	0.2	0.1	0.05	0.15	0.5
Max	0.4	0.2	0.1	0.3	1

Figure 1: Value Table



(1) When all the functions of A,B,C and D are minimum, especially when A is min Y= f(x) = 0

(2) With all mid values of A,B,C and D at least 50% optimization possible

(3) For any value of A above the mid value, at least 60% plus optimization is possible (by Moving Average)

(4) With all max values for A,B,C,D ,100% optimization is possible

IV. Discussion and Conclusion

The secondary sources indicate values for (A) → 43 to 50% , (B) → 22.%1 to 23.7% ,
C→10 to 25% and D→30% . For the purpose of our study, we have taken the following values:
A→40% ,B→20% ,C →10% and D→30%. More granular level study and analysis is possible which is not done by us in this paper. For example, from project management perspective component (A) which represents ‘Appropriate approach for Project Delivery on Schedule and Process Flow’ could be divided into many sub-components like (A_1)

Work Break Down Structure (WBS), (A_2) Budget (A_3) Scope (A_4) Resource Procurement (A_5) Delivery Schedule (A_5) Quality Control Process. Component B which represents “Collaboration/Relationship Management with respects” can be broken into sub-components like (B_1) Mode of Communication (B_2) Lead Management (B_3) Use of Analytics for Customer Satisfaction etc. Component C which represents “Value Management” could be broken into (C_1) Functional Analysis (C_2) Bench Marking of Values (C_3) Target Cost Profiling etc. Component D which represents “Removal of Waste and Disposing the same maintaining the categories during the Project Life Cycle” could be broken into (D_1) Types of Waste (D_2) Removal Plan (D_3) Recycle Plan etc, So, instead A,B,C,D we can derive more granular elements like A_1 .. A_5, B_1 ..to B_3,

C_1 .. to C_3 and D_1… to D_3 . Analysis of these using the same technique will provide more meaningful insight for the process of optimization.

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