Evaluation of Agile Construction in Managing Time Delays in the Bhutanese Construction Industry

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Abstract

This research study is carried out to find the ways to economize and improve the standard of the construction work using agile techniques. As projects become increasingly complicated, schedule delays are common and at times inevitable in construction. Those delays would ultimately result in reworks, cost overruns and legal claims. Hence, the initial motivation for this research is to explore a systematic flexibility to deal with delays caused by complex changes in construction and meanwhile to enhance the overall project performance. Since the agility and relevant theories are emerging techniques in construction, the proposed agile ideas and enablers are verified by qualitative interviews with construction professionals. With ultimate goal of reducing delays, a case study was conducted, investigating how much delays could be reduced if the agile enablers were implemented.

Key Words: *Agile, Enablers, Delay, Overrun, Flexibility.*

1. INTRODUCTION

A proper schedule is essential to the successful execution of construction projects, but completing projects on scheduled date is often hampered by inherent risk and uncertainty. Schedule delays are common and often cause considerable losses which include time and cost overruns, low quality and safety issues. Current construction is characterized with complicated and increasing uncertainties, resulting in more unpredictable delays.

This situation is partially due to the nature of design and construction processes adapted, which contain dynamic interactions among diverse parameters, such as project attributes, participant experience, cost, workers attitude and site condition constraints (Lee et al., 2006). There is a need for a flexible mechanism to facilitate project management that is more adaptive to delays.

When it comes to flexibility, the theory of agile software development and relevant methods shed light on handling unforeseen customer requirements, which improves products in the long run. What is more, service-oriented production principles have triggered a series of agile manufacturing theories to deal with rapid changes for increasing customization. Inspired from these ideas, this project presents the idea of agile construction management in the form of a conceptual framework.

To develop the conceptual framework, it was preceded with identifying types and sources of delays and agile techniques such as five agile enablers. Those findings are supported and validated through relevant qualitative and quantitative analysis.

2. METHODS

This research is carried out through the series of questionnaires and by the statistical analysis of data collected. The data is collected mainly to examine the relationships, pattern and trends in the data to develop conclusion about the research. The collection of data is done in two ways called as two-step research method. The two main data collection methods are quantitative and qualitative data collection. The qualitative data were collected through interviews and supplemented by conducting a follow-up case study.

2.1 Questionnaire Survey

The questionnaire was tested using pilot study. In this pilot study, field interviews were conducted to identify any missing variables and verified that the questions were clearly understood by the respondents. The questionnaire survey was carried out two times to gather the information and data required. The first questionnaire was formed to find the types of delays and their sources in the present construction firms. The second questionnaire was formed for the validation of agile enablers which helps in reduction of time delays in construction industry.

2.2 Method of Analysis

In the analysis method, relative index and Cronbach's Alpha Method was adopted to establish the relative importance of the causes and sources of delays and importance of agile construction in managing time delays in the Bhutanese Construction Industry. Likert's scale of five ordinal measures of agreement towards each statement (1, 2, 3, 4 and 5) is used to determine the relative ranking based on the collection of data.

2.3 Questionnaire Sampling

The sample formula used in calculating the sample number:

Sample size = $\frac{n}{1+\frac{n}{Ps}}$

Where n = Z $[2(\frac{p(1-p)}{D^2})]$, Where Ps = Population size

2.58 for 99%)

p = margin error level, D = difference of expected frequency and worst frequency.

Considering the confidence level 95% and precision level of ±10% sample number calculated was:

Table 1 Summary of Response of Questionnaire Survey

Respondents	No. of questionnaire distributed	No. of questionnaire received	Response Rate
Contractors	20	17	36.17%
Engineers	35	30	63.83%
Total	**55**	**47**	**100%**

3. RESULT

3.1 Awareness of Agile Construction

Figure 1 below shows the percentage of awareness of agile construction techniques among the contractors and engineers within the Bhutanese construction firms.

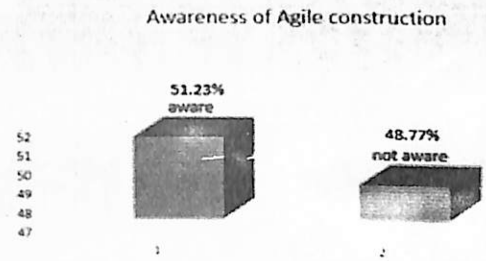
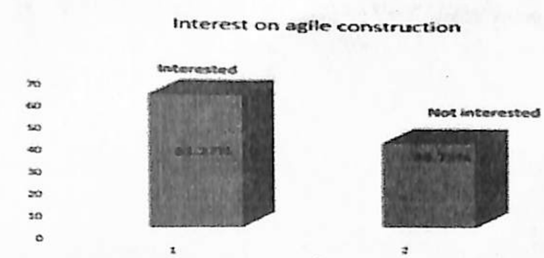


Figure 1: Awareness of Agile Construction

From the graph plotted, many contractors and engineers are still not aware of the agile technique. So, the incorporation of Agile Construction in Bhutanese Construction is useful for reduction of time delays.

