How can managing change in construction projects improve productivity?[1]

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ABSTRACT

In construction industry, productivity as always been a challenge and change a constant. Correlation between these two elements is evidence. In term of change management, thousands of methods are used throughout the different construction companies, and these different methods achieved different results. The aim of this paper is by using tools as MADM and additive weighing technique to determine which is the most efficient method to manage change by limiting its impact on productivity. Based on the analysis, company needs a clear and precise communication which goes thru well defined and structured forms.

Key words: Change processes, Construction industry, Rework, Managing change, Overruns

INTRODUCTION

Construction is one of the largest industries worldwide. It has grown from US$7.4 trillion in 2010 to US$8.5 trillion in 2015 and with the expected growth in population, it is forecast that the volume of construction output will grow by 85%. This market is a real opportunity for contractors, but isn't has easy as it appears.

Even with a grow in activity this big, construction industry struggle to adopt and integrate new technologies, no major transformation has been undertaken leading in a stagnation of the productivity if not a decline. Changes correlation to productivity is to blame. Study shows that approximately 40% of construction projects encounter 10% of change. When change exceed 20% then productivity never achieve expected rates opposed as when change stays below 5%, productivity is always better than expected. This correlation between productivity and change also affects planning and budget. Productivity being linked to performance; a reduction of productivity could result in a delay in the planning and then a cost overrun to overtake this delay.

Illustrations of these phenomena are numerous; the recently built Kuala Lumpur International Airport 2 exceeded its target price by more than RM 2.3 Billion and opened three years behind schedule. The reason for it was new design concepts and a non-structured information flow

[1] *Editor's note: Student papers are authored by graduate or undergraduate students based on coursework at accredited universities or training programs. This paper was prepared as a deliverable for the course "International Contract Management" facilitated by Dr Paul D. Giammalvo of PT Mitratata Citragraha, Jakarta, Indonesia as an Adjunct Professor under contract to SKEMA Business School for the program Master of Science in Project and Programme Management and Business Development.* http://www.skema.edu/programmes/masters-of-science*. For more information on this global program (Lille and Paris in France; Belo Horizonte in Brazil), contact Dr Paul Gardiner, Global Programme Director* paul.gardiner@skema.edu*.*

compromising a clear change process. It is already difficult to achieve an on time, on budget and on scope construction project on Earth, you could imagine how went the construction project of the international space station. The project was first initiated in 1984 with a cost estimation of US$8 Billion. Uncontrolled revision and changes over the years propelled the budget to twelve times the first estimate and the station in schedule to be finished in 2018.

As Heraclitus, the Greek philosopher, once said: "change is the only constant in construction projects." Then change management becomes critical to every construction project.

STEP 1 - OBJECTIVE STATEMENT

This paper will discuss how to improve construction projects by answering to these questions:

- How to minimize impact from change order process on productivity?
- What does a change order form must contain?

METHODOLGY

STEP 2 - FEASIBLE ALTERNATIVES & ATTRIBUTES

Here are the feasible alternatives we selected:

1. Contract clause for change order
2. Automating the change order process
3. Design-build concept
4. Integration of a standard change order form

The attributes on what these alternatives will be compared are the following ones:

1. Feasibility: The facility of implementation
2. Cost: The cost of implementation
3. RCO: Represent the reduction of the number of change order
4. Level of effort: The effort needed for the implementation
5. PICM: Represent the positive impact on the change management

STEP 3 - DEVELOPMENT OF FEASIBLE ALTERNATIVES

Contract clause for change order

According to a study evaluating the efficiency of change management, it is shown form the interviewed people that it become essential to have a contract clause dedicated in the regulation of change order. More than that, this vital part of the contract can save you some time in court or legal problems. Change orders are commonly brought up due to a modification of the original design by the owner or due to an omission in the design. Change order clauses allow the owner and the contractor to set rules regarding the creation of change order, these rules can be beneficial as much for the owner as for the contractor. For example, the clause can stipulate: the owner require from the contractor that all change order must be under written form if the contractor want to be eligible for financial compensation regarding changes

in the work. This kind of clause gives the owner power and control over change, he can reject or approved changes in the scope. This eliminate surprises. Conversely, it can be interesting for the contractor to identify all the missing scope pieces then avoid being in conflict with the owner for not filling his part of the contract they both signed.