3.2 Interest on Agile Construction

Figure 2 below shows the percentage of engineers and contractors who all are interested and not interested to know the technique of agile construction in the Bhutanese construction firms.



From the graph above, 61.27% of them are interested to know about applicability of agile construction. So, the technique is successful if it is practiced in a systematic way.

3.3 Types and Sources of Delays.

From the questionnaire survey which is done with contractors and site engineers the relevant data like types of delays and its sources are found out. The frequency of types of delays is tabulated and is represented in the graphical format, in order to compare the different types of delays in the construction industry in Bhutan.

Table 2 Types and sources of Delays

Sl. No.	Types of Delays	Rank
1	Cash flow and financial difficulties faced by contractors	21
2	Poor site management and supervision	18
3	Equipment availability and failure	17
4	Unforeseen ground conditio	16
5	Inflationary pressure	16
6	Labor productivity	17
7	Poor contract management	18
8	Delay in material procurement	19
9	Incompetent subcontractors	18
10	Inadequate Modern equipment	18

3.4 Sources of Delays

The sources of delays are identified and segregated through the various literature reviews and through the qualitative interviews. *The above mentioned sources of delays are presented in the form of graph below in Figure 3.*

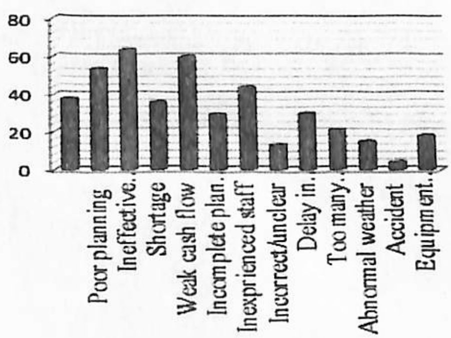


Figure 3 Sources of Delay

Cases	N	Percentage (%)
Valid	34	77.3%
Excluded	10	22.7%
Total	44	100%

In this research, for each mentioned delays their source of occurrence is found out and each of the ten types of delays are grouped under four main categories and they are as follows basically through the literature review:-

- Management Related.
- Resource Related.
- Information Related.
- Unforeseen Situation.

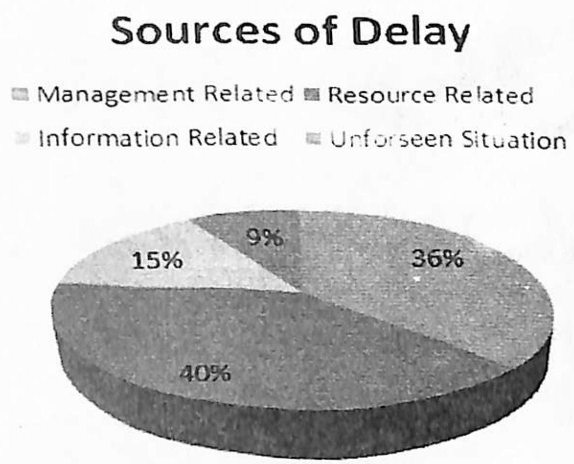


Figure 4 Sources of Delay

3.5 Reliability of Delays and its Sources

The reliability test is done to provide relationship between individual items in the scale. Each question was based on point system from "extremely significant" to "not significant at all" (Gliem & Rosemary, 2003).

From this research the value of RI is calculated as **0.49**. The value falls in the range of important and less important, which indicates that the questionnaire developed and surveyed to contractors and engineers were reliable.

Table 3 Data for Delay

Cases	N	Percentage (%)
Valid	34	77.3%
Excluded	10	22.7%
Total	44	100%

Cronbach's Alpha	No. of items.
α=0.95	10

From the above result the value of α is found to be 0.95 which indicates acceptable internal consistency and the data collected for the research is reliable.

Table 4 Data for Source

	N	Percentage (%)
Cases	13	100%
Valid	0	0%
Excluded	13	100%
Total	**13**	**100%**

Cronbach's Alpha	No. of items.
α=0.77	13

This source indicates good internal consistency and the data collected for finishing out the main source of delays for the research were reliable.