Automating the change order process

The idea of standardising issue and change order management processes is not new. The 21st century brought new innovations, among them numeric interfaces. From these interfaces are born project management software which over the years became a standard in more and more sectors. This kind of software procure a number of benefit among: Defining the workflow to enable each party to identify the origin of change orders, their role and to whom they need to transfer it. It also helps keep everyone up to date concerning dues dates by sending automatic reminder, and enable everyone the access to the same document by storing them in a centralize server. Finally, it can improve collaboration by giving access to changes orders from anywhere, people working in offices or on the field can access the same information as long as they have access to a computer or a smartphone.

Design-Build concept

Design-Build (DB) is a method in which only one entity works under a unique contract with the project owner to provide equally the design services than the construction ones. Only one company working from the conception design to the end of construction work. It is an alternative to the classic Design-Bid-Build (DBB) classic method. In DBB design phase and construction phase are clearly separated and often executed by two separated entities. The DB method as prove over the years than it often provides much greater results than the classic DBB method. Working with a DB Team enable to transform conflict between owner and contractors in a alliance where nobody will try to take advantage over the other. Changes are corrected by the DB Team instead of being used as excuses.

Integration of a standard change order form

Even if this can seem trivial, numerous construction project that are not using standardised from for change orders still exist. We will take the example of contract form used in Turkish public biddings und the name KIK. Not using standardised forms unnecessarily extend the treatment duration of change orders. Moreover, use of standard forms enable you to store them according to the type of change they are referencing to (change on the project scope, unforeseen conditions, or error/omissions). To order and store correctly and efficiently these change orders will permit a better daily change management. Here are the four crucial elements of a change order form:

1. Description of the change that is requested

The change needs to be fully described and compare to what was originally agree in the original contract or bid.

2. Documentation of the cost of the change

The contractor needs to document the costs related to the additional work, including the price of any subcontractor if necessary.

3. Contract edition based on the requested change and impact on project's end date

This part of the form officialised the change and inform on the eventual delay if there is some.

4. Date and signature by all the affected parties.

All affected parties need to sign. This includes owner, contractors, subcontractor, construction lender, surety company and any other party affected by the change. To avoid taking unnecessary risks, it is advised to use already existing forms that have already proven their efficiency. We will take the examples of AIA or FIDIC forms.

STEP 4 - SELECTION CRITERIA

We will conduct our comparison analysis of our four feasible alternatives using the five attribute we already selected. We will select the best alternative regarding their respective score. We use a Multi Attribute Decision Making (MADM) Process, the more the colour is orange, the more the score is positive opposed to the more the colour is red the more the score is negative. We will use these relative options: Very Low, Low, Medium, High, Very High. We will only accept proposals that have more than one green case. That already eliminates « Automating the change order process ».

Table 1 - Multi Attribute Decision Matrix

MADM	Contract clause for change order	Automating the change order process	Design-build concept	Integration of a standard change order form
Feasibility	Very High	Medium	Medium	Very High
Cost	Low	High	Medium	Very Low
RCO	Very Low	Very Low	Very High	Low
Level of effort	Low	High	High	Medium
PICM	Low	Very High	High	High

FINDINGS

STEP 5 - ANALYSIS AND COMPARISON OF THE ALTERNATIVES

To be able to use compensatory models, we need to represent our feasible alternatives in a quantitative manner. We will start by transforming relative options (Very High, High, Medium, Low, Very Low) in dimensionless values.

Table 2 - relative options to dimensionless values

Relative options \ Attribut	Feasibility	Cost	RCO	Level of effort	PICM
Very High	1	0	1	0	1
High	0.7	0.2	0.8	0.2	0.8
Medium	0.5	0.5	0.5	0.5	0.5
Low	0.2	0.7	0.3	0.8	0.3
Ver Low	0	1	0.1	1	0.1

Now we will use these dimensionless values to create a "relative weighting". It is a scoring model of each alternative.