3.6 Validity test

Duration for developer = = $\sum_{i=1}^{n} Ti$ *[optimistic time] / work per time*

=17532/8=2191.5 hours

Duration for customer = = $\sum_{i=1}^{n} Ti$ *[*pessimistic Pessimistic time in the above graph shows the slack time value or free float time.

The graph indicates the time line of project. The project will follow optimistic pattern when all of *time] / work per time*

=180191/8=22523.8hours

Pessimistic time for each task *=(percent probability of delay *optimistic time)/100+optimistic time*

$= \left(\frac{938.45}{100} * 17532\right) + 17532 =$ 180191*hours*.=

Slack time for a task *= duration for customer - duration for developer*

=22523.8-2191.5=20332.4hours.

Time Uncertainty*= (slack/duration for developer)*100*

={556.24/2191.5}*100=25.38%

Total slack time*= (Total pessimistic time-Total optimistic time)/(Total working hour/days)*

= (180191-2191.5)/(8*40) = 556.24hours.

A graph can be drawn taking the optimistic time and pessimistic time values against each other, the bar graph and line graph both show the difference between both the values.

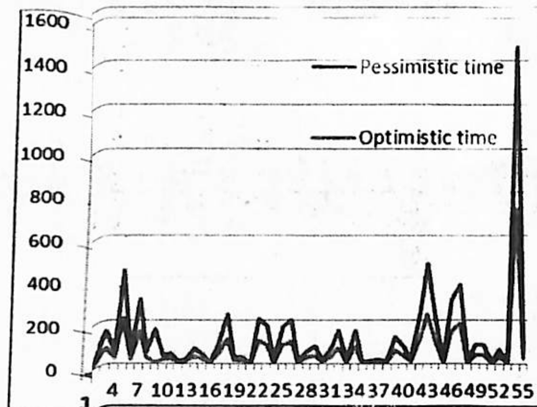


Figure 5 Differences between Optimistic and pessimistic Time

From the above graph it shows the variation between optimistic and pessimistic time. It is known that the optimistic time always lags behind the pessimistic time.

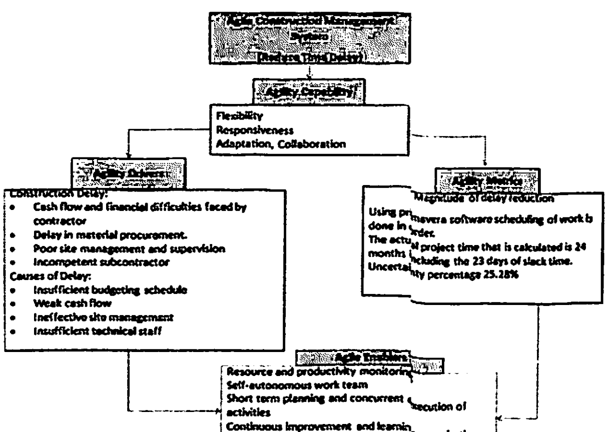
The differences between the optimistic and the project will follow optimistic pattern when all of the activities are completed without any delay or uncertainties. The project will flow pessimistic pattern when the project is to be completed with uncertainties in activities.

3. DISCUSSION

As the construction faces many delays due to various factor and issues, the many methods are also implemented to supplement those delays or to reduce the delay in the work. To deal with complex delay issues, existing literature results associated with delay causes identification and delay analysis techniques seem reactive instead of proactive.

Complex delays require a systematic thinking in a "big picture" that enhances the entire project performance. Even though the theory of agile project management and agile construction have been mentioned in construction-related studies, the effort is still sporadic and addresses general discussion on whether agility is suited to optimize the overall project performance in construction.

As a result, agile ideas are rarely used in dealing with a specific construction issues.



Frame work of Agile construction management system

In general, the framework is designed to bear three functions. These are:

The framework presents a path to pursue agility in a cause-effect manner.

The framework suggests methods (also known as "agility enablers") to become agile.

The framework provides a path to validate the proposed agile ideas, including all framework components.

When building components for the agile framework, this study particularly refers to existing results from agile manufacturing. Manufacturing has set an example for construction because of its dramatic improvements in productivity and in-depth customization. If each construction site is considered as a "temporary production line", the highly "standard production" may turn out to be the future trend of construction. Therefore, ideas inspired from agile manufacturing are incorporated in developing agility in construction.

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