Table 3 - relative weighting

Attributes \ Feasible alternative	Contract clause for change order	Design-build concept	Integration of a standard change order form
Feasibility	1	0.5	1
Cost	0.7	0.5	1
RCO	0	1	0.3
Level of effort	0.8	0.2	0.5
PICM	0.3	0.8	0.8
TOTAL	**2.8**	**3**	**3.6**

Finally, it is by using an "additive weighing technique" that we conclude our analysis. In the additive weighting technique, attributes are ranked by importance. The sum of each alternative is compared to the normalized weight (1.0) which is the maximum score to have. The attributes are ranked by importance in the following order: PICM > Cost > Feasibility > RCO > Level of effort.

Table 4 - additive weighing technique

Attributes	Weight	Normalized weight	Contract clause for change order		Design-Build concept		Integration of a standard change order form	
Feasibility	3	0.20	1	0.20	0.5	0.10	1	0.20
Cost	4	0.27	0.7	0.19	0.5	0.13	1	0.27
RCO	2	0.13	0	0	1	0.13	0.3	0.04
Level of effort	1	0.07	0.8	0.05	0.2	0.01	0.5	0.03
PICM	5	0.33	0.3	0.10	0.8	0.27	0.8	0.27
TOTAL	15	1	**TOT**	0.54	**TOT**	0.65	**TOT**	0.81

STEP 6 – RAKING AND SELECTION OF PREFERRED ALTERNATIVE

The relative weighting table gives a clear ranking from the best to the worst feasible alternatives. The more efficient solution would then be: the **integration of a standard change order form**. It is the first choice by 120% compare to using a design-build concept, which itself is 107% better than the contract clause for change order. In the relative weighting, even if we can see a ranking emerging, the gaps between the different scores are not very important. The ranking clearly confirms itself after the Additive weighting technique, where we can see that the **integration of a standard change order form** is up front with 0.81.

Ranking from the best the worst alternative:

Integration of a standard change order form; Design-Build concept; Contract clause for change order.

STEP 7 - PERFORMANCE MONITORING POST EVALUATION RESULTS

This analysis has been performed to find suitable solution to how minimize the impact of change on the productivity in construction projects. This needs to be a long-term analysis as construction projects are known to take time. We have made assumptions that productivity can be seen as the resultant of a good change management and a low number of change orders.

To monitor the performance, the users must have Key Performance Indicators (KPI) which can include: Number of change orders, processing time of a change order, delays caused by change orders, cost overrun caused by change orders etc. If the owner works on different construction projects, a Pareto analysis can be made, comparing the same KPI form one project to another with the preferred feasible alternatives

CONCLUSIONS

This paper had the goal of answering the following questions:

- How to minimize impact from change order process on productivity?

There is not magical recipe when it comes to productivity, for the simple reason is that difficult to control the human factor. However, what is certain, is that a company should not only use one method, but must have a strategy towards productivity. This paper compared three feasible alternatives and determined which one would have the best effect but it is important to keep in mind that all the feasible alternatives discussed in this paper can be implemented on the same construction project. Therefore, the impact from change on productivity would be minimize.

- What does a change order form must contain?

A change order form can contain a lot of information depending on the nature of the change or on the type of project. Therefore, most of the information is changing from a form to another.

However, there is a core for the change order and it is composed of these four elements:

1. Description of the change that is requested
2. Documentation of the cost of the change
3. Contract edition based on the requested change and impact on project's end date
4. Date and signature by all the affected parties.

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Ferdinand Huc is a pupil from Toulon, in the south of France. From a navy dad, he has lived in his youth 2 years in New-Caledonia before moving to Belgium at 11 years old, where he lived 10 years attending the French Lycée of Brussels. In 2011 Ferdinand integrated after succeeding the entry exam the Navy lycée in Brest, at a boarding school, where he stayed only a year before going back to Brussels. After graduating high school in 2013 he decided to start his engineer study back in France, in Lille. He integrated a formation of the Ecole Centrale Lille named ITEEM where engineering is mixed up with business management and entrepreneurship. As a part of his study, Ferdinand spent 8 months in New-Zealand for some internships. Now in his final year of study, Ferdinand specialized himself in Production System Management on the engineering side and choose to do at the same time a MSc in project management and business development at SKEMA. Graduating in April 2018, he is now looking for new opportunities. Ferdinand can be contacted at: ferdinand.hdv@gmail.com.